2007.3

Research and education at
Delft University of Technology

Delft Outlook

Clouds

A foggy factor in climate change

Breezy bed • **Spinoza Award winner Leo Kouwenhoven** •
Blood balloon • Ground water magic • **Why cyclists stay upright**

Contents

2007.3

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Delft Outlook

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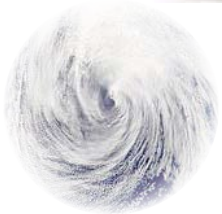
The role of the engineer will be the centre of attention during the anniversary symposium, 'Sustainable solutions, focus on Africa' on 1 and 2 November. The engineer as researcher, expert, developer, manager, inspirer. A number of them are presented in this issue of Delft Outlook. We have cloud researchers Jonker and Russchenberg, who are using new insights in an attempt to unravel the link between clouds and our climate. There are Kooijman and Schwab, who are increasing our fundamental knowledge about the way a bicycle works in an attempt to arrive at the ultimate model. Then there is Spinoza Award winner Leo Kouwenhoven, who from time to time gives his doctorate and postdoc students the prod in the back they need to take the next step. And there is professor Savenije in Tanzania, stimulating his doctorate students in the irrigation project they are developing together with local farmers.

Frans Godfroy
Editor-in-Chief

7



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5

COLOPHON

coverphoto

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No hands

Playing a CD, talking on the phone, processing an e-mail, or simply turning your seat around to chat with your passengers, while the car continues on its course on autopilot. Soon it will all be possible with the C,mm,n (pronounced 'common'), the car of the future.

The car of the year 2020 is an open-source project, so anyone can help develop the vehicle, which runs on hydrogen gas. Industrial design students Neele Kistemaker and Caroline Klop started by designing an interior that reads a driver's body language to see what is wanted apart from driving.
The driver sits in a swivel seat with the steering wheel attached to it. Push the wheel lightly away from you, and you are in full control of the car. Pull the wheel towards you, and you automatically engage cruise control. With the wheel turned partly away, the driver decides only which road to take.
A display provides information about speed and energy use. A touch screen incorporated in the window frames enables the driver to play music, make a phone call, or send short e-mail messages. Other C,mm,ns provide the car with information about congestion and road works. If you push the steering wheel away to talk with your passengers or watch a screen in the rear window, the autopilot will let the car join other C,mm,ns in procession. Safety systems such as ABS and sensors take over control from the driver so you can let yourself be driven by the car.

More information:
www.autoindetoekomst.nl

IN·BRIEF

Linked qubits

The fundamental calculation unit of the quantum computer finally exists. Researchers at the faculty of Applied Physics have created it.

For qubits – quantum-mechanical data carriers – the researchers used superconducting rings. They were rewarded with a publication in Nature.
With his work, the main author of the article, Ir. Jelle Plantenberg, has reached a major milestone in an ongoing Delft research project on superconducting rings. Back in 2000 some of Plantenberg's fellow researchers proved that electrons can flow through the rings both clockwise and counterclockwise. This energy state, known as superposition, is a prerequisite for quantum-mechanical calculations. Two years later they were able to set the rotation direction of the electrons at will.
Plantenberg has now succeeded in linking two of these qubits. The current in one of the two rings, the control qubit, induces a small magnetic field, which changes the energy state in the other ring, the target qubit. This enabled Plantenberg to use the qubits to create what is known as a controlled NOT gate, the basic mathematical unit of the computer of the future, the quantum computer.

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Breezy bed

No more sticky nights with this air-conditioned bed designed by industrial design students Thomas van den Groenendaal and Yoeri Nagtegaal. Why cool an entire bedroom if there is a more economic alternative? Nico Visser, who is professor of sustainable tourism at the National Academy for Tourism and Traffic, together with ecoconsultant Tim van den Brink asked the students to tackle this problem. The result is a cooling unit that uses a tube to conduct air over the bed, where the cool air descends softly and quietly. A knob at the head of the bed can be turned to set the air-conditioning unit to one of four positions: breeze, fresh, cool, or cold. This month the students will be visiting the island of Bonaire, where they hope to discover that the unit provides comfort to guests and hotel owners alike. Three local resorts will be providing a room in which guests can try the bed.

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Ball bridge

No concrete, no timber, no steel, but twelve thousand plastic balls are what Ing. Tillmann Klein of the Faculty of Architecture used to create this bridge. Together with a group of students he filled a plastic bag with the small components. He then sucked the air out of the bag, creating a structural arc capable of supporting weight. The researcher was inspired by vacuum packed coffee.

PHOTO: SAM REN[illegible]STER, FMAX

Twisted DNA

ILLUSTRATION: TU DELFT/TREMANI

The drug Topotecan fights cancer by disrupting the process of cell division. But how the drug works exactly remained unclear, until Delft researchers at the Kavli Institute for Nanosciences managed to get a live look at the process inside a DNA molecule.

