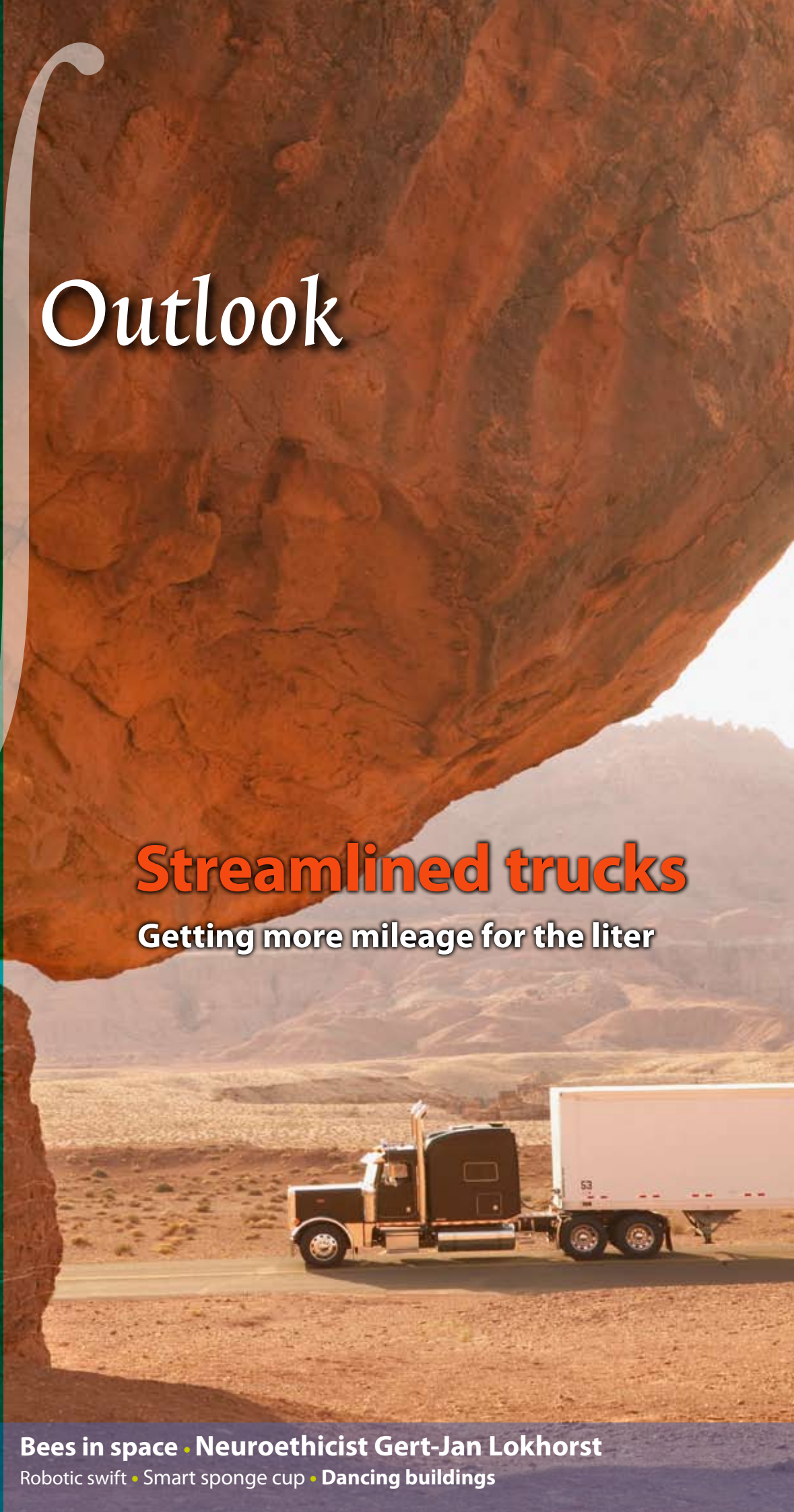
2007.2

Research and education at
Delft University of Technology

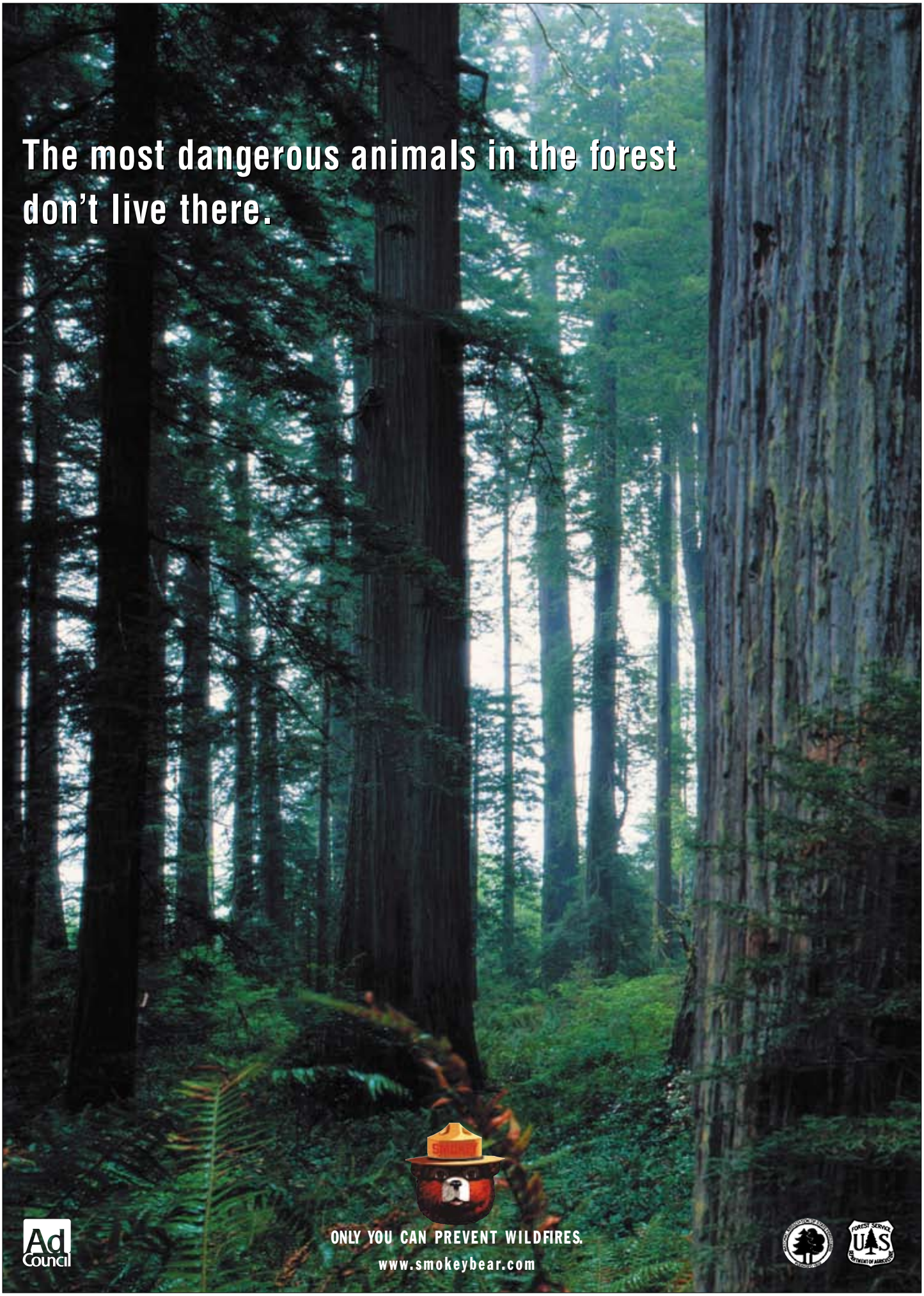
# Delft Outlook



## Streamlined trucks

Getting more mileage for the liter

**Bees in space** • **Neuroethicist Gert-Jan Lokhorst**
Robotic swift • Smart sponge cup • **Dancing buildings**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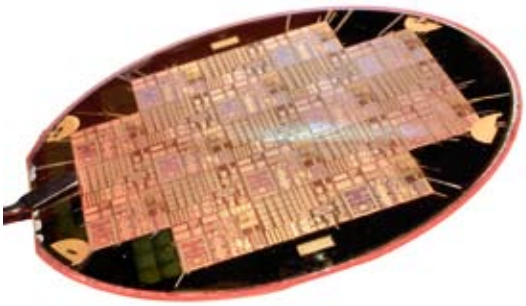

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Delft Outlook

## [Edit]DO

When an innovative new idea reaches the developmental stage, it's often impossible to predict if it will one day make history. Take for example the futuristic design that students at the Faculty of Aerospace Engineering want to apply to trucks. If it is up to these young researchers, the truck's design will resemble that of the pointy, tapered bicycle helmets that cyclists wear during time-trials. Such a design could cut fuel consumption in half. But along the way, will such a design ultimately prove realistic in practice?

Or consider the chip made of glass, with which researchers Lis Nanver and Leo de Vreede hope to cause a revolution in microelectronics. Thanks to this integrated glass circuit, mobile phones - which are now full of messy compromises - will soon be really efficient and multidimensional. Will this become the standard for the electronics industry someday?

And even if a design does make a breakthrough, it's still doubtful whether its inventor will make history along with it. As was the case with hydraulic engineering expert Johan Ringers, a man that history would've forgotten if Tessel Pollmann hadn't written an impressive biography about him forty years after his death.

Frans Godfroy,
*Editor-in-Chief*

# COLOPHON

**coverphoto**

Photo: Walter Hodges/ANP

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# Mommy speaks

Industrial design student Helma van Rijn has designed a 'linkx' toy that enables autistic children to play while at the same time learning words. Parents can attach labels to objects, say a bicycle, and use it to record their voice speaking the name of the object. When the child holds a playing brick in front of the label, it will hear the familiar voice of mummy or daddy telling him or her what the object is called.

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Photo: Helma van Rijn

# Smart sponge cup

Photo: Hans Stakelbeek

Drinking while running at the same time is not easy. So, TU Delft industrial designer and sports buff Alberto Ruiz Luca de Tena came up with a cup that has a sponge for a cover. The cups were used for this year's edition of the Rotterdam marathon on 13 April, an event that eventually had to be cancelled due to the extreme heat. Normally runners are handed cardboard cups which spill more water on the ground than is left for the athletes to drink. The sponge on the innovative cardboard cup invented by Ruiz Luca de Tena prevents the spillage. In addition the sponge enables the runners to drink calmly and steadily.

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# Space bees

Aerospace Engineering student Wouter van der Geur, together with RMIT University in Melbourne, Australia, is trying to find out if bees can help to produce food on long space missions. A return trip to Mars for example, will take about nine hundred days, Van der Geur estimates. If astronauts are to have enough to eat during all that time, the entire spacecraft would have to be crammed full of food. As an alternative, space travellers could grow their own vegetables and fruit in space. That is, provided bees can fly in space and pollinate flowers.
Later this year the first batch of ten bees will be travelling to the International Space Station (ISS) to see whether they can land on an artificial flower in zero gravity conditions. As part of his graduation assignment, Van der Geur is developing a method to detect and analyse the movements of the bees. British scientists have done previous research, using radar to track bees with aerials attached to their backs. Video analysis will be better suited to the cramped conditions inside the small space greenhouse, Van der Geur thinks.

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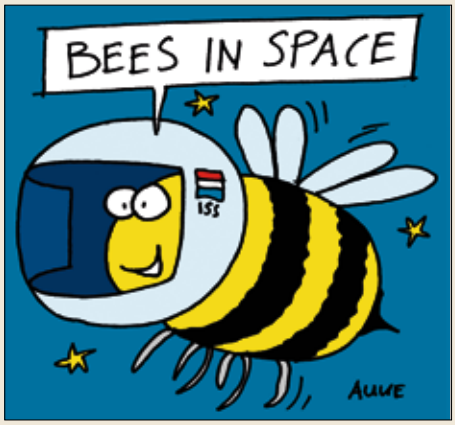
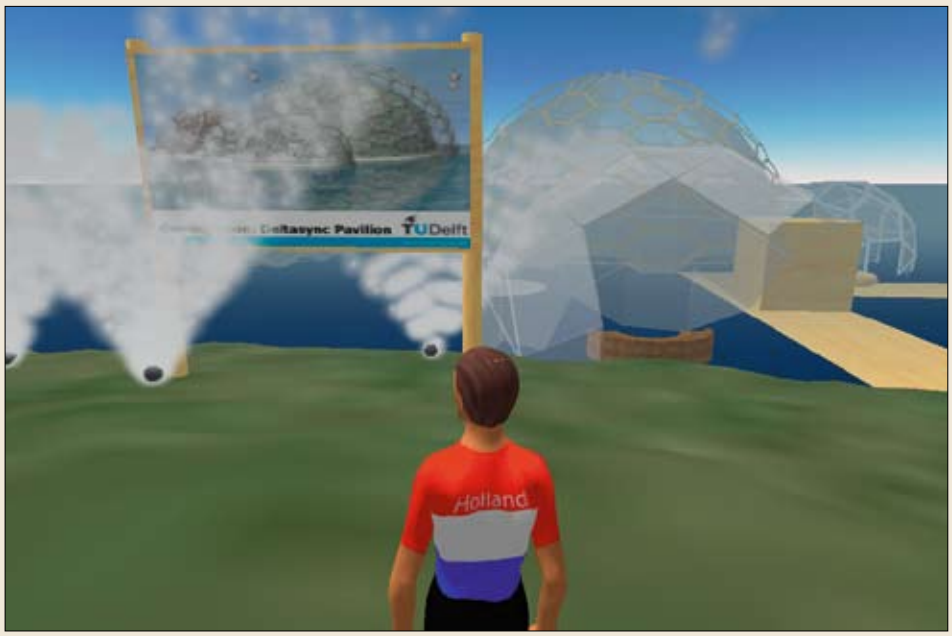



Illustration: Auke Herrema

# TU Delft's Second Life




**A visitor to the virtual world of Second Life will soon be able to see a floating city sporting the Delft University of Technology logo.**

Whereas until recently virtual worlds were associated mainly with entertainment, the focus has been shifting to more serious applications. Dr Igor Mayer of the faculty of Technology, Policy, and Management thought it was about time that TU Delft made its presence felt in the virtual world. "Second Life offers a brilliant platform for presenting Delft designs and inventions," says the researcher, who is also one of the project leaders. "You might soon be able to take a spin round the campus in the Wasub submarine, or fly the power-generating kites of Professor Ockels."
A team of Delft researchers are currently working on two islands, as the plots of virtual land are known in the jargon of Second Life. One of the islands will be called Next Generation Infrastructures. When it is finished, researchers can go there to experiment with new interactive communication techniques. The island was named after a national research programme of the same name which focuses on new knowledge infrastructures and in which the TU is participating.
The other island will be turned into a revolutionary campus surrounded by virtual water, which is a first in Second Life. Hydraulic engineer Ir. Rutger de Graaf of the faculty of Civil Engineering and Geosciences intends to construct a floating building on it.

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# Branded at Industrial Design

Blue. That is the new brand name to be launched by the Industrial Design department. The products, which include a chess set, a lamp, and a vase, will be on sale in the TU Delft shop starting in late June.
Design lecturer Ger Bruens decided to launch the brand because he saw many good designs by students end up in a drawer. "We often stimulate students to find a manufacturer to produce their design, but this is not so easy for fledgling designers," Bruens says.

More information:
www.blue.tudelft.nl.

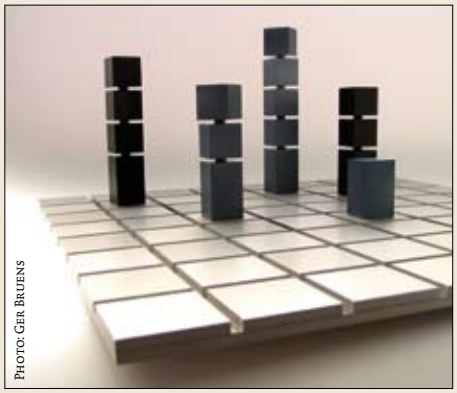
Photo: Ger Bruens

# Elephant yeast conquers energy market

**Ethanol manufacturer Nedalco will soon be using a fermentation technique developed by microbiologists Professor Dr Jack Pronk and Professor Dr Hans van Dijken (Applied Physics) to produce environmentally friendly biofuels on a large scale.**

The company intends to produce 200 million litres of bioethanol a year by the end of 2008, in a plant to be built in the Dutch province of Zeeland. The fuel produced is a so-called second-generation biofuel. Currently most ethanol is produced from maize, corn, sugar beet, and sugar cane. Baking yeast is used to convert the C6 sugars contained by the produce into ethanol. In second-generation ethanol production, the C5 sugars or woody sugars, which are difficult to break down, are also converted into ethanol. Until recently baking yeast could not perform this conversion. Some years ago, however, a microbiologist at Nijmegen University discovered a type of yeast in elephant dung that could convert these sugars. Pronk and Van Dijken transferred the genes controlling the process to baking yeast thus enabling the yeast to do the job. In the past few years the two Delft researchers have improved the genetically modified yeast by selecting the best-performing yeast from successive generations.
The new yeast is also capable of processing such waste products as pulp from maize, corn, sugar beet, and sugar cane, as well as woody vegetation such as straw. "The production per hectare of agricultural land can be doubled using this technology," Pronk said in an interview with De Volkskrant daily paper.
TUD, Nedalco, and Bird Engineering consultants have now set up a joint venture to exploit the invention. They can look forward to a high demand for biofuels in the next years. According to European guidelines, in 2010 5.75% of all petrol must be biofuel, and the European Commission intends to raise the biofuel content to 10% by 2020. The construction of the plant will cost Nedalco 150 million euros. The company hopes to raise a government grant, since the cabinet has earmarked 60 million euros to stimulate innovations in the field of biofuels.