They observed how Topotecan causes the enzyme topoisomerase to become attached to the DNA. This prevents other enzymes from reaching the DNA to duplicate it. This effect, which was already known, disrupts the cell division process, causing the cell to die. "Healthy fast-dividing cells are also killed, resulting in such side-effects as hair loss," researcher Dr. Daniel Koster explains, "but the drug directs most of the damage at cancer cells."
Koster and his colleagues also discovered an effect that had so far remained unknown. As the DNA is duplicated, it becomes twisted, like a telephone lead. The topoisomerase normally removes the twists by unwinding the DNA. Topotecan slows down this process, so the DNA remains twisted, which inhibits cell division. The discovery is such a breakthrough that it earned the researchers a publication in Nature.

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Even the smallest droplet counts

The observatory at Cabauw is packed with advanced instruments for atmospheric research. Even so, the International Research Centre for Telecommunications and Radar (IRCTR) of Delft University of Technology thought there was still something missing, a radar device that could see the minutest water droplets inside a cloud.

Photo: Sam Rentmeester/FMAX

"We must be able to see these very small droplets if we are to understand how clouds are formed and disappear again," says Herman Russchenberg of the IRCTR. "Knowledge about the life of a cloud is important to understand how the climate develops. After all, clouds also reflect sunlight." Over a period of four years the IRCTR developed a highly sensitive and accurate drizzle radar system capable of detecting very small droplets of water. Russchenberg: "The radar images included in television weather reports show that the air contains a lot of water, but they are not accurate enough to show how much exactly. The purpose of the new radar system is to measure this property, albeit it for a much smaller expanse of sky." The system was installed in August on a 200-metre high tower at Cabauw, rising above buildings and trees that could affect the readings. The installation had to be postponed a few times because of the high winds that often occur at such heights. By late September the drizzle radar system readings will start to help unravel the mystery of how rain is formed.

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Page 24: A foggy factor in climate change

Photo: Hans Stakelbeek/FMAX

Solar race

Late in October Nuna 4, the fast solar-powered car built by aerospace engineering students, will be defending its title at the World Solar Challenge in Australia. Nuna 4 is slightly slower than its predecessor, because the driver sits in a more upright position and the new car carries fewer solar panels. The students think it may make for a closer race than in previous years.

More information:
www.nuonsolarteam.nl.

IN·BRIEF

Anniversary symposium

What can universities of technology contribute to the sustainable development of developing countries, and African countries in particular? And what is the engineer's role in the process? These are the central questions to be discussed during the international Delft University of Technology Anniversary Symposium on 1 and 2 November.

Introductory speakers include the prime minister Jan Pieter Balkenende, the minister of development cooperation Bert Koenders, and Jeroen van der Veer, chairman of Royal Dutch Shell. From South Africa comes Khotso Mokhele, president of the National Research Foundation, to reflect on the importance of sustainable solutions from an African perspective.
During the symposium international guest speakers will present cases focusing on the central themes of the symposium: water, energy, mobility, and health. Preceding the symposium, on 31 October departing professor Saul Lemkovitz has organised an event during which the symposium participants and other interested persons can sharpen their minds on a number of mainstays of sustainable development: economics, politics, and society.
The rector, professor Dr Ir. Jacob Fokkema, is looking forward to guests, both Dutch and foreign, actively participating: "Their contribution forms a major source of input for education and research in the field of sustainable development for developing countries".

More information: www.lustrum.tudelft.nl.

IN·BRIEF

Speaking in icons

Primary school children in different countries communicating in an icon language to overcome differences in language and culture. Four Delft information technology students came up with the concept, which they named Iconnect, and they are currently working on a practical implementation. Iconnect comprises three components: a chat screen, a game screen, and a video screen. Children aged six to ten can use the chat screen for classroom communications in the icon language. The game screen can be used to compose pictures using images from one another's countries, or to play a memory game. The video screen can be used by the children to see one another using a webcam.
The students' idea won them first place in the Dutch preliminary of the Imagine Cup 2007 programming contest. They finished in twelfth place in the worldwide contest held in August.

More information:
www.icon-nect.nl.

Space can

Delft students will probably be launching their Delfi-C3 satellite into space this autumn.

The nanosatellite, the size of a can of soup, will be able to hitch a ride on an Indian rocket. The satellite was developed in a joint project with a number of polytechnics by graduate students of the faculties of Aerospace Engineering and of Electrical Engineering, Mathematics, and Information Technology, in collaboration with Dutch Space, TNO Industry and Technology, Systematic Design, the National Aerospace Laboratory, and MicroNed. The students hope to use the nanosatellite to test a new type of solar panel and a solar sensor.
The launch will be Delft University's first. The plan is to launch another two satellites in formation orbits around the earth by 2012 at the latest, together with the Chinese university of Tsing Hua. The purpose of the satellites is to observe the earth and collect data on phenomena such as rising sea levels and sinking land masses. Tsing Hua has previously launched two microsatellites weighing approximately 25 kilos.