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# Spy birds

**As their bachelor degree assignment, TU Delft students have designed a robotic swift. The idea is that it should soon be impossible to tell the difference between 'Roboswift' and a real bird.**

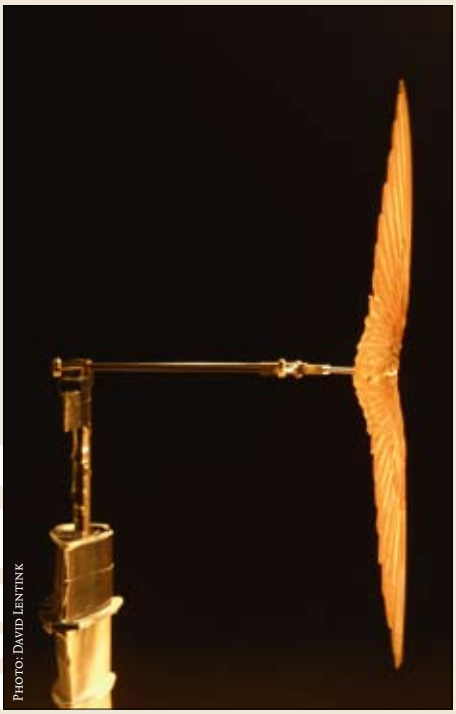

Photo: David Lentink

Design a radio-controlled aircraft with extendable wings that flies like a swift. This was the assignment that nine bachelor students of the faculty of Aerospace Engineering were given by Wageningen University biologist and TU Delft aerospace engineer David Lentink.
The originator of Roboswift, as the device is to be known, recently made the cover of Nature magazine with his research into the aerodynamics of the swift's wings. By constantly adapting their wings when manoeuvring in flight the birds can improve their flight performance by up to three times, as was discovered from the research he conducted with colleagues from Wageningen, Delft, and Lund (Sweden).
By tweaking the wings in the same manner, Roboswift is likewise to be made into a formidable flier. "And," Lentink says, "since the plane will ultimately look like a real swift, it will be ideal for use as a spy platform, or to observe birds."
The student's mission is comparable to the one the engineer came up with two years ago, when ten students used his research results into the aerodynamics of insects to design the flapping-wing Delfly plane.

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# Doused in style

**A trendy fire-extinguisher and a fire curtain. Two TU Delft students won a design competition for fire-preventing products.**

People often think fire extinguishers detract from their interior design, or that the things are simply in the way. "As a result, the thing gets put away inside a drawer, where it will be of little use. Before you can get to it in the event of a fire, it might be too late," says sixth-year industrial design student Maarten Heijltjes. Together with co-student Sanne Pelgrom he came up with a solution to the problem, a designer fire extinguisher, which they entered in the 'Mooi uit the Brand' (doused in style) design competition.
The competition was an initiative of the Verbond of Verzekeraars, the Association of Insurers in the Netherlands.
In addition to the slimline fire extinguisher, the two students designed a new fire blanket. The fire curtain hangs behind the normal curtain, protruding roughly ten centimetres on either side. "That way it will always be visible, so people will always be able to find the blanket in the event of a fire."

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Photo: Sanne Pelgrom en Maarten Heijltjes

# Graduation projects at Spyker

**TU Delft and Spyker plan to collaborate on the design of a Dutch Formula 1 race car.**

The headquarters of the Dutch Spyker Formula 1 racing team is located right next to the Silverstone racetrack. Last year, Director Michiel Mol approached TU Delft with an idea for collaborating on the development of the 'Oranje' (Orange) racecar.
Professor Adriaan Beukers, of TU Delft's Faculty of Aerospace Engineering, found this a good idea, and in early May he and his fellow researchers travelled to Silverstone. "For graduating students, solving problems associated with a race car is a very attractive proposition," Beukers says.
Spyker's technical director, James Key, also liked the idea. "The technical specifications for race cars are constantly changing. This is a nightmare for us, because Spyker is a small team and we don't always have enough people to make these changes quickly," Key explains. 'Only' three hundred people work on the race car before the team's drivers, Christijan Albers and Adrian Sutil, race with the car. "Our facilities are also relatively small compared to our competitors," Key adds. "Working with TU Delft would therefore be very beneficial for us."


Photo: Spyker

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# Delft 'Super village' in Tanzania

**The village of Makanya in Northern Tanzania should changed into a sustainable 'super village', a testing ground for Delft research projects in the fields of sustainable accommodation, agriculture, and energy.**

PHOTO: TOMAS VAN DIJK

The village of Makanya in Northern Tanzania should changed into a sustainable 'super village', a testing ground for Delft research projects in the fields of sustainable accommodation, agriculture, and energy.
During the anniversary lecture on sustainable development in November Prof Dr Ir. Huub Savenije will put forward a proposal to his colleagues to transform the village into a kind of field laboratory for sustainable development.
"I'm not saying that we can solve the problems they have, but at least we can help, and the research opportunities are fantastic. In fact, the latter is the basis for the proposal. TU Delft cannot be a proponent of sustainable development and then stop at organising a conference. That would be hollow rhetoric."
Savenije thinks that Makanya (pop. 6,000) is the ideal place to achieve the university's ambitions, since it has a main airport nearby with direct flights to Amsterdam. For some years now the village has been the jumping-off point for a team of predominantly Delft researchers, who are mapping the water streams in the surrounding hills. They are trying to determine how the local farmers could use the water, of which there is precious little, more efficiently, e.g. by enhancing the permeability of the soil and improving the irrigation systems. Savenije's team has got to know quite a few people, some of whom speak English. The Tanzanian partner of the Delft team, Sokoine Agricultural University, has close ties with the village elders. According to Savenije technological challenges abound in and around the village, which is surrounded by an enormous plantation where sisal grows. As far as the eye can see, the tall flower stalks of the agaves point several metres into the sky. The fibrous leaves of the plant are used to make rope, and the stakes make rather unsturdy fencing. "But perhaps the stakes could be turned into windmills," Savenije says. "I don't think anyone has tried yet."

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IN·BRIEF

# New knowledge about old Apollo

**The last Apollo space capsule is being tested in the wind tunnel of the Aerospace Engineering (AE) faculty. The newly gained knowledge will be used to improve the Apollo spacecraft for future moon landings.**

The United States intends to launch another manned space mission to the moon in 2011. The crew exploration vehicle will be a larger and improved version of the Apollo spacecraft, the first of which was launched forty years ago. A research group at AE has prepared a project plan for research into the airflow around the vehicle during its return to earth.
The project is being carried out at the NATO Research and Technology Organisation (RTO), which seeks to further the exchange of research and knowledge between NATO countries. For the Apollo research project AE is working with the American space administration NASA, and the European Aeronautic Defence and Space Company research institute, among others. NASA is not the only ones to profit from this research, says AE lecturer and project coordinator Louis Walpot.
"The knowledge about airflows will also benefit the European Exomars project, which involves the design of a vehicle for Mars landings."A total of seventeen Apollo missions were launched between 1967 and 1972, eleven of which included moon landings. The United States later launched space shuttles, which return to earth glider-fashion and can be reused. "The problem is that the heat-resistant layer protecting the shuttle during re-entry often sustains damage, calling for costly repairs," says Ir. Ferry Schrijer, a member of the research group. "The Soyuz capsule system, which the Russians have been using for a long time, but which cannot be reused, is much cheaper." So, the Americans went back to their old recipe, the space capsule.It is the return to earth of the cone-shaped vehicle that is of particular interest. The capsule re-enters the atmosphere at a speed of mach 20, i.e. twenty times the speed of sound. "The drag of the air slows it down, so it can land safely." The problem is that the air causes friction, heating up the capsule. The material protecting the Apollo from the heat covered the entire capsule, including the rear end.
Schrijer: "We might not need so much protection on the back. We want to reduce the mass as much as possible. Getting one pound of weight into space requires fifty to sixty pounds of fuel."
To better assess the need for a thick protective layer on the rear of the capsule, Schrijer and his research group are going to measure how the air flows along the rear of the spacecraft, and how hot various spots on the capsule will get. This summer they will be testing a scale model in the supersonic and hypersonic wind tunnels, in which wind speeds of mach 2 and mach 7 can be achieved. Schrijer: "We want to find out at which point the nice laminar airflow turns into chaotic turbulence."

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# Shaping up blunt bodies

## *Aerodynamic tail improves lorry fuel economy*

**Lorries are great for transporting goods, but their inferior aerodynamics means they get fewer kilometers a liter of fuel. Bad news indeed for the environment, and for hauliers' purses. But according to researchers at Delft University of Technology, cones and wings attached to the rear end along with technical tricks suspended under the vehicle could reduce fuel consumption by up to fifteen percent.**

Maaike Muller


Photos: Sam Rentmeester/FMAX

"Well, here it is, our witch's hat." Wearing a dustcoat many sizes too large, Gandert van Raemdonck, a doctorate student at the Faculty of Aerospace Technology, walks up to a shiny white lorry. The giant shed at the Kees Mulder coach-building company in Katwijk houses many more lorries, but this one stands out with its cone-shaped rear end. On the back of the lorry, four sections of plastic sheet have been attached to form a kind of pyramid with its apex missing. This boat tail structure improves the aerodynamic properties of the vehicle, reducing its fuel consumption by as much as ten percent. This was the conclusion Aerospace student Ronald Assen drew from computer calculations and wind tunnel tests.

*'We still don't know how the airflow along the trailer interacts with the size of the wake and the energy of the vortices'*

Van Raemdonck's small team of researchers are investigating airflows on lorries, and together with transport companies and coach builders are looking for ways to improve the aerodynamic properties of these vehicles. Lorries provide ample scope for innovation. With their rectangular shape, known as blunt bodies to the experts, they are never going to win any prizes for aerodynamic design. The researchers are hoping to find a solution that will reduce the fuel consumption of lorries by fifteen percent.
The front end has already been taken care of. Walking along the lorry, Van Raemdonck points out the modifications that make the front end more aerodynamic. He calls our attention to the rounded corners and the vehicle's rear-view mirrors. "This lorry also has a roof wind guide to provide a more gradual transition between the cab and the trailer." The purpose of it all is to make the lorry smoother in order to enable air to flow more easily around it. "It's rather like an airplane wing; you don't want to bang a nail into that either, not unless you want to create all kinds of strange vortices."

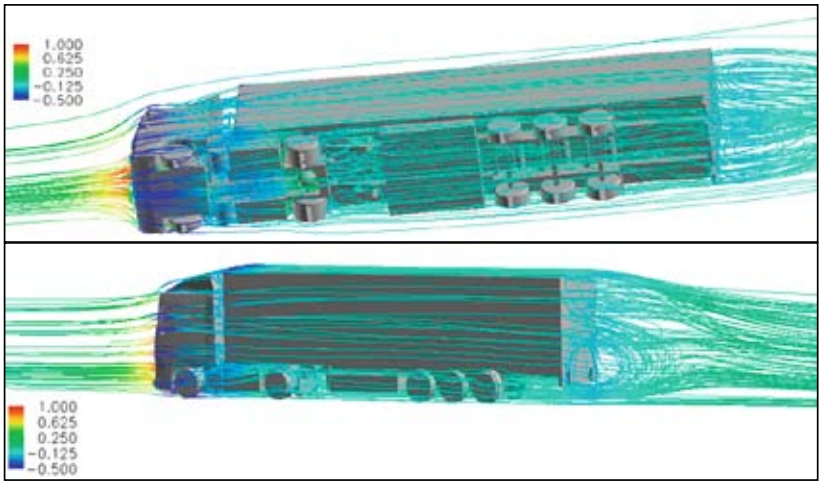
## Rear end

Such vortices are also created at the rear end of a lorry. According to De Vlaming and his supervisor, Michel van Tooren, this is why there is more to be gained by improving the rear end rather than the front.
"Aerodynamic guides on the back can reduce drag by about twenty-five percent on an average, representative trip through the Netherlands. For large distances with more constant speed, the reduction will be even greater," says Van Tooren.
A large part of the drag to which a lorry is subjected, is caused by its wake. At the rear, at the point where the vehicle has just gone past, a vacuum is created for a short while. Air rapidly flows back to fill the void, and the result is that two counter-rotating vortices are created behind the moving vehicle as well as any number of chaotic airflows around them. Thus within the lorry's wake there is a low-pressure zone holding the lorry back as it were. This effect increases as the lorry moves faster.
"The more we can reduce the wake, the better," Van Raemdonck says. He searched through patents and publications of the past hundred years looking for ways to reduce the wake. All the devices he found worked by helping the air that flows along the sides of the moving trailer to fill the vacuum behind it as quickly as possible. The airflow cannot negotiate the sharp angle at the transition from the trailer's side to the rear end. The cone-shaped boat tail helps the air to flow more evenly. "It works on the same principle as the pointed rear end of a cycling helmet," Van Raemdonck explains.

## Blowpipes

In another application discovered by Van Raemdonck the airflow is helped around the square edges by adding air. The rear end of the trailer is fitted with a kind of frame with rounded edges. Extra air is blown from tubes to pull the airflow around these edges. Van Raemdonck is very fond of this solution. "It is an active system, so it can always be adapted." Instability in the wake for example, can cause the trailer to rock from side to side, so the lorry driver constantly needs to correct its course to keep a straight line. Adding more or less air could possibly cancel the instability. To what extent this Coanda effect could reduce the wake is something that Van Raemdonck intends to investigate. From the United States comes news of varying results. In wind tunnel tests drag was reduced by half but road tests yielded greatly inferior results.
As an Aerospace Engineering graduate student, Marius van Straaten did research on an old solution to make lorries more aerodynamic. He rejuvenated a concept invented in 1933 by Frei, a researcher at the Danzig Polytechnic, in which the air that is left wandering in the wake of the trailer is captured by metal slats and pushed inwards. Van Straaten tested these wings in the wind tunnel and did some computer calculations on them. The results were an estimated improvement in fuel economy of approximately ten percent. Van Raemdonck: "Who knows, I might just develop an enlightened new idea during my research. Not knowing which method is best makes it all very exciting."
In spite of computer calculations and extensive wind tunnel experiments and road testing, the most effective way of reducing drag still eludes the researchers. Intuition plays a major part in their designs, for example when determining the angle of the boat tail. If the test results fall short of expectations, the researchers change the angle and test again to look for any improvement. Van Raemdonck thinks that more knowledge about the airflow around a lorry will be needed to improve design methods. ▸▸

*Researchers design mostly by intuition*




Gandert van Raemdonck aims to gain greater insights into how airflows stream along a truck when it is driving. He uses *computational fluid dynamics* to model the airflows of the truck. The computer program allows him to turn the truck in such a way that he can study it from all sides.

### Like a washing machine

In fact, there should be a stamp of approval for lorries, is what Professor Michel van Tooren thinks. There should be a label to indicate how aerodynamic a lorry is. A vehicle with protruding air horns and spotlights would end up in the lowest category, while a smooth vehicle with rounded corners and other means of reducing drag would be classified as 'good'. "Just like the labels for washing machines that indicate how much electricity and water they use," says Van Tooren. It will be a long while yet before such a label is introduced, if ever. First, a method must be devised to measure how aerodynamic each type of vehicle is. "And of course, the hauliers must support the idea."

### The numbers

Fifteen percent less fuel consumption sounds great, but even if the Aerospace Engineering researchers can manage that, what's in it for the haulier? Gandert van Raemdonck does the sums on a piece of paper. Suppose a lorry travels 250,000 kilometres a year, and does three kilometres to a litre of fuel. Each year, it would use 83,000 litres of diesel. If a litre of diesel costs one euro, reducing the fuel consumption by five percent would save four thousand euros per lorry per year. A reduction of fifteen percent would save twelve thousand euros per lorry in a year.

"Although this subject has been researched in the United States, we still don't understand how exactly the air flowing around the trailer interacts with the size of the wake and the energy of the vortices in it."
Van Raemdonck intends to unravel the mystery by doing some fundamental research in addition to his experiments. Using a scale model and old as well as new measuring techniques in the low-speed wind tunnel, he hopes to gain enough insight into the airflows to enable researchers to use computers to come up with improved solutions. Soon Van Raemdonck and other researchers will be able to start their road tests with improved designs.