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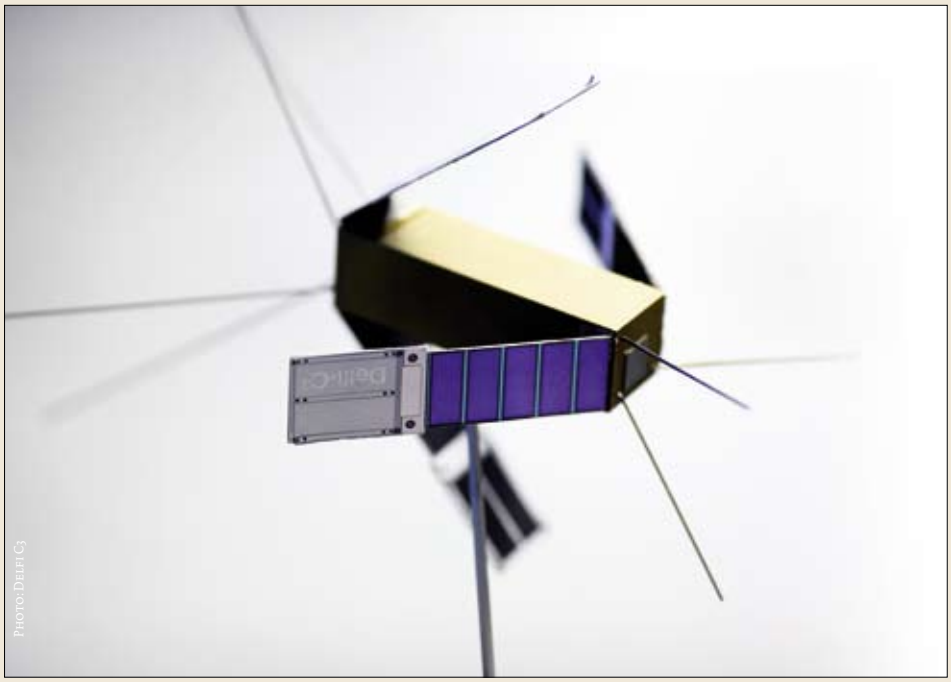

Photo: Delfi C3

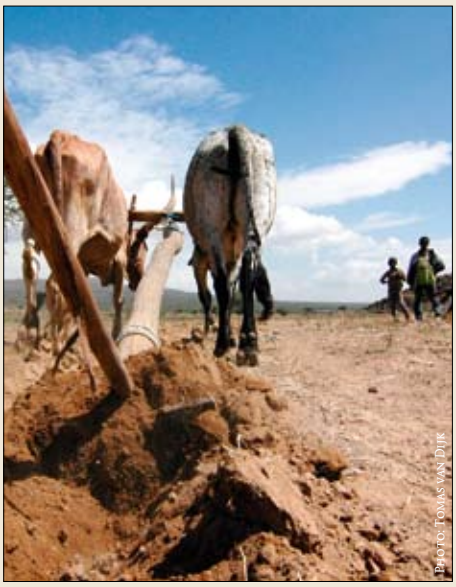
Photo: Tomas van Dijk

Tilling the soil

New ploughshares would enable Ethiopian farmers to increase their annual grain output by 23 percent, and to work the land in a more sustainable manner, according to Dr Ir. Melesse Temesgen.

"The problem with the Ethiopian plough, known as the Maresha, is the method of crosswise ploughing," says Temesgen, who completed his doctorate research at the faculty of Civil Engineering and Geosciences. "To grow the local grain, teff, farmers use ploughshares to draw V-shaped trenches in the soil. They cannot work in the adjacent strips of soil in the same direction, as this would cause the ploughshare to skip into the existing furrow. To work all the available land, the farmers cut their furrows at right angles thus speeding up soil erosion.
To solve the problem, Temesgen introduced five new types of ploughshare based on Western models. These can be readily attached to the wooden structure of the Ethiopian ploughs. One type is a real share, a curved piece of trapezium-shaped metal that cuts the soil from below and throws it to one side, making crosswise ploughing a thing of the past.

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Delft researchers unravel the bike's operating principle

Bicycles made to measure

For almost a century and a half, mathematicians have been racking their brains about the bike. How can a rolling bicycle be so stable of its own accord? Delft researchers now say they have completed the model to end all models. Bicycle manufacturer Batavus intends to use it to make better bikes for the elderly and disabled.