### Flesh and blood driver

The real testing ground, of course, is on the road with a flesh and blood lorry driver coaxing a real lorry though the wind and rain. Although his fundamental research isn't finished yet, Van Raemdonck is already preparing himself for the first real-life test drives on the road. The rear end of the white Scania lorry has been fitted with a boat tail, and now the vehicle, which is used to train lorry drivers to drive fuel-efficiently, makes the same trip around the town of Barneveld twice a day. These trips are all identical so they can be readily compared. In fact, Van Raemdonck would have preferred it if the lorry had been used for regular long-distance trips from Amsterdam to the south of Italy. "Long-distance driving at constant speed offers much greater fuel economy benefits than short trips around town."
Whatever the case may be, the boat-tailed lorry won't be on the road yet, as Van Raemdonck failed to obtain the required permission for the test vehicle from the RDW, the Dutch vehicle certification authority. Mechanic Jeffrey van Rijswijk found it hard to believe when he was told he would have to remove his creation the next day. He had spent two days putting the boat tail together, and he had some difficult moments. "The top sheet in particular was hard to fit, and I had to use a cherry-picker to reach the spot." He managed to complete the job in time, but without the prerequisite permits there is no way the boat-tail lorry will be allowed out on the road. "It's a great shame we have to dismantle the thing," Van Raemdonck says, "But the truck is in almost constant use. I just wanted to put the boat tail together to make sure we could fit it in a couple of hours once the permit comes through."
Dutch legislation stipulates a maximum length for vehicles. An articulated lorry must not exceed 16.5 metres. Hauliers want to use as much of the permitted length

*The lorry does the same trip around Barneveld twice a day. This helps in the research because the trips are then easier to compare*

as possible to carry goods in. “This is why our lorries are always snub-nosed,” says Aerospace Engineering Professor Michel van Tooren. “In the United States lorries have more aerodynamic cabs, with pointed snouts.” And road testing with the boat tail is allowed in the States.

## Safety

“The boat tail extends a few metres behind the trailer, and presents a safety problem as well as one of length,” says Allert van Meurs, who works at the RDW. “Normally, a car colliding with the rear of a lorry would be stopped by a crash bar. But the boat tail doesn’t have one so a car crashing into the back could slide underneath.” Van Raemdonck is currently looking for a way to satisfy the regulations while still managing to innovate the lorry. Meanwhile the test lorry will soon take to the road without its boat tail, but with an advanced measuring system. This system, which was developed by the researcher himself, records ‘practically everything’, from wind direction and wind speed to vehicle speed and fuel consumption. “This will provide us with a baseline measurement, i.e. the fuel consumption under various conditions without aerodynamic features. When the vehicle with the boat tail can go on the road, we will have a clear record of the improved fuel economy,” says Van Raemdonck, who is busy installing his data acquisition system inside the vehicle’s cab.

*‘A car could shoot straight underneath the boat tail on impact’*

A short while beforehand he had been lying prone on top of the lorry to install an anemometer. And once the cone is removed from the back, he will start mucking about with resin and synthetic fibres. He points up to a small platform three metres above the ground, screened off by a slender chain. “That is going to be my laboratory.”

Last year, Van Raemdonck developed a method of reducing drag on lorries without contravening the law. His substructure fits below rather than behind the vehicle, and channels the air that currently blows all over the place. “Aerodynamically speaking, the underside of a lorry is a mess. My research also provides solutions to that problem.” As he is currently working on a patent application, he cannot divulge any details. Even so, wind tunnel tests have demonstrated that the relatively simple solution will improve fuel economy by five to nine percent. “Perhaps even more, if I manage to improve the shape. However, I’m not selling daydreams, so I want to test the system on the road first.”

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### Turn them into trains

Better aerodynamics aren’t the only way of improving a lorry’s fuel economy. A lot of fuel is used to simply keep the engine running. It takes a lot of energy to overcome the friction of mechanical parts inside the engine and gearbox. An efficient engine can save a lot of fuel. The road drag of the vehicle’s wheels must also be overcome. Reducing a lorry’s weight would be one option. Researchers at the Aerospace Engineering department have developed the ‘Cold Feather’, a refrigerated trailer for transporting flowers and vegetables. The weight of the Cold Feather has been made ‘as light as a feather’ by removing part of the steel supporting structure and replacing it with a new material. A single sample was built, which weighs three tonnes less than a normal trailer. “The weight reduction will save up to two thousand litres of fuel per trailer in a year,” Professor Adriaan Beukers says.

Yet another way of reducing the rolling resistance is to use different tyres. Thinking aloud, Beukers reinvents an age-old idea. “Turn them into trains.” Steel on steel offers much less friction than rubber on tarmac. He can just imagine the system and lets his imagination run riot. “It’s simply a great idea. Trailers would be carried abroad on flat-bed wagons. Trains would run along every motorway in Holland, with pick-up places for trailers all over the country. An instant solution to traffic jams.”

# Dancing building prevents collapse

## *Super strong lightweight composite can carry a ton*

**In future, anybody caught inside a building during an earthquake need no longer fear the roof collapsing on them. Thanks to the use of composite materials, all the building will do is dance along, riding the waves of the earthquake. At least, according to Professor Ir. Adriaan Beukers of the Aerospace Engineering department of Delft University of Technology or TU Delft. He is developing composite columns that will enable a building to be put up in a matter of seconds.**

Robert Visscher

Giant lorries trundle onto a stretch of wasteland. Thick slabs of concrete are piled on top of one another. A button is pressed, and the floors begin to move. Between the concrete pieces composite columns suddenly appear where a few seconds ago there were only small packages a few centimetres thick. They expand to become two and a half metres tall, carrying floor upon floor of the immensely heavy building. Where only moments ago the sand was whirling, a few minutes later a brand new apartment building has risen as if from nothing. This is the vision that Adriaan Beukers, professor of composite materials and structures, has of the future. "The columns are as flat as a pancake, and will be packed between the concrete slabs. All you need is a little room for a hose to inject water under pressure into the columns, and hey presto a building has been erected. The water inside the columns can then be used as a heat exchanger, so you can pump hot water into them during the winter, and cold water to cool the building during the summer. It is a very smart building, cheap to put up, more robust, and with inexpensive cooling and heating facilities."

Barbapapa

But we haven't got as far as this yet. "At the moment you might think we're talking pure fantasy, but we're very close to being able to realise a building of this kind," Beukers predicts. And he knows what he's saying. For many years his department has been researching the possibilities offered by composite materials. Composites consist of fibre-reinforced synthetics, several layers of which are pressure-bonded to form a lightweight material that can carry a great load. It sounds simple, but the practical implementation is very complex. Nonetheless Beukers has managed to reach a new, major milestone. He proudly points out a black piece of composite about a metre high. It's not much to look at. It moves in all directions, looks like rubber and doesn't appear to be very strong. "But this composite is extremely tough," Beukers says. "Appearances can be deceptive. This one-metre piece of composite can carry a weight of fifty to sixty tonnes. That's a big load and it brings the vision of inflatable buildings a whole lot closer. You could make the piece several times this size and use it to support a concrete floor."

### Barbapapa

The composite is a bit like the shape-shifting cartoon figure Barbapapa, who – 'Clickety Click, Barba Trick' – could transform his body into any shape required. And that is exactly what Beukers


Photos: Sam Rentmeester/FMAX

Satellite dish at Airborne Composites in Ypenburg

has tried. "We want to be able to produce a piece of composite in any shape we like, so we can make practically anything and not just columns."
The Taniq company, which is run by TU alumni and uses technology developed at TU Delft, is currently developing composite shock absorbers for cars. "We can also use composite to make flexible oil pipes to float in the ocean. The composite pipeline would ride along with the flow and protect the oil by being so strong."

## Pancakes

To some extent, Beukers owes his current progress with the composite research to a patent granted twelve years ago, when TU Delft developed a piece of composite about fifty centimetres in diameter that looked like a flattened car tyre. Beukers likes to refer to it as the pancake. "If you take this small pancake, only a few centimetres thick, and apply eight bars of pressure, the pancake will expand to lift a weight of up to forty tonnes. A very handy standby when a lorry has overturned. All you have to do is slip the pancake under the lorry and pump it up to push the vehicle back onto its wheels."
The pancake came in very useful on 11 September 2001. "The firemen used it to push the floors of the collapsed Twin Towers apart to free people trapped inside. In Los Angeles and Italy, composite materials are being used on a regular basis when disaster strikes. Israel has a special version that can actually lift a Hercules transport aircraft in the event of a crash. You used to need a crane for a job like that."

*'We want to be able to create anything from composites'*

"The new columns we are currently developing," Beukers continues, "are in fact a series of these pancakes stacked together to make the assembly more rigid and capable of lifting even greater weights."

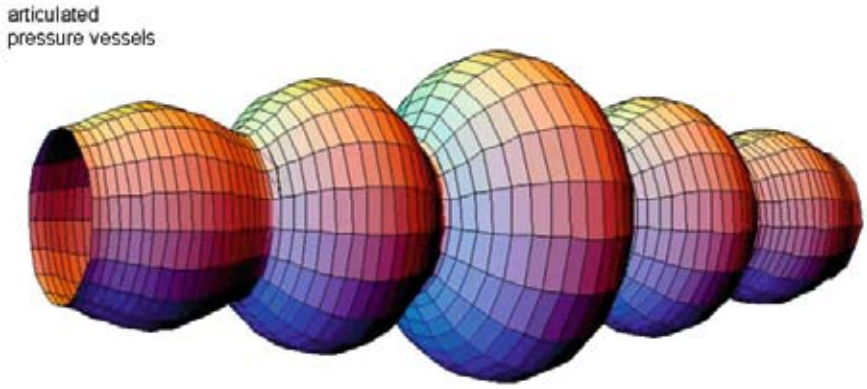
## Dancing columns

In the future buildings held up by composite columns would be immune to earthquakes. Instead of coming crashing down under these extreme forces of nature, as is the case with the ▸▸

current generation of concrete and steel structures, composites would ride along with the waves of the earthquake. A building would be dancing rather than collapsing. “A lot of lives could be saved,” Beukers says. “The pressure inside each composite columns could be controlled individually. If a building starts to lean over, you can add pressure to the bending columns to give them extra strength and bring the building back to its normal shape. The same could be done with viaducts. Concrete is a very brittle material that does not stand up well to natural disasters. Concrete columns cannot take anything in the way of deformation, but composites can. Composites don’t break, they bend with the strain. And so a viaduct will also move with the shock waves of an earthquake. By removing the pressure from some of the columns and adding pressure at other points, the object can be kept stable.”

We could have composite bridges that can be raised and lowered. “If the water level rises, you could raise the bridge so cars and trains can still cross. You could also raise the bridge to allow tall ships to pass underneath. You would never again have to wait for an open bridge to close. We could have smart viaducts, bridges, and buildings.” To Beukers the question is not how it is going to be done, but when. To a large extent the future of composite materials depends on the level of acceptance of people at large. And that is exactly where most of the problem lies, for no matter how much new technology Beukers develops, people will eventually have to want to use it. The trouble is that many people do not regard

*Beukers supplies lightweight composites to sports car manufacturer Spyker and for the new bike of champion cyclist Theo Bos*




Carbon element that can be put under pressure

compressed plastic as a reliable material. "Plastic has long been considered a disposable product – a weak material. I can understand that people find it hard to believe me when I say that steel and concrete will no longer be necessary. After all, it sounds absurd, doesn't it? I like to compare the richness of composite materials with that of potato crisps. Crisps are not much to look at. They are full of air, but even so you're sold on them the moment you taste one. They are salty, they crackle, and they taste lovely. All in all, a fantastic product. Just like composites they have more to offer than you would think at first sight."

*People do not regard compressed plastic as a reliable material*

## Small businesses

The future of composites depends on small businesses, according to Beukers. They are the ones that are going to have to accelerate the development of the material. Ever the businessman, the professor likes to stimulate his former students as much as possible to start businesses of their own, and hands out TU composite patents. Jan Peeters and his Composites Team, for example, are developing small composite bridges for use in newly developed residential areas. In a workshop in The Hague that used to be part of the Fokker works, Marco Brinkman of Airborne Composites built a giant dish aerial that is now being used to scan the heavens. "It just goes to show how much can be done. TU Delft is also developing composite wind turbines," Beukers says. "Using a mould we can produce a vane for a 70-metre diameter wind turbine in one go, and within an hour. After that you just leave it to polymerise for another hour, and you're done. All you then have to do is to send it on its way. Using current processes, production would take days." To ensure that composite products will no longer be viewed as disposable plastics, Beukers has started to actively cultivate interest among third parties. He now supplies lightweight composite material to Spyker, manufacturer of bespoke sports cars, and for the extremely expensive new bike to be used by top cyclist, Theo Bos. "It helps us to demonstrate the high-tech nature of composite materials. They are lightweight, which makes them extremely suitable for use in sports cars and bikes. Composites are a godsend to Formula 1 racing, where they can help in building lighter cars. The only drawback at this point is that everything we make still is very expensive. By helping with the development of Formula 1 racing cars and world-class bikes, we can improve the status of the product, making it more than just a bit of plastic. Once the jet set starts to buy composites, because they want a Spyker car or a bike like the one Theo Bos rides, the rest will follow. Before you know it, there will be buildings that can be erected simply by pressing a button."

More information: a.beukers@tudelft.nl, +31 (0)15 2785144.

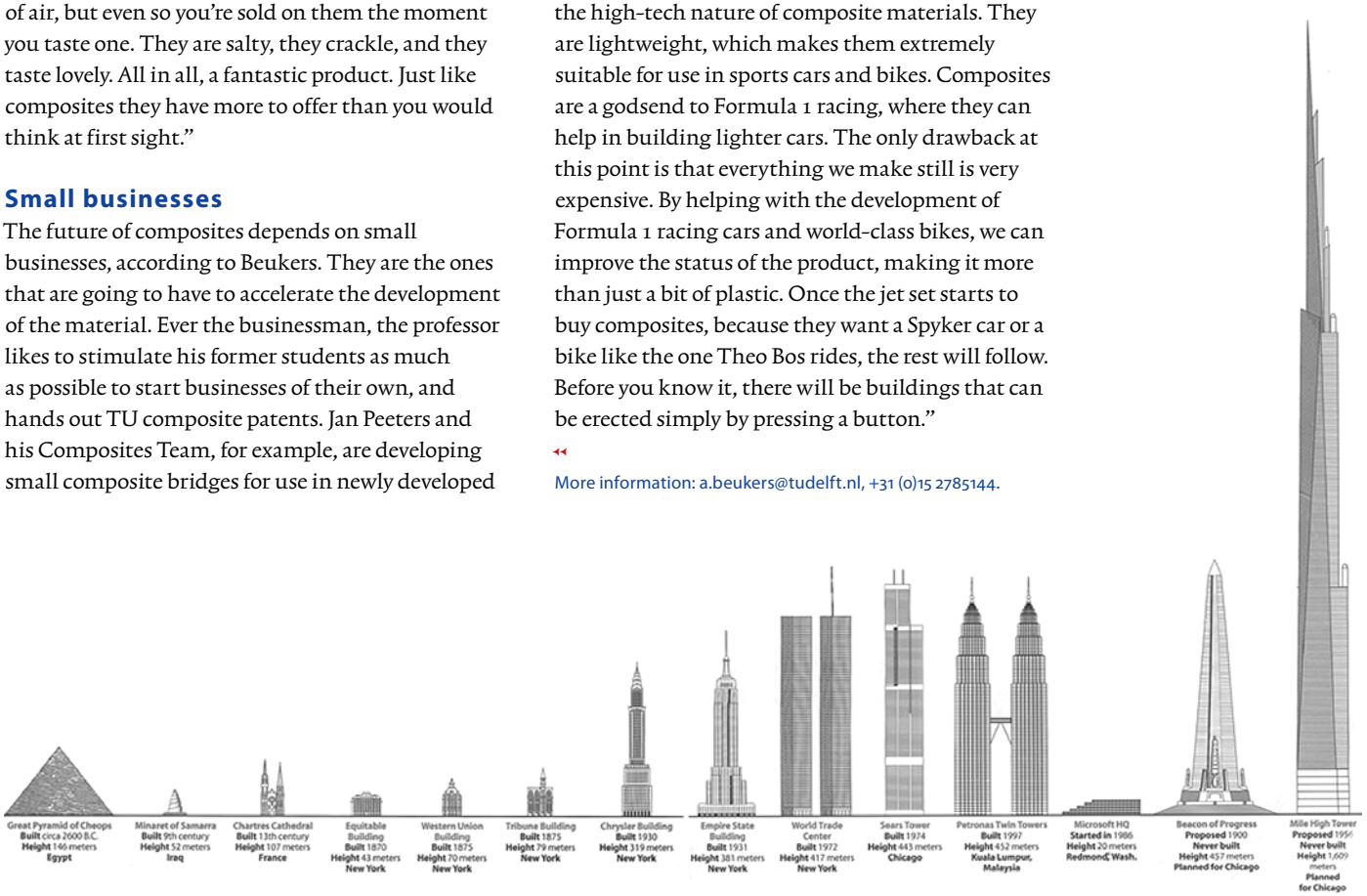



Illustration: Adriaan Beukers

[Back]GROUND

Photos: Nout Steenkamp/FMAX

# ‘Free will cannot be found anywhere in the brain’

**Neuroethics is a discipline that could launch many a heated debate in the next century. Philosopher and physician Dr Gert-Jan Lokhorst of the faculty of Technology, Policy, and Management at Delft University of Technology (TU Delft) this year received a subsidy of 400,000 euros from the Dutch Scientific Research Council for research into the ethical and legal aspects of brain science and neurotechnology. “I notice that ethicists tend to over dramatise.”**

Joost Panhuysen

*Using your own brain to consider how the brain works. Doesn’t this mirror effect make you dizzy from time to time?*

“I’m not really afraid I’ll get lost inside my own brain. After all, a scientist doing research on the effect of alcohol on the brain needn’t worry about becoming an alcoholic, does he? Even so, I must confess I do have a recurrent nightmare, in which a famous brain scientist selects me as his guinea pig, pulls my brain out of my head to show it to his students, and then stuffs it all back in again. I tend to worry that the last bit might go wrong.”