Tomas van Dijk

The conveyor belt passes at speed under Ir. Jodi Kooijman and his bicycle. Kooijman, an enthusiastic off-road cyclist, pedals until his speedometer indicates sixteen kilometres per hour. On the sideline, Dr Ir. Arend Schwab of the Faculty of Mechanical Engineering, Maritime Technology, and Material Sciences (3ME), at the agreed upon moment, yanks a rope attached to the bike's luggage carrier. For a brief moment Kooijman veers to the right, but his bicycle regains its balance within a fraction of a second, appearing to automatically retrace 'the line'.

This video-recorded incident took place on a large conveyor belt at the department of motion sciences of Amsterdam Vrije University. The experiment is just one of those the two 3ME researchers have carried out in the past couple of years to test a mathematical model defining all the forces that act on a moving bicycle. A publication about this bicycle model recently appeared in the 'Proceedings of the Dutch Royal Society', the Royal Dutch Academy of Science.

Schwab shows another video recording. Here, Kooijman is giving a bicycle a hefty push. The bicycle is laden with measuring equipment and the carrier holds a laptop computer that records the bike's every movement. The unmanned bicycle rolls on following a straight line in the sports centre of Delft University. Kooijman runs after it and pushes the bicycle sideways. The bike wobbles a bit, the handlebars move from side to side, but the bike soon regains it's straight course.

"The bike's speed must be between fourteen and twenty seven kilometres per hour," Kooijman says. "At those speeds, the bicycle is inherently stable. If it goes faster, it will wobble less, but if you then push it sideways it will lean over to one side until it topples. The data match our model predictions exactly."

Balance in motion

Ever since the invention of the pedal-driven bicycle around 1860, researchers have been trying to determine what makes a bike fairly stable of its own accord. They added formula after formula, each one of them derived from the laws of motion as defined by Newton and Euler, but they never managed to develop a completely accurate model for predicting a bike's riding characteristics.

"Bicycle manufacturers never knew exactly how a bike works either," Schwab says. "They have always had to resort to experiments to improve their products. Not that there's anything wrong with that, but now they can use our model to feed into a computer all the factors affecting a bike's steering properties. The model then calculates how the bicycle will behave at different speeds."

Together with colleagues at Cornell University in the U.S. and at Nottingham University in the U.K. the Delft researchers perused more than fifty publications written by scientists on the subject since the early days of the bicycle. Many mathematicians claim that the bicycle mainly derives its stability from the fact that it takes effort to change the direction of a rotating mass, the gyroscopic effect.

Scientists never managed to develop an accurate model that could be used to predict a bike's riding characteristics

"The gyroscopic effect certainly plays its part," Schwab says. To demonstrate this, he produces a wheel weighted with lead around the rim, and gives it a mighty jerk. Only with great difficulty can the wheel be made to change direction.

"However, mathematicians who took this principle to heart were wrong," Schwab continues. "When we disregarded the weight of the wheels in our model we

Photo: Sam Rentmeester/FMAX

Photo: Sam Rentmeester/FMAX

Arend Schwab explains bicycle research using a toy bike.

discovered that it was still possible to make the bicycle stable. And there is no truth in the idea that bicycles with small wheels are unstable."

Countersteering

We all know intuitively the main combination of forces that ensure we stay upright when riding a bicycle. They involve leaning over and steering and they explain why, when we wish to turn to the right, we have to first turn the front wheel slightly to the left. The action, known as counter steer, results in a force that causes the bicycle to lean over to the other side, which is the direction in which we wanted to go. This also explains why we fall over if we pass too close to a kerb. We just can't manage to get away from it without hitting it.

As for the steering properties, the greater the angle at which the fork of the bicycle points forward, the more stable the bicycle will go in a straight line, but also the more difficult it will be to go round corners. "The distribution of mass is also very important," Kooijman says. "Moving the centre of gravity of a bicycle forward makes it more stable."

150 Years of bicycle research

The fact that a velocipede, as the (still front wheel-driven) bicycle was known in its infancy, turns corners by first steering in the wrong direction, was proved in 1869 by Scottish engineer and physicist William John Macquorn Rankine. The fact that countersteer is also used to maintain balance however, wasn't proved until in 1897, when French mathematician Emmanuel Carvallo published his 180-page, award-winning monograph on the dynamics of monocycles and bicycles.

The French scientist was also the first to realise that the amount of trail is extremely important for a stable bike ride. The trail is the distance between the point where the steering axis intersects the ground and the point where the front wheel touches the ground. The trail causes the wheel to follow the direction of the vehicle. Vehicles with a large amount of trail, such as old-fashioned bicycles and Harley-Davidson motorcycles, give a more comfortable ride, but don't corner as easily as vehicles with less trail.

"Unfortunately, Carvallo had disregarded the weight of the fork in his model," Schwab says. "As a result his model wasn't accurate."