*In your research proposal you state that philosophy, which for centuries has contemplated such problems as the relationship between the mind and the body, could play an important role in the debate on neuroethics.*

“The way people look at dilemmas in neuroethics is always affected by their own philosophical outlook, even if they fail to recognise the fact. About ten years ago, the Dutch Public Health Council published a report about whether psychosurgery should be banned or not. The conclusion was that there was no reason to ban psychosurgery, since it only involved cutting into brain, and did not affect the soul. That is a conclusion you can only reach if you believe in a strict separation between mind and body, which is a view that in philosophy has been long regarded as out of date. It just goes to show that a discussion with philosophers can be helpful. By the way, ninety percent of philosophy is nonsense, but the remaining ten percent is very useful.

*Over the past few years, neuroethics has been on the increase, in particular in the United States. Can this breakthrough be explained from recent developments in brain research and neurotechnology? After all the possibilities of scanning brain activity using brain imaging have increased enormously.*

“Yes. Brain imaging offers great possibilities. Specialists can trace tumours more quickly. The big question is, can the technology also be used for other purposes? One spin-off is neuromarketing, which attempts to use results from brain research to find out how customers can be induced to keep buying certain products. Brain research is said to show that mentioning the Coca Cola brand name produces a more powerful response than mentioning Pepsi Cola. At least that is what the scientists would have us believe, but I have my doubts. Inside the brain you’ll find one giant cacophony, and to my mind it is wishful thinking to expect that something as trivial as a favourite brand of soft drink could be traced among all the chaos. But if one were to emphasise minute differences in the brain scans, for example by colouring the active areas in the brain bright red, you could easily create the suggestion. Pure manipulation.”

*If neuromarketing is just a hype, there is little for a neuroethicist to worry about.*

“But there is. In the United States, hospitals are doing brain research into purchasing behaviour on behalf of Coca Cola, with the Coca Cola company footing the bill for the expensive equipment they need. You might ask yourself whether researchers ought to be collaborating in such a venture. And suppose prospective employers were to insist on a legal basis for allowing brain scans as part of a job application procedure. That too would be questionable, since scanning images don’t provide any clues whatsoever about a candidate’s psychological make-up. If on the other hand an employer were honestly to believe that they do, a job applicant could be turned down on the wrong grounds. Anyway, I don’t think the law will be quick to allow such tests.”

*You do not seem to be too pessimistic about the possible applications of brain research and neurotechnology.*

“Of course, it’s easy to come up with ▸▸

As a six-year old boy at an uncle’s birthday party Dr Gert-Jan Lokhorst became fascinated by a Time Life book about the working of the brain, and was immediately hooked. The fascination remained the linchpin of his career. In the late nineteen eighties he did research on artificial intelligence (‘didn’t turn out as we expected’) and neural networks. Having studied medicine, in 1980 Lokhorst decided to study philosophy at the Erasmus University, where later he would obtain his doctorate and work as a lecturer until 2004. For the past three years he has worked for the philosophy section of the faculty of Technology, Policy, and Management at TU Delft. The research he will be supervising over the next years will be part of the 3TU Centre for Ethics and Technology. Lokhorst is married to philosopher Dr Marjolein Degenaar. They have two children.


pessimistic scenarios such as pilots being given brain implants to improve their communication with the technology of their aircraft, or a dictatorial regime that attempts to use electrodes in the brain to treat 'character disorders' in rebellious prisoners. But I hope we never reach that pass in our society.

What does strikes me is that ethicists tend to over dramatise. 'The end is nigh unless we heed the signs.' They act as if our society is deeply troubled about the themes they bring up, but much of the unrest is brought about by their own actions."

*Wouldn't it be wise to consider the risks of a new technology in advance?*

"Certainly. On the other hand history teaches us that sooner or later we will start to use any technology we can lay our hands on. Ethicists can make a song and dance about it, but their role will remain marginal."

*So why did you opt for neuroethics?*

"Because the field is a fascinating one for a philosopher. Nanoethics is about what might conceivably happen in nanotechnology, but my field touches on issues that the ancient philosophers racked their brains over. Philosophy thus acquires a new measure of relevance. In some cases artists are better equipped than scientists to point out the dilemmas in neuroethics. Aldous Huxley's Brave New World remains frighteningly relevant, even after 65 years."

*Will we ever be able to read a person's mind using brain research?*

"No. Our being able to observe thoughts as activity in the brain does not mean that we can actually read them. We cannot dig as deep into the brain as privacy defenders may fear, or some anti-terrorism buffs might hope. Scientists saying otherwise are naive. Ever since Aristotle, philosophy has been concerned with the human conscience. For the past thirty years, externalism within

the philosophy of the mind has been the prevailing view, holding that the contents of our thoughts are mainly the result of external factors. The corollary is that we will never really be able to read a person's mind. Philosophy exists through discussion, so it goes without saying that externalism itself is not without controversy. However, discussions reveal that brain scientists and ethicists alike often know little about the latest developments in philosophy. Nonetheless, they are interested all the same.
The fact that we will never be able to read a person's mind does not mean that privacy is not an issue. Scientists have already demonstrated the ability to erase the memory of laboratory animals, even though accurately selecting the area you want to erase remains difficult. Such technology could someday be used on human subjects."

*Are there any circumstances in which one might be permitted to erase a person's memory?*
"We now have a new concept that may help to find an answer to such questions, the extended mind hypothesis. The theory is that one should treat whatever is inside the mind in the same way as whatever is outside the mind. As I am not permitted to tear up your notepad, neither may I erase your memory."

*Traumatised people might perhaps benefit from having part of their memory erased.*
"That would be a useful application. But again an issue that raises some awkward questions. Memories make up a great part of our identity as Paul Verhoeven demonstrated in Total Recall. Are you still a complete human being when important memories have been taken away from you? Just imagine being able to remove all the bad experiences from your past life – you'd never grow up."

*The most dangerous temptation is to tamper with the human brain in order to secure the happiness of mankind. Find a way to prevent people from making decisions on impulse, to make their thoughts a little less egocentric and aggressive, and a brave new world will be lying just around the corner.*
"Tinkering with our brains is not so simple. But even so I can't reject the scenario out of hand either. Perhaps one day we'll have a drug that will turn ordinary people into better saints than Saint Francis. The question is, should you add the stuff to the public water supply, or ban it?"

*Is this where the interests of the individual clash with those of society as a whole?*
"A society can only function if a certain measure of variety prevails among thee people and their ideas. A community of saints doesn't sound like my idea of fun. Everything would grind to a standstill. Just compare the notions with our concepts of heaven – mind-numbingly boring.
There lurks another danger in the ability to improve our brain, and that is that we would never again be satisfied with our mental capabilities. We'd keep tinkering with our brains like a kind of cosmetic surgery. Michael Jackson thought he would look better with a lighter skin and a smaller nose, but his action launched a long process of suffering."

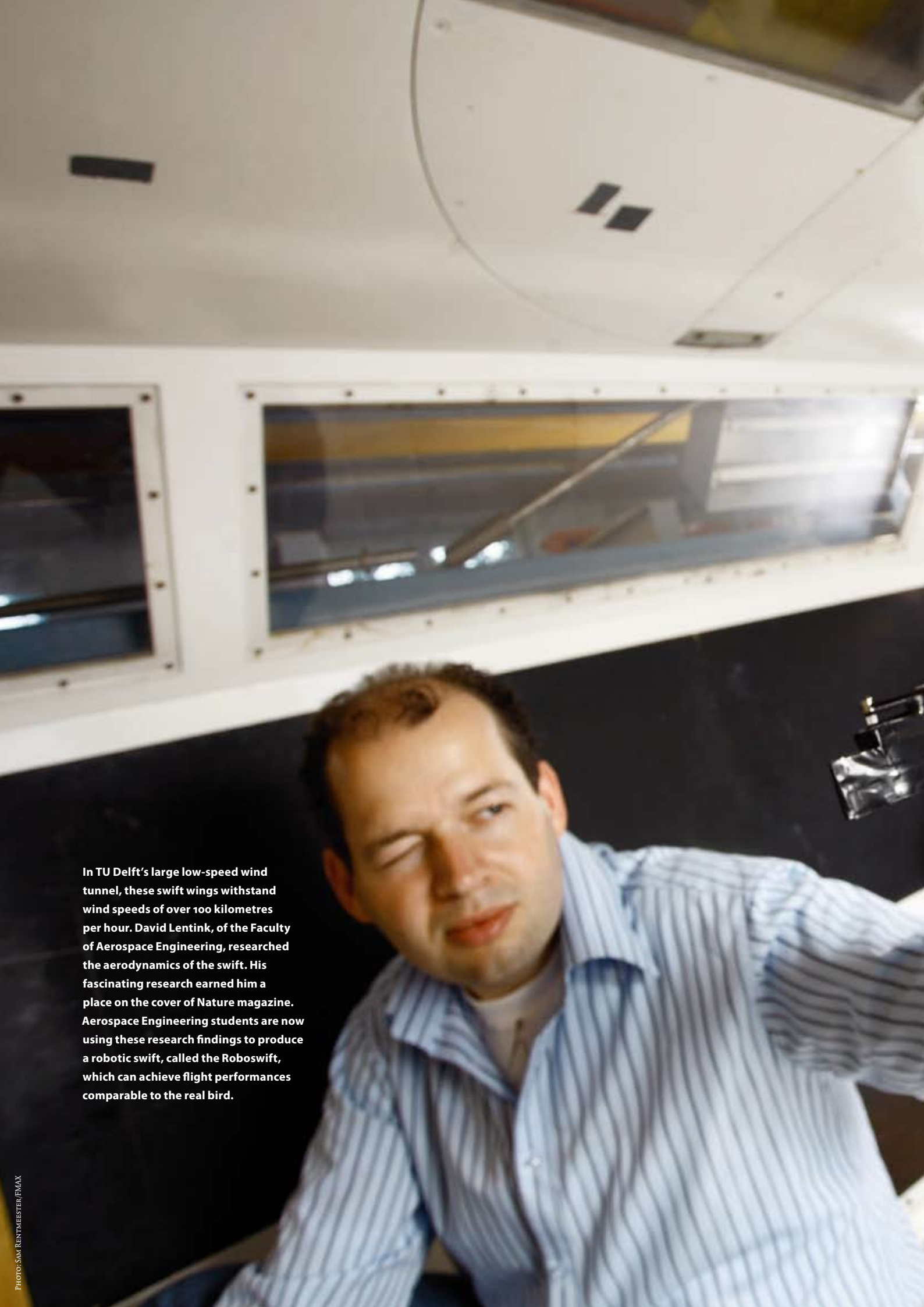
*Is there such a thing as a free will, or is the concept being undermined by the results of recent brain research?*
"Concepts such as free will, morality, and responsibility are useful, and in fact we cannot live without them. But we can never pinpoint free will in our brain, nor love or hunger. That's not how the brain works. Scientifically speaking, a concept like free will is useless. In my research I would like to demonstrate that there is an unbridgeable gap between everyday and legal language on the one hand, and the language of brain scientists on the other. We must take care not to try to describe the world of our brain in a language unsuitable for the task."

*Couldn't both languages complement each other?*
"Sometimes. But you must take care not to mix the two without further thought. A judge trying to assess an accused person's guilt will be using age-old concepts like free will and responsibility. If a lawyer defending a client accused of murder were to suddenly come up with a theory that the real killer is in fact a tumour in the brain, we need to be careful. As far as I know, no judge or jury has ever acknowledged the validity of such a defence, and I think that is a good thing. When deciding whether someone is legally accountable, we should consider that person's behaviour rather than their brain. Perhaps results from brain research will some day be spectacular and relevant enough to let them carry weight in a judgment, but we haven't reached that point so far."

*Couldn't a person argue that the cause lies in faulty wiring in the brain? Are we always responsible for our actions?*
"That is a fundamental issue that is currently becoming highly relevant. Civil servants in high places at the Ministry of Justice and the Ministry of Home Affairs are currently considering the possible effects on legislation of new insights in brain research. These people also sit on the experts panel that was established to support our research."

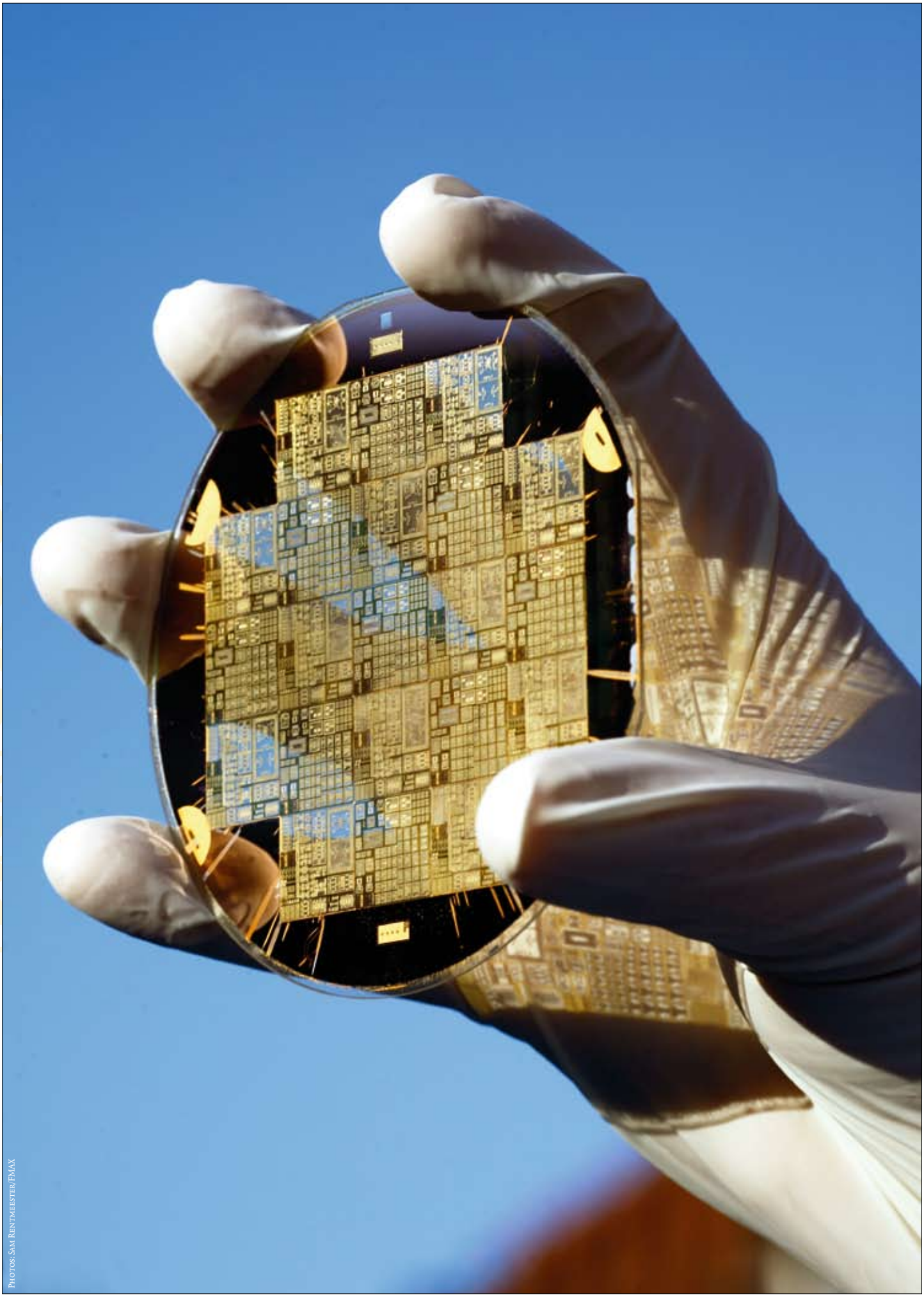
*Should the government heed the results of brain research in legislation?*
"No. Science changes from week to week. You cannot keep up with it. Suppose governments in 1870 had decided to base legislation on the latest scientific views. Those laws would have been obsolete by 1930."