Around the turn of the century British mathematician Francis Whipple also published a model covering the bicycle's riding properties. "He came very close," Schwab says, "but his equations have a few minor errors in them. Apparently, some of the plus and minus signs accidentally became transposed when his article went to press, so we cannot draw any firm conclusions from his work."

German researcher Ekkehard Döhring was the first to present a fully accurate model for the self-stabilising properties of a two-wheeled vehicle. He also experimented with a few motorcycles. In 1955 he finished his doctorate thesis on the subject, but he was never able to verify his model experimentally.

The Delft scientists included twenty five such parameters in their model. All of them are relate to the two connected motion equations, one for leaning over and one for steering. "It remains unclear how exactly all these parameters affect the stability," Schwab says. "In the final model these parameters appear in fairly complex forms as coefficients to the motion equations. For practical purposes most researchers used to simplify the equations by disregarding certain parameters, but the results tended to be far from ideal. And scientists who failed to make the connection between leaning and steering certainly were on the wrong track altogether."

Thoroughbred

A model that indicates whether a design will result in a thoroughbred racing bike or in a stable ride suitable for the elderly, is something the bicycle industry has been eagerly awaiting. Rob van Regenmortel, product development manager of bicycle manufacturer Batavus, is following the Delft research effort with an eagle eye. Van Regenmortel: "Traditionally, when designing a bike, we use three parameters: the general geometry, the distance between the axles, and the angle at which the fork points downwards. Most of these properties were established back in the 1970s. Take the angle of the tube that carries the saddle. On our old-fashioned bikes this tube is mounted almost vertically. On bikes made by Gazelle on the other hand, it is inclined slightly more backwards. These are simple design choices all bicycle manufacturers made at one point and which they then more or less stuck to for the simple reason that their products kept selling. Now that we have Schwab's model, we hope to be able to start designing bicycles aimed directly at special target groups."

'Bicycle manufacturers never knew exactly how a bike works either'

Van Regenmortel would like to collaborate with Schwab and Kooijman on a future project that will also look at the riding behaviour of the cyclist. The ultimate goal of the bicycle research effort is to include the cyclist's riding behaviour in the model so as to be able to investigate the combination of the bicycle and its rider. "We could then actually make a 'tailor-made' bicycle for everyone," Van Regenmortel says. "People who find it difficult to maintain their balance would no longer have to ride a tricycle."

Ultimately, the model is intended to improve customer communications. "Perhaps we could label bicycles with numbers to give customers an idea of their riding properties. People looking for a bike to carry lots of luggage on holiday could then be recommended a type two bicycle, say, and someone needing transport to work and back might be wanting a slightly more thoroughbred machine, say type four. It's just an idea."

But how do you measure people's riding behaviour? On the conveyor belt in Amsterdam, Kooijman and Schwab have already collected some manned bicycle data through the simple expedient of riding the test bikes themselves. "Scary is the word," Kooijman says. "You're cycling at some speed inside an enclosed space without moving forward. It feels very weird. You're constantly afraid of hitting the wall. We can't ask elderly or disabled people to ride a bicycle that way to collect data. In future we will have to conduct our tests on the road, and then copy the cycling behaviour in a robot bicycle."

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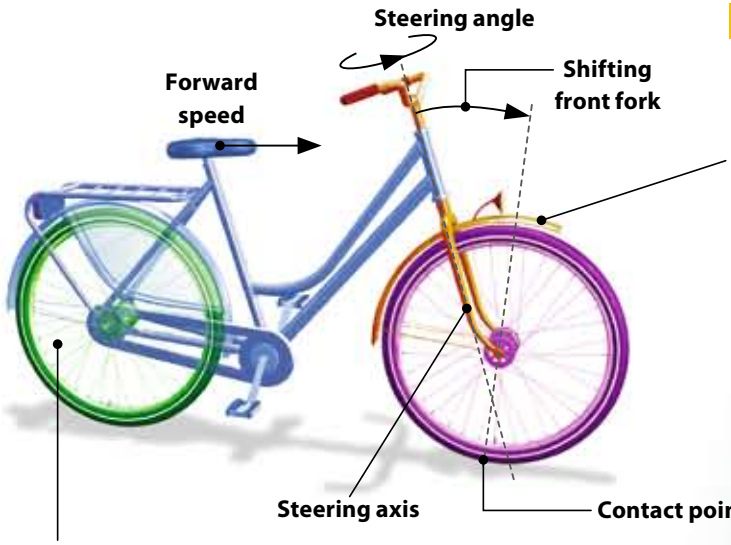
www.ocp.tudelft.nl/em/staf/schwab/.

Learning to ride a bike. The principle of leaning and steering is not easy to acquire, but once learnt it is never forgotten.