*Will we gain insight into ourselves as we come to understand more about how our brains work?*
"Insight in a medico-technical sense, yes, certainly. But psychological insight of the kind encountered in the works of Dostoevsky? No, I don't think so."



**In TU Delft's large low-speed wind tunnel, these swift wings withstand wind speeds of over 100 kilometres per hour. David Lentink, of the Faculty of Aerospace Engineering, researched the aerodynamics of the swift. His fascinating research earned him a place on the cover of Nature magazine. Aerospace Engineering students are now using these research findings to produce a robotic swift, called the Roboswift, which can achieve flight performances comparable to the real bird.**

Photo: Sam Rentmeester/FMAX



Photos: Sam Rentmeester/FMAX

# Microchips on glass

## *'Exotic' pcb for all-in-one phone*

**What about a mobile phone that uses a single microchip to receive all the available frequency bands, plus extras such as television, gps, and Internet access? Or, in due time, see-though implants that will monitor your state of health, and equipment that will let you see through fog. Researchers at Delft University of Technology (TU Delft) have discovered a radical new way of integrating communication circuits in a microchip, using an electronic components that was considered utterly unsuitable for the purpose, and an improbable substrate, glass. "I think the future lies with glass microchips."**

Maarten Keulemans

Exotic, strange, weird; Professor Dr Lis Nanver and Dr *Ing.* Leo de Vreede have heard it all before. The piece of glass they have placed on the conference table looks ordinary, but is rather special. "So far our results in this field are the best in the world," says De Vreede. Nanver adds: "With this technology I can almost create the perfect device. I even believe that the world will be forced to switch to this type of technology in a couple of years."

The subject of our conversation is a small, circular sheet of glass looking nothing like a normal wafer with microcircuits on it. The object rather resembles a piece of engraved glass. Or, perhaps, a prop from an episode of Star Trek. It's not just because of the unusual material used for the substrate, but also because of the wafer-thin silicon circuits it carries. Look closely and you can see that some of the circuits have metal terminals on the back - highly unusual. Three-dimensional microchip technology on glass? And then there are these strange rectangles around which the circuits have been created. They are variable capacitance diodes, or 'varactors' as the jargon would have it. Even more peculiar, since varactors belong to the realms of cruder electronics like radios, television sets, amplifiers. They are useless in mobile phones, is the current consensus. Much too sensitive to signal interference.

Nonetheless, De Vreede and Nanver, who both work at DIMES, the Delft institute for microelectronics, are convinced that this is the way forward for microelectronics. They think that one day their glass microchips will end up in our mobile phones. It would mean phones with a much more efficient layout, longer periods between recharging, and most of all, added functionality. "We would just have a phone offering standard access to all kinds of ether-based networks and services," says De Vreede. "Think TV-on-mobile. Think GPS, or communication networks using different frequency bands and protocols, like they have in the United States."

"It is certainly an interesting technology, and it might very well be a breakthrough," says innovation manager Dr Ir. Bart Smolders of NXP Semiconductors, formerly known as the microchip division of the Philips electronics company. Smolders is currently engaged in research to find out if discrete components using silicon on glass could be a business proposition. "You need a lot of money to bring an exotic process like this up to production standard, so we want to make sure we get our sums right."

### Maze

On the outside, mobile phones may appear to be state-of-the-art devices but on the inside they are a collection of compromises. One of the most notorious problems is the lack of circuit integration. For each transmission protocol, the average mobile phone has a separate, discrete circuit on board, a ▸▸

bit like an old-fashioned telephone exchange from the nineteen-fifties, a jumble of plugs and cables. Bluetooth, GPS, wireless LAN, foreign telephone protocols, they all have their own circuitry to rule out interference as much as possible. "You're simply not alone in this world, and for each signal you're trying to receive, there are countless competing signals," says De Vreede. This means you're stuck with a maze of separate circuits. "The result is hardware proliferation, meaning users are looking at buying a new phone every time they want to use a new feature, like GPS for example."

What the microelectronics world wants is a general control, a variable component that will make a single radio transceiver circuit suitable for all purposes. But such a component would have to satisfy many different criteria like being small, cheap, reliable, fast-switching, lossless, and capable of picking up exactly the right signal at any given moment.

So far, attempts by other researchers have yielded a mixed bag of results. Some are betting on adjustable, microscopically small machines (microelectrical mechanical systems, MEMS). Although these offer good capabilities in the way of signal loss, they need a vacuum to work in and are slow to switch. Others are focusing on circuits using a barium strontium titanate (BST) alloy, a material with adjustable properties – a variable dielectric constant, to be precise. But BST, too, has its drawbacks.

Enter the glass varactor microchip created by Dimes. "Our results are whole orders of magnitude better than anything anybody else has managed to achieve, and there is still ample room for improvement," says De Vreede.

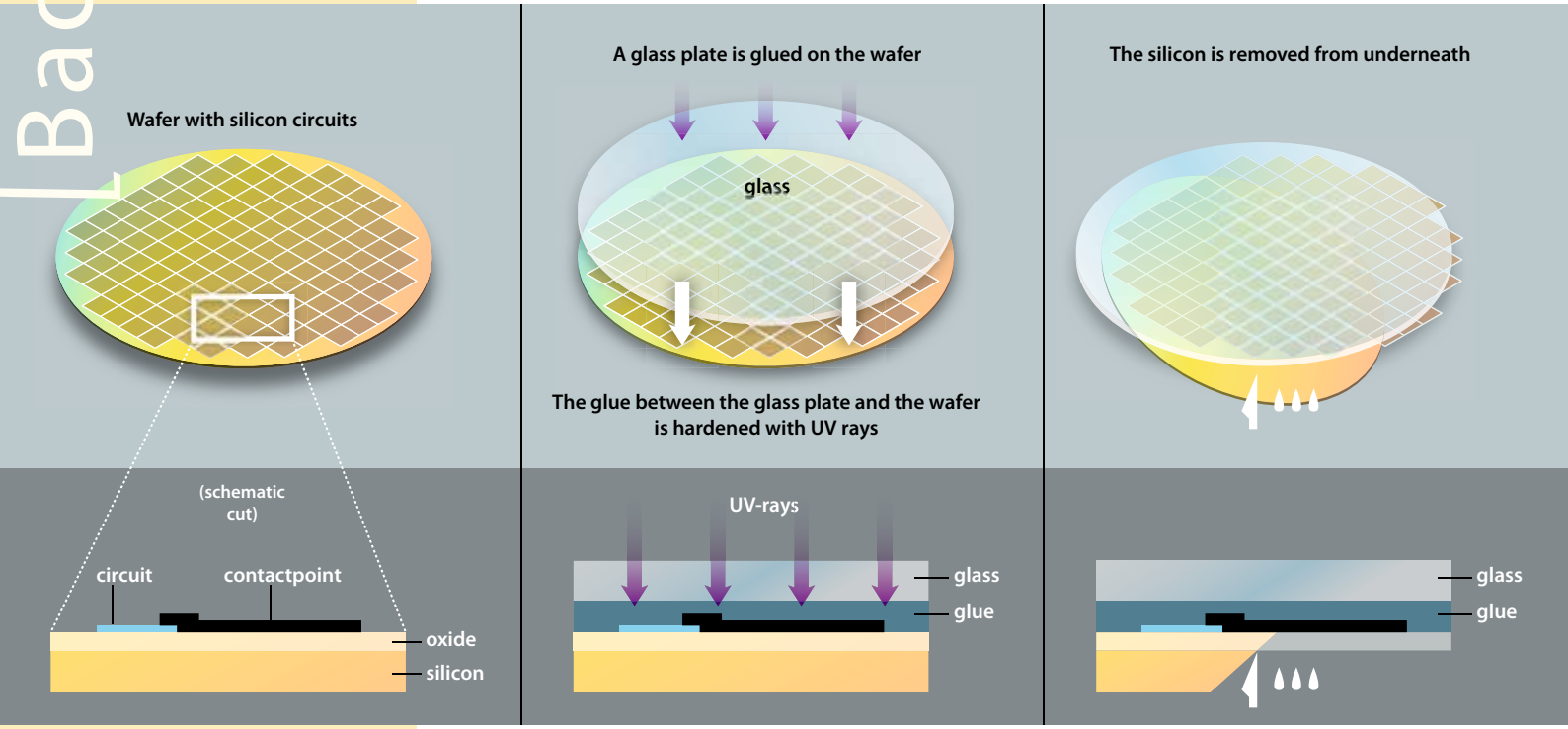
## Troublemaker

The whole thing started as a bit of a game, Lis Nanver recalls. Running up to the millennium Nanver had inherited a technique developed by researcher Ronald Dekker at Philips which had then been put on the back burner. That technique was a simple way of making microchips using glass. The process is extremely straightforward. You take a silicon wafer containing circuits, attach a glass sheet to it using special glue, turn it over, and etch away the silicon on the other side to leave just the circuitry and the glass (see infographic).

Meanwhile, one floor up and a corridor further along in the same building, Leo de Vreede was engrossed in what at first sight looked like an utterly boring problem, signal distortion in varactors. Varactors (variable capacitance diodes) are known to cause signal attenuation and distortion when used for high-frequency communication applications. If you put in a radio wave it will come out less strong and slightly different in shape, just like waves hitting the shore. De Vreede was about to discover a way that would instantly change varactors from being born troublemakers into immaculately operating, lossless supercontrollers. "It's a rather complicated story," De Vreede warns. "What we found out is that, in a certain circuit configuration, and in combination with the right profile and the right impedances at the right frequencies, you can make these varactors work exactly how you want them to." Loosely translated, De Vreede discovered how to connect varactors in such a way that they no longer distort the signal. And 'no distortion' in this case really means 'no distortion'. "Zero distortion! In theory our configurations are perfectly linear."

## Finger layouts

By now the time was ripe to test the concept in practice. "I first tried to hand the project to a doctorate student, but he couldn't believe it was be true," De Vreede grins. In the end, he found a student, Koen Buisman, who was prepared to test



### Careful, fragile!

Of course, glass microchips can break. And especially so if you stick a thick layer of copper on top, according to Rik Jos of NXP. "The coefficients of expansion of copper and glass are very different. I wonder if the whole lot isn't going to break under the strain of temperature changes."
No problem, according to Dimes. It's simply a matter of building a bridge. "We call it a via," De Vreede (photo) explains. "First you create little stilts down to the circuitry, and then you put the copper on top of those. You then have an elastic structure that prevents thermal expansion problems."

the varactor circuits. This was in the summer of 2004. Buisman immediately ran into problems. To make the super circuit work, so the theory goes, he needed a 'leakproof' microchip. He also needed to connect the varactor circuits with a very low resistance, without any lossy detours like the ubiquitous finger layouts or any unwieldy auxiliary circuits buried deep inside the chip itself. "You want just the device, without any of the rubbish that usually surrounds it."
That was where the glass microchips came in handy. Glass is a perfect insulator, and in the meantime Nanver had been able to devise a method for connecting circuits using a short-cut route on the back of the microchip. She does this by injecting silicon from behind with arsenic ions, and hitting the microchip very locally with a laser beam, which activates the injected silicon. "Only twenty nanometres or so of silicon are melted this way, and this happens very quickly, within a microsecond. So you can create extremely good contact points without damaging any other parts of the wafer."
In 2005 Buisman had got the varactor circuit working - switchable, suitable for high frequencies, and extremely distortion-free (see text box for details). Gradually, Nanver, De Vreede and their students and supervisors started to redesign the mobile phone. Bit by bit, circuit by circuit, component by component. The growing list of completed microcircuits already includes a number of tunable filters, phase shifters, and several ▸▸

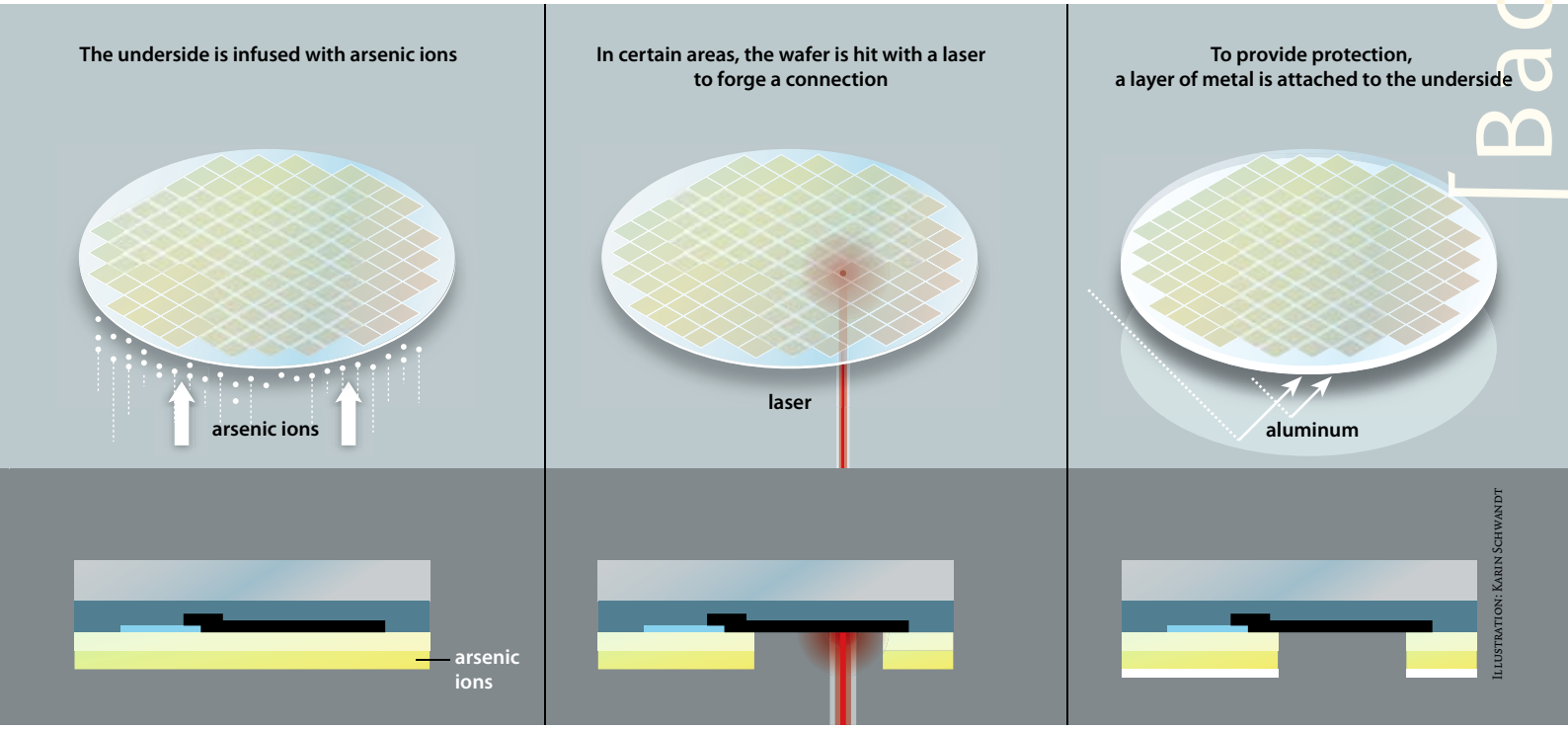



Illustration: Karin Schwandt

Producing the chip at the Dimes lab.

amplifiers. All of them perform beautifully, and none of them measures more than a handful of square millimetres.

## Tricks

As they progressed, the Dimes researchers developed additional tricks, including a diode with an insulating layer of boron only ten atoms thick. "The result is a very nicely performing diode, with a large capacitance and very low losses," says Nanver. "And there is much more. Practically every piece of the technology is new." So far it has brought the Delft researchers two patents, a growing pile of scientific publications, and of course, enquiries by NXP.

There are also some drawbacks. Glass microchips are relatively expensive to make because production always starts with an expensive type of wafer, a silicon-on-insulator wafer. Another problem is heat. Glass does not conduct heat very well, and so the circuits cannot get rid of their excess heat very easily and can become overheated. In the current generation of circuits the scientists have solved the problem by using very thick metal connections to act as heat sinks. Another solution developed by Nanver and her colleagues is to spray the glass microchip assemblies with an electrically insulating material that will carry away the heat, all without affecting the performance of the superchip.

Dr Ir. Rik Jos, a research fellow at NXP who has been involved in the Delft research for many years now, foresees a different obstacle. The Delft scientists could well be on the wrong track altogether. When asked what he meant, he suggested that varactors made from the semiconductor gallium arsenide might work much better. This is a material which allows electrons to move about much faster, resulting in a higher Q-factor, or quality factor. "I have a problem with silicon on glass. It is very exotic, so the production costs are huge. Varactors made from gallium arsenide involve a much more conventional process. There are lots of companies that can do this."

### Glass microchips

**Benefits:**

- Integrated switchable circuits
- Extremely good signal thanks to high Q factor, high linearity
- Wide range of applications
- Compact dimensions
- Suitable for low control voltage

**Drawbacks:**

- Relatively expensive
- Exotic, awkward to produce in large numbers
- Fragile

Gallium arsenide is in fact one of the materials being investigated by Nanver and De Vreede in collaboration with American company, Skyworks. Even so, De Vreede has not yet been convinced. “The fact remains that nobody so far has achieved the values Lis managed to get using silicon on glass. Saying that the same can be done with gallium arsenide is easy, but we don’t have any proof to date. Our calculations say that the conventional production methods for gallium arsenide offer no easy solution either. The best option would be a combination of gallium arsenide with glass. This might be more expensive, but it would offer superior performance, and could well be an interesting alternative for other, more demanding applications than mobile phones.”

## Health care

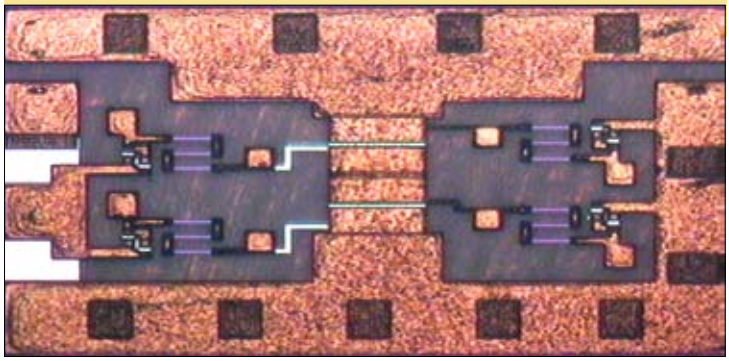
So what if the glass microchip really takes off? According to Nanver, we can then expect to find them inside everything that’s wireless and communicates in next to no time. “The glass microchip opens the way to integration of functions, to microchips that interact with their environment. You could have a microchip inside your body that monitors your state of health, or they could be used for climate control, or in chipped products that scan themselves when they pass the till.”
Or think in terms of miniaturised terahertz scanners, deep infrared devices that can see through clothing and inside suitcases. Nanver laughs: “You might soon find just such a scanner on your mobile phone. Who knows what it could be used for?” De Vreede can see the technology return in all-weather systems that will let you see through fog. “There will be all kinds of new applications that will affect our life in many different ways.”
For the time being, don’t expect to find any glass PCBs inside your phone. If the technology is ever going to be applied, glass PCBs will probably first find their way into discrete components, which will in turn be snap-linked to other microelectronics. But Nanver is fairly sure that in the longer term the glass version will triumph. “I can really see it happening. Silicon will increasingly be mounted on glass. You simply cannot avoid doing so for very small dimensions. That’s easy to predict. Given what we stand to gain from glass-based circuitry, I think this will be the technology of the future.”

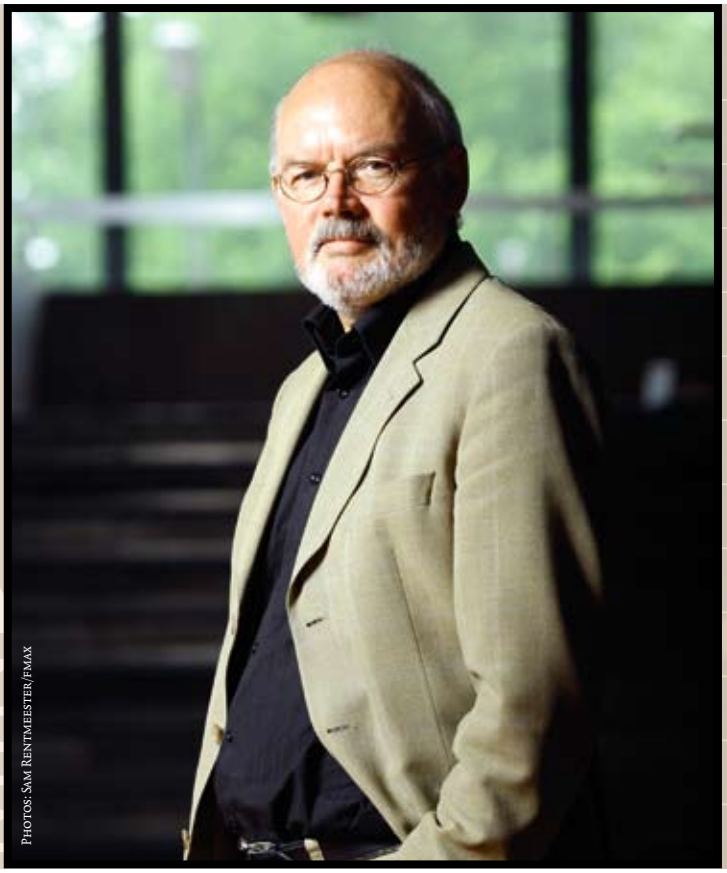
More information: Professor Dr Ir. Lis Nanver, l.k.nanver@tudelft.nl, +31 (0)15 278 3814; Dr Ing. Leo de Vreede, l.c.n.devreede@tudelft.nl, +31 (0)15 278 6187.

Prof.Dr.Ir. Lis Nanver.

### By the numbers

The varactor diodes made at Dimes can be coaxed into delivering their wonderful performance by switching them in an anti-series configuration at the right connection impedances. Given the right conditions, the varactor element will achieve a Q-factor in excess of 100 at 2 GHz for very high capacitance values (approx. 25 pF). Until recently the assumption was that semiconductor varactors could not exceed a Q of 60 at the required capacitance. MEMS can achieve a Q of up to 200 for small capacitances, but at higher values (10 pF) they offer a significantly lower Q factor (approx. 50). The use of BST generally results in a Q of less than 30.
The Delft varactor diodes have a high capacitance per surface area, which results in very small circuits. They also have no moving parts and do not require expensive packages, so they can be easily integrated into complicated microcircuits. They require a relatively low control voltage (Vcont < 10 V) and feature a very high linearity, which is very important for use in mobile telephones. “During the last tests we even had quite a bit of trouble measuring linearity. And that was using a purpose-built test rig.”





Photos: Sam Rentmeester/fmax

# Prof.dr.ir. Piet Wesseling

*'To a teacher, what a student says must be the most interesting thing he's ever heard'*

# Involved

ProfessorDr Ir Piet Wesseling (Rotterdam, 1942) left TU Delft early in June after a thirty-year tenure as professor of numerical mathematics. He always saw the professorship as his final destination. All the previous jobs he had held were simply the means of getting there. Wesseling graduated from TU Delft as an aeronautical engineer in 1964. Three years later he received his doctorate in aeronautics and applied mathematics at the California Institute of Technology. From 1967 to 1968 he was a senior researcher at the Jet Propulsion Laboratory in Pasadena. He then returned to the Netherlands to work at the National Aerospace Laboratory in Amsterdam, where he was a senior researcher until 1972. The next five years were spent as a lecturer in numerical mathematics at Twente University. Wesseling has written two important books, one on multigrid methods, and one on computational fluid dynamics.

Saskia Bonger

In this series, a professor and a student each answer the same questions to create a double portrait. In this edition: Piet Wesseling and Kees Vuik

**How would you characterise one another?**

Wesseling: "Vuik is level-headed, sensible, versatile, and reliable. He's an all-rounder as a lecturer, turning his hand to teaching, research, organisation, and popularising numerical mathematics. He is very much appreciated by his students, and he looks across the boundaries of his profession. He is nice to work with."

Vuik: "Wesseling is steady, hard-working, and involved."

**What makes him stand out?**

Wesseling: "He has a very good relationship with his students. He also has one of the best web sites in our field. I always refer others to it when they come with questions. It is a privilege to have someone like him in our group."

Vuik: "Piet knows his onions. As his successor I've been left a filing-cabinet full of material, all in perfect order. I've still to find my way around it. Piet is also very well-read. Two years ago our work took us to China. We had our moments when we wondered who knew more about the old city, our guide or Piet. He could tell you all about it."

**What did you learn from him?**

Wesseling: "Vuik has always been a great support to me. He has taught me to go for the feasible targets, how to separate the wheat from the chaff. There is no point in being a perfectionist. I know I tend to be one, and I'm even a bit of a supporter of perfectionism, but only in my writings, not in daily life. It's not always easy, because I come from a family of school teachers.

I like to use Vuik as a sounding board. There are no barriers in our department, so anyone can criticise anyone else. I grew up in the seventies, when there was no hierarchy. I was 35 years old when I accepted my professorship. At the time there were no ranks or grades, and there still aren't."

Vuik: "Mathematics and leadership. Our department is organised chaos, though I may be exaggerating a bit. The ideas come from the bottom, and that is the way I like it to be."

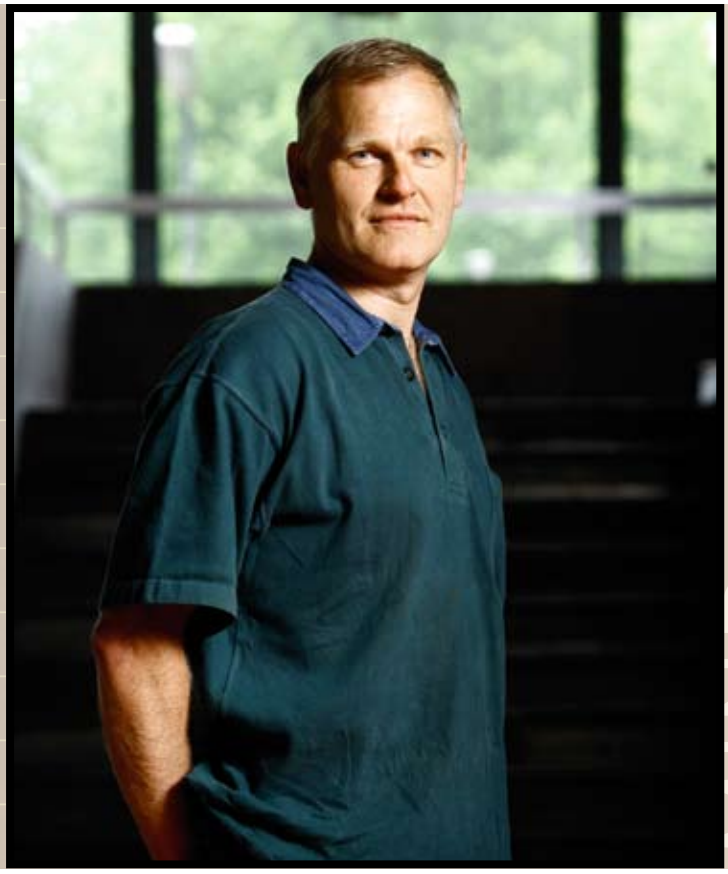
**What makes a good master-pupil relationship?**

Wesseling: "You must have confidence in one another, and give one another priority. If students come in with a problem, I'm not going to say they should come back next week. I don't want to leave them dangling for too long. To a teacher, what a student says must be the most interesting thing he's ever heard. And if a student's idea doesn't work, it's time to do some brainstorming together. Neither

# Prof.dr.ir. Kees Vuik

*'Our department is organised chaos'*

# Reliable



Professor Dr Ir. Kees Vuik (Capelle aan den IJssel, 1959) succeeded Piet Wesseling as professor of numerical mathematics. Their relationship goes back a long way. Vuik attended his first lectures given by Wesseling in 1978, and graduated four years later. Vuik left Delft to work for his doctorate in Utrecht. He then spent six months with the Philips company to complete the work he had started during his research. In the late nineteen-eighties Vuik returned to Delft, where he first became lecturer, and afterwards held a professorship.

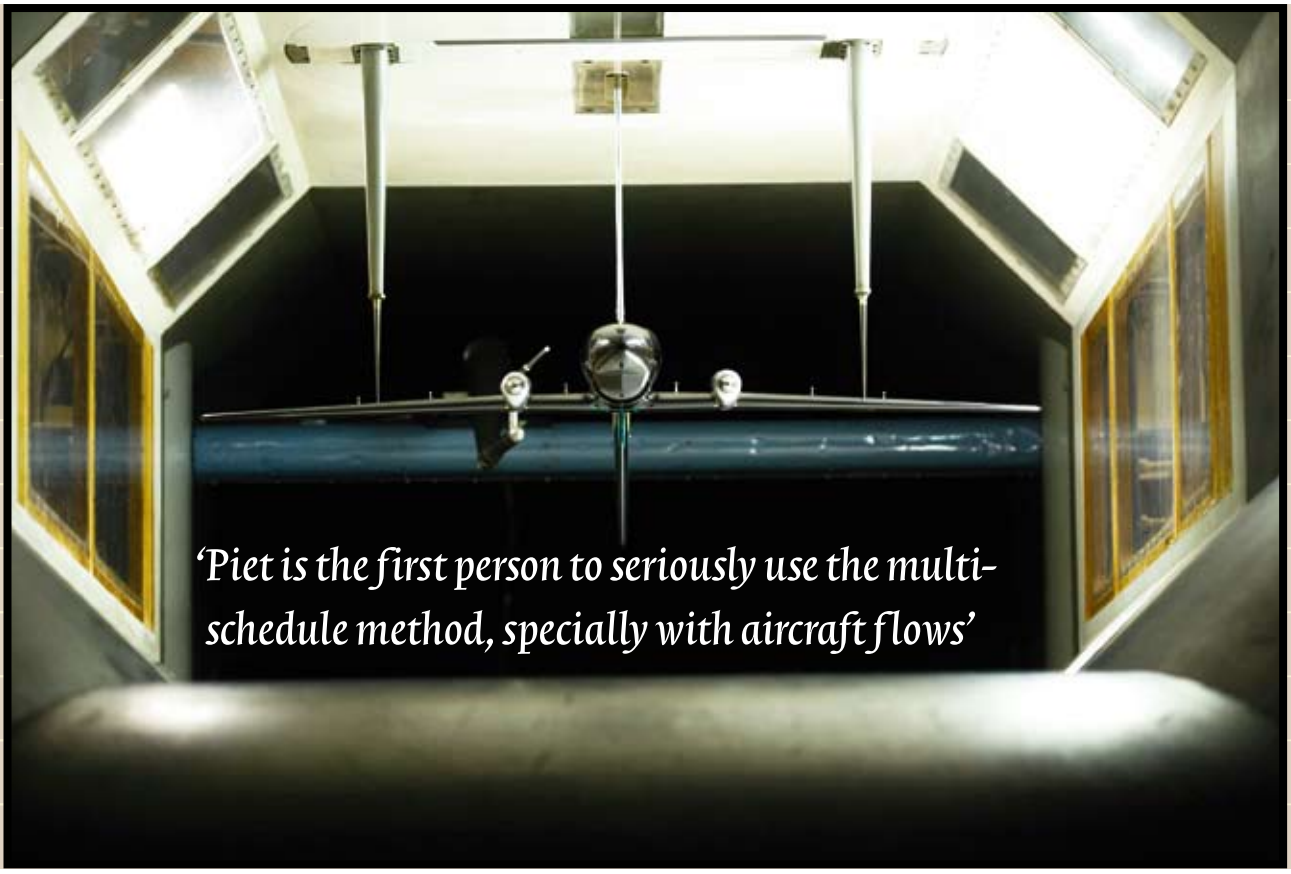
person should be afraid of making a blunder. Vuik and my colleagues create interaction by setting the right example."
Vuik: "A teacher must be capable of listening and responding to a student's questions. It is also important to bring students, and doctorate students in particular, into contact with international scientists, as ours is a small world. If you want to achieve anything, you need a network. Wesseling is very good at networking."

**Was your relationship more like that of a father and son, or like a married couple?**
Wesseling: "We were like an older and a younger brother. I was young when I started. Some of the students were almost my age. The result is that you don't have any natural authority, so you shouldn't put yourself on a pedestal when lecturing. But then, times weren't like that back then."
Vuik: "Our relationship has evolved from a father and son relationship into that of two friends. A teacher must be like a father figure, in a positive sense. He must give directions, and he must always be prepared to answer students' questions. I could ask Piet's opinion on anything; not just about science, but also about philosophical questions or dealing with colleagues."

**Did you ever have words about the direction of your research?**
Wesseling: "Vuik graduated under me. He was awarded his doctorate in Utrecht and then returned to work here. We have always seen eye to eye. We think along the same lines, and we both have a paternal streak. Students need a little coaching."
Vuik: "It is impossible to have words with Piet. The worst that could happen is that you agree to disagree. I try to emulate him in that, and it gets easier as I grow older."