To make a lefthand turn

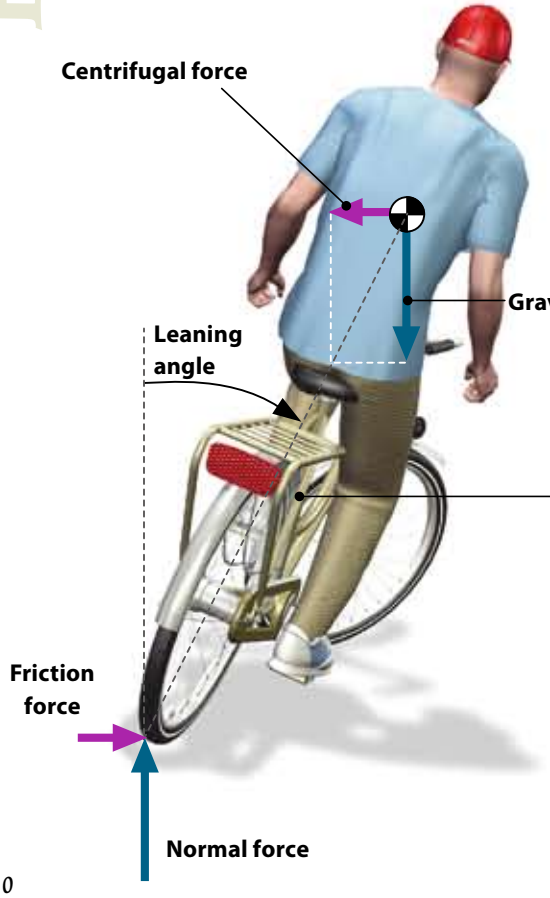


Bike model

A bike model is used to simulate the balance and steering behavior of a bike. This models uses 25 parameters to describe the bike (four bodies: rear wheel, rear frame + cyclist, front frame and front wheel) and has three degrees of freedom: leaning angle, steering angle, and forward speed. The result of the calculation model agrees precisely with the experiments. The model moreover clearly shows that no one parameter dominates the dynamic behavior of a bike. In this way for example the gyroscope effect of the wheels contributes to the stability. But also without this effect: that is, with mass-less wheels, the bike can still be self-stabilizing.

Bike turns to the left

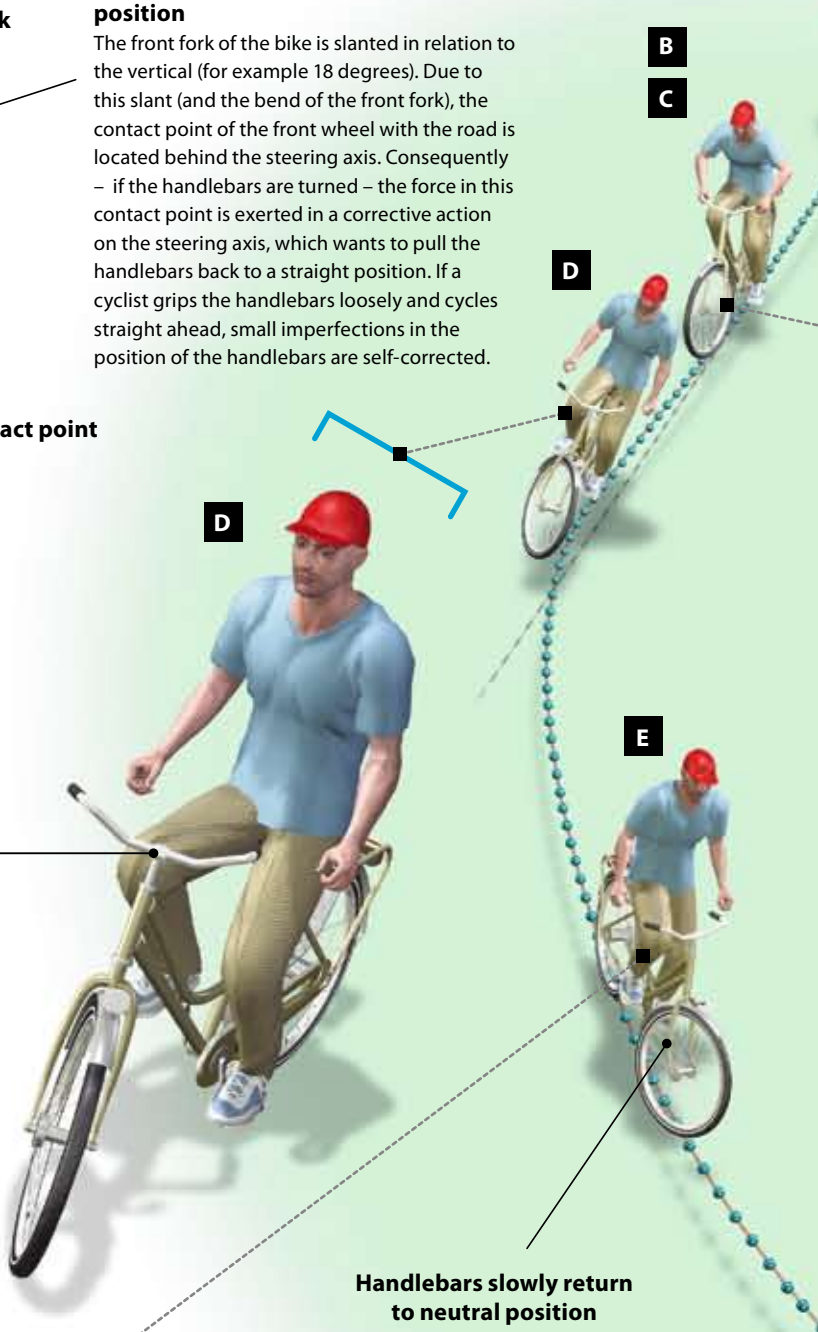
The handlebars are further turned to the left, while the bike leans more and more to the left. The bike turns to the left. After 2 seconds, the handlebars and leaning angle are at a maximum, 10 and 14 degrees respectively.