**Can you name a piece of good or bad luck that stuck in your mind?**
Wesseling: "When Vuik did his research for his doctorate in Utrecht under the supervision of my old friend Van der Sluis, the latter was looking for proof of the convexity of grooves in a silicon etching. In Utrecht they tend to go in for pure mathematics, whereas in Delft we practise applied maths. We just make the etching. I suspect Vuik found it difficult to look for proof. Even so, he did it."
Vuik: "The good luck is being appointed his successor. There was tough international competition. It was a serious selection; Piet never wanted to have an heir-apparent. He has always delegated lots of work to me and my colleagues, so I've done lots of things before."

**Do you socialise?**
Wesseling: "No. I live a long way from Delft. I did invite everybody round once for a garden party, ▸▸






but as the boss you must take care not to invite one person and forget another. You must treat everybody equally."
VUIK: "Very little. I myself try to invite all my graduate and doctorate students to my place once."

**What is the other person's best habit?**
WESSELING: "He always arrives on time for work on his motorbike, come rain or shine."
VUIK: "He never gets angry."

**And what is the worst?**
WESSELING: "I have no idea. I myself am forgetful, and always have been. I tend to forget small matters to be able to keep track of more important things."
VUIK: "I wouldn't even know about mine. Perhaps that I sometimes take on more than I can handle."

**What did the other person do for the profession?**
WESSELING: "Vuik has gained prestige with his analysis of moving edges. The boundary between two metals in an alloy is in motion. If you can determine the position of the boundary, it lets you improve the heat treatment of alloys, for example. It's not that Vuik made a breakthrough in this field, but he became very good at it.
Of greater importance may be the rapid solution of equations using the deflation method Vuik devised together with Reinhard Nabben. If you want to solve problems using a fast computer, you also need a fast algorithm. The deflation method has contributed to the fact that the oil industry can now calculate the location of oil reserves a hundred times faster than before."

VUIK: "At the start of his career Piet worked on the multigrid method. It made him world-famous. Let me explain what the method is about. Say you want to solve a problem with a number of unknowns. With the standard method the quantity of work increases faster than the number of unknowns. In Piet's method both increase at the same rate. He may not have been the one to invent the system, but he was the first to find a serious application for it, calculating airflow on aircraft."

**What is the target the numerical mathematics department should be setting itself for the next few years?**
WESSELING: "They are going to have lots of problems funding research, because direct funding is steadily decreasing. They are also being forced to come up with increasingly large schemes for funding. It will be a challenge to do so without spending too much time on it."
VUIK: "Teaching is very important to me. I try to be flexible, using new teaching methods for instance. On the other hand, if students don't like what I'm doing, I'll be the first to drop it. In terms of research we must remain with the international elite. And we are going to have to put more effort into maintaining our international contacts."

*Marital status:*
WESSELING: Married since 1964. Three children.
VUIK: Married, seven children.

*Favourite book:*
WESSELING: 'Les Misérables' by Victor Hugo.
VUIK: 'Out of Mind' by J. Bernlef.

*Favourite newspaper and magazine:*
WESSELING: Trouw, Economist, and Nature (on-line)
VUIK: NRC Handelsblad, Newsweek, Natuurwetenschap en Techniek, and nature magazines.

*Invention you would like to be yours:*
WESSELING: The multigrid method.
VUIK: The airplane.

# Flexible but unbreakable

## *Johan Ringers, Father of Post-war Reconstruction*

**Biographer Tessel Pollmann rescues from oblivion the engineer who for six decades was one of the most influential people in the Netherland**

Sjaak Priester


Illustrations: 'Van Waterstaat tot Wederopbouw'

(Will the new broom of the Water Management Directorate make a clean sweep…?)

When hydraulic engineer Johan Ringers received his honorary doctorate in Delft in 1930, he was only 45 years old – rather young for an honorary doctor. The first half of his career alone was enough to merit the distinction. Nonetheless, fifteen years later Dr Ir. J.A. Ringers (1885-1965), during and after the Second World War, was to become even more famous as the 'Father of Post-War Reconstruction'. Sixty years ago, every Dutchman, and many other people all over the world, knew who Ringers was. Hardly anyone else in his profession commanded the respect he did. No wonder that in 1955 TU Delft (still a polytechnic at the time) turned to Ringers to deliver the official address for its fiftieth anniversary. Although he had already finished his career proper, Ringers still counted as the national troubleshooter. If Ringers couldn't solve the problem, nobody could.

Today, Ringers' name has sunk into oblivion even among civil engineers. For that reason alone it is a good thing that Tessel Pollmann (1940), who worked for the Department for the Conservation of Historic Buildings until she retired, recently published a substantial biography of this 'flexible but unbreakable man'. On 28 November she was awarded her doctorate for the book at the University of Amsterdam.

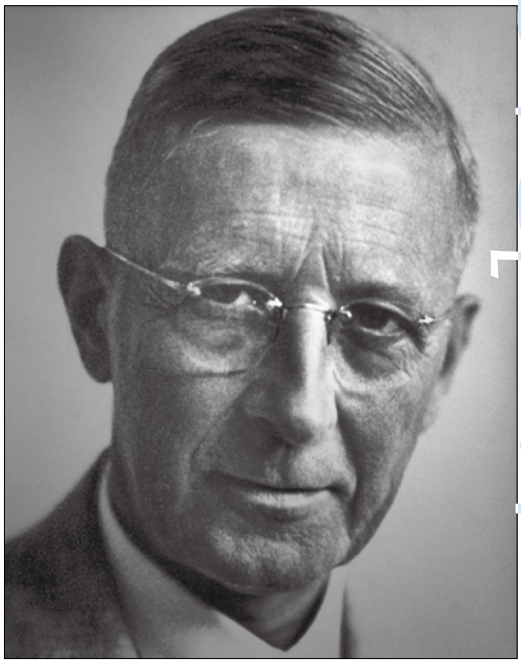
The life of Ringers is practically impossible to summarise in a few words. At an already advanced age he promised his wife that from then on he 'would not accept more than eight or ten jobs' at a time in order to find more time for his family. He was a workaholic long before the term had been coined. He needed a permanent army of assistants and secretaries to maintain his diary. And there was something else he was a pioneer of: networking. Anyone who was something became included in his 'connections'. If Ringers didn't know you, you didn't matter.

## Rather dull

Johan Ringers was born in Alkmaar, the son of a building contractor. He studied civil engineering in Delft from 1902 to 1906 and was thus on the spot when the Polytechnic School was given academic status and became the Institute of Technology. As in later life, he was diligent, serious, frugal, and in fact, rather dull. He didn't care a bit for the 'foul language' and 'drinking excesses' of the student union. Immediately after graduating (with top marks) he went to work for the Directorate for Public Works and Water Management. As just a young engineer he was given the supervision of the complicated and what would today be called innovative construction of a set of locks near the town of Hansweert in the canal that runs through the island of Zuid-Beveland, at the time one of the busiest waterways in Europe. Considerably ahead of his time, he argued, albeit to no avail, for the simultaneous construction of a tide-driven electric power station.

Following an interruption of four years spent on Java as the supervising engineer and ultimately managing director of the Dutch East Indian Railway, he returned to the bosom of hydraulic engineering in Holland. He spent nine years working on the Northern Locks at IJmuiden, at the time the world's largest shipping lock. He was to consider this project a high point in his life.

In fact his next job carried even more prestige. He became the managing director of the 'Maatschappij tot Uitvoering van de Zuiderzeewerken', the combination of contractors that drained the Wieringermeer lake and built the Afsluitdijk to separate the Zuyderzee from the sea, all in a matter of three years. These two projects put the Netherlands back on the map as a country of hydraulic engineers. And high time too, as Holland had lost its pioneering position early in the twentieth century. Initially, Ringers even had to travel to Germany every fortnight to get updated on the latest developments in the field. The Germans already knew how to use reinforced concrete, whereas the Dutch engineers still put their trust in wicker and rocks. The Germans also understood the benefits of scale model studies. Ringers introduced these methods in the Netherlands and so laid the foundation for the Hydraulic Laboratory. His combined work in 1930 gained the 'bearer of ingenuity' his Delft Honorary Doctorate in 1930. In the same year Ringers was appointed director-general of the Directorate for Public Works and Water Management.



*If Ringers couldn't solve the problem, nobody could*

## Delicate job

On the eve of the Second World War Ringers was asked to revive the country's neglected inundation defences to prepare against the possibility of a German invasion. It was an immense task, made delicate by the Dutch desire for neutrality. With the benefit of hindsight we know that it was also a pointless undertaking, since a twentieth century army was not going to be stopped by knee-high water. The German occupation put Ringers in a rather special position. Contrary to what we may think today the reconstruction of the country did not begin after the war, but began during the occupation – even within a week of the bombing raid on Rotterdam that brought the country to its knees. From as early as May 1940, with the consent of the occupying forces, plans were made and executed to rebuild Rotterdam and other badly hit towns, and repair the other ravages of war. The big man behind it all was Ringers, the 'Government Commissioner for Reconstruction and the Building Industry'. In a sense he was the (unpaid) emissary of the ▸▸

Grandees visit IJmuiden

Dutch government in exile, negotiating with the occupying power.
Ringers was a powerful man; nothing, not even a hen-house, could be built without his permission. The strict control was necessary because of the lack of materials and means. The Germans, who during the first years of the occupation still harboured hopes of capturing the hearts and minds of the Dutch population, left this section of the authorities in peace. Collaborators were carefully excluded from the public service structure Ringers created about his person. As was found after the liberation, 'a healthy Dutch heart beat within the organisation'. The Reconstruction organisation was later to evolve into the Ministry of Public Works and Waterways. Although Ringers was in a position that practically invited him to collaborate, he never fell for the temptation, as a parliamentary enquiry, stating the obvious, found after the war. He demonstrated his patriotism for example by publicly supporting the Jewish star engineer Josephus Jitta in a speech at TH Delft in March 1942. What's more, he took an active part in the resistance, both in practice, for example by passing on reports about the port of Rotterdam to England, but especially in the National Committee, which was preparing for the interim role of ruling authority in the Netherlands until parliamentary democracy could be restored. Ringers was the intended 'Temporary Commander', whose task was to prevent the liberated country slipping into chaos. After all, he was 'straightforward, a Dutchman through and through, not a plutocrat, not a politician', which made him acceptable to all parties.

Ringers as a young engineer

## Elite treatment

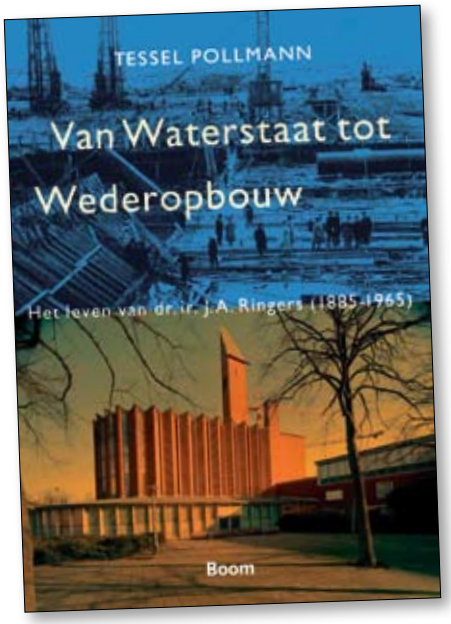
In April 1943, as a result of the 'Englandspiel' (or England Game), the group was betrayed, and Ringers, together with 150 others, was imprisoned in the Oranjehotel in Scheveningen. He was later transported to the Vught, St.-Michielsgestel, and Sachsenhausen concentration camps. In each of these the prominent Dutchman received elite treatment, and the other prisoners often elected him their leader. As a fellow prisoner put it, 'Ringers was made of material that could be bent, but would not break'. This lasted until two weeks before the end of the war, when the severely weakened Ringers got caught up in the Death March, the dreadful march back to Holland. The terrible hardship he suffered ensured that he would never be his old self again. According to Pollmann Ringers suffered from post-concentration camp syndrome after the war. In spite of this, he became Minister of Reconstruction and Public Works in the first post-war cabinet. His political career did not last long, as he had lost his knack of finding solutions in complicated conflict situations. After only two years he resigned over insurmountable differences of opinion regarding the Dutch policy on Indonesia. Although in many respects his was a progressive-liberal outlook, Ringers held rather old-fashioned beliefs on colonialism that did not fit in with the post-war era. He did not trust Sukarno, who after all had conspired with the Japanese, and he did not want to entrust the Dutch East Indies to such a man. As it turned out, Ringers' resignation did not result in his complete withdrawal from public life. He remained involved in trade and industry in many ways, and as late as 1953 he sat on the Delta Committee to rebuild the Dutch sea defences. Over four hundred pages about a civil engineer most of whose work took place – albeit often to his chagrin - within the four walls of meeting rooms in The Hague, does not sound very exciting.

Nonetheless, 'Van Waterstaat tot Wederopbouw' has become what is in places a compelling read, for two reasons. First of all, from 1974 until 1989 Tessel Pollmann was on the editing staff of the Vrij Nederland periodical, where she learnt (or perhaps already knew) how to put suspense into even the

*If Ringers didn't know you, you didn't matter.*

most unmanageable subject matter.
Secondly, a life of Johan Ringers at the same time documents the history of the Netherlands, such is the extent to which the two were entwined. The history of the Netherlands in the first half of the previous century was a tumultuous period involving: industrialisation, the decline of Dutch colonial power, and two world wars. Practically every Dutchman who was somebody crossed Ringers' path, from National Socialist leader Anton Mussert to social democrat prime minister Willem Drees. Pollmann does not confine herself to the grand scheme of things, however. In spite of the economy with which the businesslike, busy Ringers dealt with his personal views and daily matters in his letters and diaries, Pollman manages to extract precisely those things that make this written monument to an engineer and honorary doctor from Delft the story of all Dutchmen. An excellent read.

Tessel Pollmann: 'Van Waterstaat tot Wederopbouw – Het leven van dr.ir. J.A. Ringers (1885-1965)'. Boom, Amsterdam 2006. ISBN: 9789085062554. 448 p. geïll., € 25,-.




# [VAN BREUGEL]

COLUMN

## Responsibility

On 22 March, professors of TU Delft met to discuss the social responsibilities of scientists, with a special focus on Africa. I have yet to meet a colleague who did not consider the occasion a success. Anybody who has just finished reading W.F. Hermans' Among Professors will wonder how this is possible in the year 2007. Nonetheless, it is. In the meantime, it might be interesting to find out why the theme merited such an animated discussion. Was it the discussion leader's opening question: whether the group could find a definition of responsibility? Oh, the deafening silence! Apparently nobody had anticipated the question. And let's face it, no definition was found. Perhaps that was the reason why the remainder of the discussion proceeded in such a lively fashion.
Taking responsibility includes being accountable. But to whom? To Africa? If Africa asks the questions, who is going to have the guts to answer? Everybody knows the figures. Twenty percent of the world's population uses up eighty percent of the energy and raw materials. Millions of Africans have to live on a dollar a day or less. Thousands are dying from hunger. Generations are being wiped out as a result of aids. Witnesses of the way local agricultural projects are falling victim to decisions made by economic powers are left with little more than a feeling of impotence. These dilemmas have been written about time and time again. One could hardly expect that an afternoon session of Delft professors would produce unexpected results.
But then, if Africa leaves us mystified, who can wait for an answer? During the discussion one colleague said — if I remember rightly — that we build what we build for people. Building must be one of the oldest technologies known to mankind. Which is why the first building regulations date from around 2000 B.C. The code of Hammurabi lists the responsibilities of an engineer. If the collapse of a house were to result in the death of the principal, the builder should pay with his life. If the son of the principal were to be killed, it would cost the life of the builder's son. Fifteen hundred years later the Jewish book of Deuteronomy specifies that the flat roof of a house must be fitted with a parapet. Should the lack of such a feature cause a person's death, the builder would take on a blood-guilt. These ancient writings show us that people were allowed to aspire to greater prosperity and living comfort — stone-built houses rather than tents — but never at the expense of another person's life. The simple rule was that prosperity must not be achieved at the expense of others. Dare we examine our own prosperity to determine which part of the cost we have left, knowingly or otherwise, for others to bear? Or do we consider our level of prosperity to be an inalienable right, and do we pay lip service to the idea that others should enjoy the same level of comfort while we are fully aware that our planet is utterly incapable of supporting the concept? Anybody willing to have Africa question our responsibility should not only be prepared to wish good fortune to the other party, but also to share it, so that our prosperity may actually benefit those in need. That way, taking our responsibility seriously will become a whole new challenge.

**Professor Dr Ir. Klaas van Breugel is the managing director of the Microlab and educational manager of civil engineering at the faculty of Civil Engineering and Geosciences.**

An overview of the most important awards, appointments and othe remarkable personal particulars at TU Delft

DIMES, the Delft Institute of Microelectronics and Submicrontechnology, has a new scientific director. **Professor Dr Kees Beenakker** started in March as the successor to Professor Dr Joachim Burghartz, who left in September 2005 to work at the Stuttgart Institute of Microelectronics. In the interim, Professor Dr Ir. Patrick Dewilde acted as deputy director. Beenakker had worked at DIMES since 1989, and was considered one of the architects of the Delft-Chinese collaboration effort in the microelectronics field.