BIKE CHARACTERISTICS 1

Handlebars want to return to straight position

The front fork of the bike is slanted in relation to the vertical (for example 18 degrees). Due to this slant (and the bend of the front fork), the contact point of the front wheel with the road is located behind the steering axis. Consequently – if the handlebars are turned – the force in this contact point is exerted in a corrective action on the steering axis, which wants to pull the handlebars back to a straight position. If a cyclist grips the handlebars loosely and cycles straight ahead, small imperfections in the position of the handlebars are self-corrected.



Handlebars slowly return to neutral position

The bike makes a curved line back to the left, as the handlebars and leaning angle gradually decrease.

BIKE CHARACTERISTICS 2

For every leaning angle, there's a corner

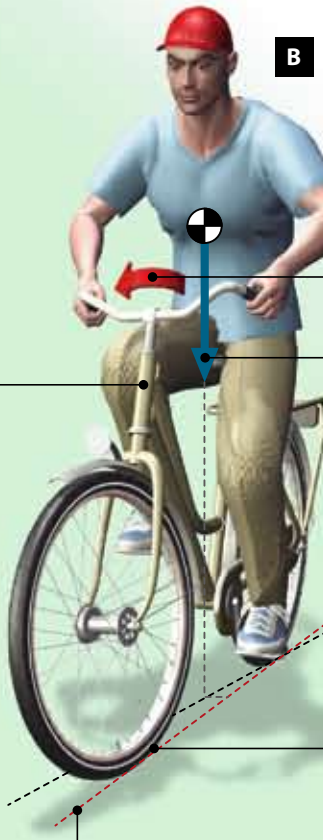
When a bike enters a corner, the cyclist leans to the inside. The force of friction from the ground on the tires is perpendicular to the speed. This center-seeking or centripetal force propels the cyclist through the bend. The cyclist balances between the tendency to fall over under its own weight and the tendency to break out of the bend. The bike does not fall over as long as the torque from the centripetal force equals that of the force of gravity. The centripetal force depends on the speed of the bike and the diameter of the bend. This delicate balancing act sets a specific leaning angle for every turning circle at a given speed.

FOCUS

.... you must briefly steer to the right

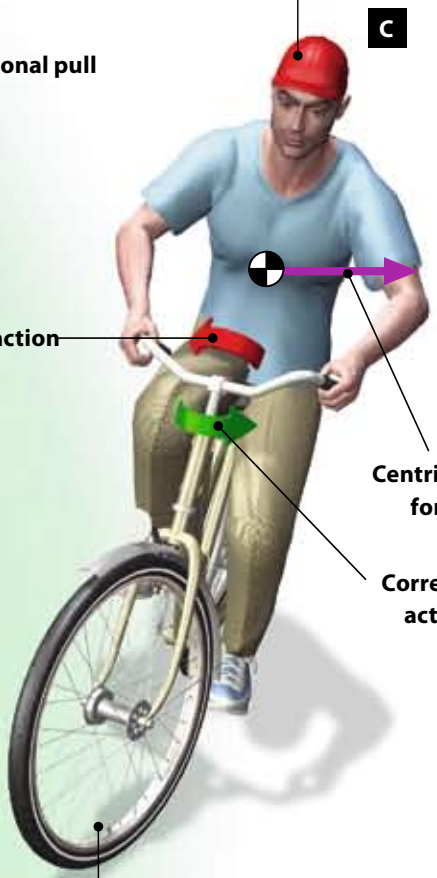
Practically nobody is conscious of the fact that they must steer briefly to the left ion order to make a right-hand turn. But this is not so strange, because the swerve is very small (approximately 3 degrees) and happens very quickly – 0.5 seconds. The wet tire tracks from cycling experiments reveal that we all do this. Apparently we learn this unconsciously when we learn to ride a bike. This so-called counter-steering is however well known among motorcycle riders.