**Professor Dr Stamatis Vassiliadis**, who worked at the faculty of Electrical Engineering, Mathematics, and Informatics, died on 7 April. Born in Greece, he was Professor of the design of parallel/distributed embedded computer systems, and founder of the master's course of computer engineering at TU Delft. The international fraternity of electrical engineers, IEEE, and the Association for Computer Machinery both awarded him a fellowship. After his work for the IBM computer company, where he became the all-time top-ranking inventor with 74 patents, in 1995 he accepted a position at TU Delft. During the last assessment of the Electrical Engineering faculty, his research group, with over fifty doctorate students, was considered part of the international elite.

In the queen's birthday honours list **Professor Dr Ir. Harrie van den Akker**, who has been supervising the Kramers Laboratory since 1988, was made an Officer in the Order of Orange-Nassau in acknowledgment of his work for scientific teaching and his social involvement. **Professor Dr Ir. Henk Stassen**, former dean of the faculty of Mechanical Engineering and Maritime Technology was made a Knight in the Order of the Dutch Lion for his pioneering scientific work on prosthesis improvements, among other things.

On 1 May 2007 **Professor Dr D.D. (Douwe) Breimer** joined the Board of Trustees of TU Delft. He succeeds Ir. Drs. H.N.J. Smits, who had sat on the board since 1 July 2003. From 2001 until 8 February 2007 Douwe Breimer was the rector of the University of Leiden. Since September 2005 he had combined the post with that of chairman of the university's Board of Governors. Since 1975 he had worked for Leiden university as professor of pharmacology. From 1996 to 2001 he was also vice-chairman of the general board of NWO, the Dutch organisation for scientific research, and up to 1 September 1999 he was chairman of the medical section of the KNAW, the Royal Dutch Academy of Sciences. Since September 2003 he has been a member of the Innovation Platform. Breimer has published over five hundred books and articles, and he has received many honorary doctorates in recognition of his scientific work. In 2000 he was made a Knight in the Order of the Dutch Lion, and on 8 February 2007 he became an Officer in the Order of Orange-Nassau.

On 18 May the Military Technical Academy (MTA) of Bucharest bestowed an honorary doctorate on **Professor Dr Ir. Piet van Genderen** for his contribution to the scientific collaboration between TU Delft and the MTA in the field of telecommunication and radar. The MTA was originally a military technical university, but these days the academy is open to civilians too. Van Genderen has been a part-time professor of radar design techniques at the faculty of Electrical Engineering, Mathematics, and Informatics since 1994. He also works for the Thales company, which manufactures radar systems.

Planetary expert **Dr Daphne Stam** of SRON, the Dutch Space Research Foundation, is using a Vidi subsidy of 600,000 euros she was granted last year to reinforce a planet research group at the Aerospace Engineering Faculty. This new research group is now being formed at the department of earth-based observations and space systems, also known as DEOS. Stam is interested in particular in planets outside our solar system. Among other things she will be searching for exoplanets that may offer conditions suitable for the development of life.

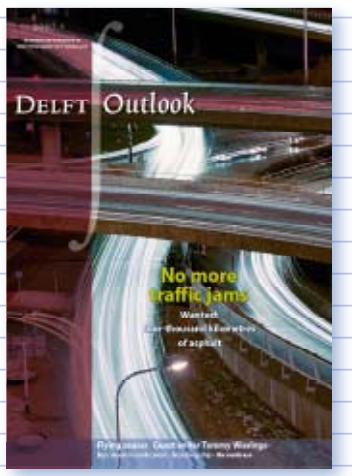
**Professor Dr Ir. Piet Wesseling** has been made a Knight in the Order of the Dutch Lion in recognition of his contribution to the development of analysis methods in numerical mathematics for a host of technical applications, including the calculation of water levels in seas, airflows around aircraft, and the flow of water around ships' hulls. Wesseling received the decoration on 6 June from the mayor of Bloemendaal on the occasion of his retirement as professor of numerical mathematics at the faculty of Electrical Engineering, Mathematics, and Informatics.

After more than thirty years as a professor at TU Delft, **Professor Dr Ir. Guus Berkhout** retired on 8 June. In addition to holding the chairs of geophysics and innovation management, for the past 25 years he has been on the board of the Delphi consortium, in which TU Delft and oil and gas exploitation companies develop know-how for seismic measuring methods. Until his appointment to the Board of Governors of TU Delft in 1998 Berkhout had been professor of acoustics.
During the symposium to commemorate his retirement, his colleagues recalled Berkhout's achievements in the fields of acoustics, geophysics, and innovation management. Berkhout, a co-founder of the European Centre for Innovation, wrote hundreds of scientific publications and a number of books, including 'The dynamic role of knowledge in innovation'.

## Four thousand kilometres of tarmac (1)

An article carrying the title 'Wanted: four thousand kilometres of tarmac' (Delft Outlook 2007.1) presented a 'motorist's dream' based on research at the transport and planning department of the faculty of Civil Engineering and Geosciences. The cover of the issue billed the article as "No more traffic jams'. Soon, so the article states, the new road network based on this thought experiment would be presented to the trade press. I can only hope for a little more reflection before this actually happens.
Drawn on a general map of the Netherlands, a ten-lane motorway between Rotterdam and Amsterdam connects two dots. However, when we arrive at he end of the massive motorway, Amsterdam turns out to be anything but a single dot. It is a large city somewhere in which our destination is to be found. The city has its own traffic space, which not only is very limited in capacity when compared with a ten-lane motorway, but which also has to deal with its fair share of in-town traffic. A city like that would not even be able to cope with the enormous influx of cars, and the ten-lane motorway would soon become a ten-lane shunting yard, nothing but a very wide car park.
The bird's eye view of the national road map has resulted in an error of scale. In the article, the researchers state: "We have been thinking too small by several orders of magnitude." I maintain that the reverse is the case, and that they are thinking too big by several orders of magnitude.
A second issue is that the design of a new road network presumes the existence of the current urban structure and the current transport demand rather than a future scenario (whether desirable or not). Since cars, whether mobile or stationary (parking space!), take up lots of space, any urbanisation based on motorised transport will take up increasing amounts of space. It will stimulate an increasingly expanding range of destinations, and consequently, dispersion – dilution – of the transport demand. This contrasts with an urbanisation based on collective transport, which requires the bundling of transport demand, i.e. the concentration of destinations. Needless to say that collective transport takes up much less space per individual.
The above is not intended to detract from the usefulness of thought experiments. They can be extremely useful when analysing complex problems, even if they lead to results that are socially unacceptable. I have maintained for years that motor transport in this country would benefit from a considerable reduction in the number of main road exits (trunk traffic, with an underlying road network for local traffic connecting the limited number of exit locations. This is analogous to the system of service roads we know from shopping streets, but at a much higher level of scale. The system matches the existing system of fast and slow trains, although they do not need to run on dedicated rail networks.

*Dr. Ina Klaasen, associate professor of urban design and planning/spatial planning, faculty of Architecture.*




## Four thousand kilometres of tarmac (2)

I could hardly believe my eyes as I read the article 'Wanted: Four thousand kilometres of tarmac' (Delft Outlook 2007.1) by Maarten Keulemans. Ms. M. Snelder will be receiving a doctorate for her efforts. No more traffic jams.
The plan will reduce travelling times by seventeen percent, in addition to saving us two hundred euros every second (easy money!). The traffic on Ms. Snelder's motorways will be hurtling four to five lanes wide in each direction straight through the Green Heart, over the Veluwe nature reserve, and through the Midden-Delfland area. Issues such as noise and air pollution and lack of space are ignored for the moment. Nor does climate change count. The cost of bridges, tunnels, and viaducts is also disregarded. What our cities will be looking like remains unclear. The fact that commuting distances will increase, resulting in more motor car use, does not appear to play a role.
To cap it all, the A4 (widened to triple lanes each way and finally completed) after half a century cuts though the Midden-Delfland no-noise area.
Ms. Snelder's experiment is about motoring mobility. I have always understood mobility to show many different facets, including cycling, public transport, shipping, flying, and lest we forget, walking (five kilometres per hour). To my mind a cohesive research effort on the subject would be much more useful than this exercise in futility. The article is not worthy of Delft Outlook.

*P. van Bruggen, member of the Stop RW19/A4 Foundation.*


HORA·EST

# Propositions

In an educational system it is not always clear who gets to learn most, pupil or teacher.
*Made Rri Ari Penia Kresnowati*
Chemical engineer

A croquette is a culinary black box.
*Kjelt van Rijswijk*
Aerospace engineer

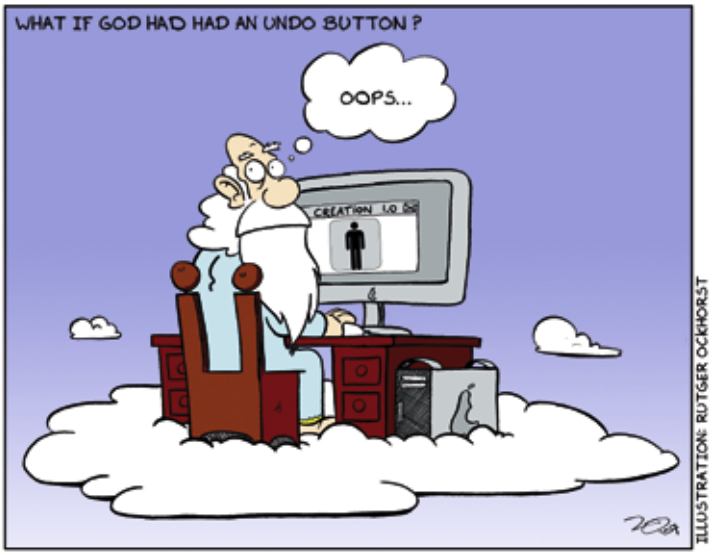
Family planning provides a better means of saving water than water management.
*Karen Meijer*
Civil engineer

The rule that states that the exception proves the rule is proven because there is no exception to this rule that can prove it.
*Ton Hubregtse*
Chemical engineer

Solvitur ambulando (solutions are found while walking). This argues for the introduction of workplaces with walking space.
*Marieke Sonneveld*
Industrial designer

Polytechnics become universities when their real estate list passes fifty years of age.
*Jackie de Vries*
Architectural engineer

The truth shows where differing opinions collide.
*Maarten van Reeuwijk*
Civil engineer




Commercial software without an 'undo' button is out of date.
*Olivier Hoes,* civil engineer

# [Sound]bites

"American people like to think that the stars and stripes are still standing on the moon. The fact is, the flag fell over on our return to earth. Because this is such a sensitive issue in the U.S. we decided not to mention it."
*Buzz Aldrin, former astronaut, in a lecture at TU Delft*

"Demolition of cheap rented housing and replacement with more expensive purchased houses lead to the dispersal of a large part of the original residents. It is no longer poverty itself, but the poor that are being fought."
*Dean Prof. Ir. Wytze Patijn of the faculty of Architecture about the Stadsvisie Rotterdam 2030 program, in NRC Handelsblad*

"Given fine weather you can even see the sea. But of course, it also works the other way round, and the tower will be visible from a long way off. That is the downside."
*Drs. Frank Wassenberg, researcher at the OTB research institute, about the proposed Belle of Zuylen tower in Utrecht, in NRC Handelsblad*

"Public transport currently suffers from a bad image. This is because people keep repeating the same horror stories about trains with square wheels or leaves stuck to the track. Just a few delays, nothing more, but the stories have taken on a life of their own."
*Dr. Ir. Remon Rooij (Architecture) in Trouw*


Photo: Sam Rentmeester/FMAX

"The soles of our feet are being neglected as organs of touch."

Defence
"Like hands, the soles of our feet are there to perceive the world, but from day one we encase them in shoes. We even get buried wearing our shoes. We spend preciously few moments on our bare feet, and when we do, we tend to be unaware of the fact. Unlike the way we enjoy stroking a cat, we don't enjoy touching with our feet. And we could, for example by walking on bare feet through the grass in the spring. I give massages, and people love it when I massage their feet. I'm hoping that feet will receive more attention. I hate to think of all those feet stuck inside all those shoes."

*Marieke Sonneveld*
Industrial design engineer

An alumnus of TU Delft writes a column and passes the pen on to another alumnus of his or her choice.

I always get these surprised looks from people when I answer their question where I attended university. And then – even after all these years – I find myself having to use too many words to explain why my current line of work isn't so strange. Being a banker at the National Microfinance Bank in Tanzania. Before that, general manager of a sawmill and chipboard factory, also in Tanzania. And my working life started with seven years at the ING bank.
The nice about it is that after Delft most problems tend to be not so complicated. Learning to be a banker turned out to be much simpler than building aircraft, and in my previous job I was able to calculate down to many decimals how much damage our company was sustaining due to the staggering corruption around us. Giant spreadsheets enabled us to keep a tight rein on the business and to rapidly detect the theft (usually by our own employees) of diesel in stock changes or increased fuel consumption of lorries. On the other hand, in Delft you at least managed to solve the problem by calculating it. In these parts calculations only let you know the extent of the problem. Even worse, while you're doing your sums the problem usually gets worse. And nobody wants to see your calculations, let alone believe you.
Fortunately you don't stop learning when you graduate. Attending TU Delft gives you a firm footing and when you graduate you find so many companies wanting you that you can choose where you start to work and where you go on from there. The people at ING welcomed the fact that I wanted to work in a field that meant little to me at the time, commerce. After less than two years as a trainee I became a regional manager at the ING Bank. And even though the problems were a little less complex during that period, I did learn an awful lot. After seven years at ING I finally decided that I wanted to learn other things, and I found a challenge in the field in which my father worked, tropical forestry. And now I'm in microfinance banking.
These days I spend a lot of time travelling through Tanzania, and I think that innovation, technical or otherwise, can provide a solution to many problems, provided the implementation is not too much of a problem. The productivity of the country is still very low, and this is partly due to old techniques and ditto equipment. The important thing is that the local population are participants rather than recipients. So instead of foreign aid taking the form of providing ready-made solutions (and financing them as well), we should discuss the problems together and help find the ways to means and know-how. A small loan to the entrepreneur will greatly improve a scheme's viability compared with a fully financed solution. With my still rather limited experience of Delft, banking, and Tanzania I see this as the solution, and that is what I want to put effort into.
There you go, another 450 words.

*Arjan Poels*

Ir. Arjan Poels (33) studied Aerospace Technology from 1991 to 1998 at TU Delft. He now lives and works in Dar es Salaam, Tanzania. Arjan Poels passes the pen on to TU alumnus and mechanical engineer, Ir. Michiel Mol, who runs his own furniture-making business.



# Air-filter hedge

Photo: Sam Rentmeester/fmax

Three wires, a piece of chicken wire, and a hedge. That is all that the general manager of the botanic garden, Drs. Ing. Bob Ursem needs to filter fine dust from the air.

Maaike Muller

By adding a positive charge to the fine dust particles that float over a motorway, Bob Ursem can pull them from the air as if they were magnetic. Ursem recently applied for a worldwide patent on his invention.
A major component of the fine dust magnet consists of three thin wires that are suspended between the lamp posts, high above the central reservation of a motorway. The wires carry a high voltage, causing them to send out positively charged particles. "The fine dust gets bombarded with positive particles, as it were," Ursem explains. When the two collide, the neutral dust becomes positively charged as well. "This creates a space cloud with a positive charge."
The positively charged cloud is attracted by anything with a negative charge. The earth for example, or the chicken wire and the hedge in the scheme devised by Ursem. These also carry a negative charge, as they are connected to the earth. The scheme provides for a three-metre high fence of stainless steel chicken wire behind the crash barrier. When the cloud of fine dust passes the chicken wire, many of the particles will stick to the wire. Any dust that passes through will end up in the hedge behind the barrier. Ursem: "The hedge would be formed by conifers, yew for example, which has a good filtering action thanks to its many needles. The result will be that instead of floating in the air, the dirt will be trapped on the road surface, the chicken wire, and the hedge. "These can be cleaned at regular intervals, by rinsing with water, or by applying a magnetic field."
Ursem got the inspiration for his scheme from the clean-air box he keeps in his room. It purifies the air by charging airborne particles, which are then pulled into the box. "I thought I'd scale the thing up to super size, and add plants to filter the exhaust fumes." In collaboration with the bam building company he tested his idea on a purpose-built stretch of road. The system managed to remove about two-thirds of the natural fine dust particles from the air. These are particles of sand, sea salt, and clay. It also removed two-thirds of the fine dust produced by petrol engines, and just over one-third of the particles resulting from diesel combustion. Ursem: "That was without the hedge. We are now conducting tests with the edge added, which will yield even better results."
Ursem hopes to have the first wires suspended along motorways before the year is out. "There are other places besides motorways where the system can be of benefit. Demolition sites, for example, or busy streets in towns."

More information: Drs. Ing. Bob Ursem, w.n.j.ursem@tudelft.nl.

# 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.*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