Straight ahead
A cyclist bikes with a constant speed straight ahead (5 m/s = 18 km/u).

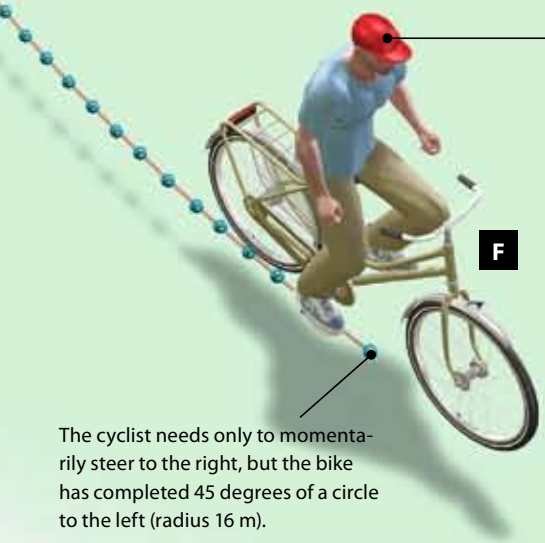


Briefly steering to the right
The cyclist briefly turns the handle bars to the right. The cyclist begins to slightly swerve to the right. (For a period of approx. 0.5 seconds, the cyclist applies right side torque to the handle-bars of 1 Nm = approx. 300 gram on the left side of the handlebars).

Handlebars turn to left
While the cyclists is still turning the handle bars to the right, the handlebars begin (after approx. 0.3 s) to turn to the left (the handle bars and leaning angle are both approx. 3 degrees). After 0.5 seconds the cyclists releases the pressure on the handlebars. After 0.6 seconds the handlebar returns to a neutral position (see bike characteristics 1)



Mass wants the bike to fall to the right
A bike is supported by two contact points under the wheels. When a cyclist bikes straight ahead and turns the handlebars momentarily to the right, this causes the contact point under the front wheel to shift to the left. The center of gravity of the entire bike is now found to the right of the straight line between the two contact points that causes the bike to want to fall to the right (the gravity generates a leaning moment to the right). This is a really small effect which depends on the speed.



Straight ahead
After 10 seconds the bike travels further in a straight direction.

The cyclist needs only to momentarily steer to the right, but the bike has completed 45 degrees of a circle to the left (radius 16 m).

BIKE CHARACTERISTICS 3

Bike falls to the left by steering to the right
The centrifugal force (a consequence of the turn to the right) generates a leaning moment to the left, making the bike in the right turn want to fall to the left. This effect is directly related to the square of the speed and is virtually always greater than the effect of the shifting of the contact point (for speeds greater than 0.2 m/s = 0.7 km/h). As a consequence of the handlebars turning to the right, the bike thus falls/inclines to the left. The leaning angle then increases gradually.

Ground water gains

Crop yields in the hilly north of Tanzania could do with some improvement. Researchers at Delft University of Technology together with local farmers are mapping the water system and developing new irrigation techniques. "We're sparring partners for the farmers."

Tomas van Dijk

It is time for a break, but instead of playing in the school yard as usual, dozens of children in blue and white uniforms are jostling for space around a strange-looking wire mesh cage in a field next to their school. Four scientists have locked themselves inside the cage with a rain gauge and a large evaporation dish.
Nothing of what goes on inside the cage escapes the children's attention. Research assistant Ally Hussein, resplendent in his black cap, tapes the rain funnel more securely in place and chases off a wasp with a cloud of repellent. Doctorate student Ir. Marloes Mul of the UNESCOIHE hydrological research institute opens her laptop computer to display a number of irregular rain plots. Professor Dr Ir. Huub Savenije of the Faculty of Civil Engineering and Geosciences connects a number of glass jars with plastic tubes. "Let's just hope these people don't need any jam jars," he laughs.
The Masika – the second and longer rainy season in Tanzania – could erupt at any moment, according to the researchers. The air is humid and clouds are gathering over the surrounding hills. This is an important research period for Mul, because for the remainder of the year she will be tracking the water that is about to fall. Her supervisor Savenije has dropped by to see how the research is progressing.

'The crux of the story is that they need more ground water'

For the past three years Mul has been investigating the water system in the semi-arid hilly terrain around the village of Makanya in Northern Tanzania. Together with six other doctorate students she is taking part in a project called Smallholder System Innovations in Integrated Watershed Management (SSI). The purpose of this research project, which is funded by NWO (the Dutch organisation for scientific research), the Dutch Ministry of Foreign Affairs, and the Swedish government agency for development aid, is to generate hydrological knowledge while at the same time helping farmers to use the available water more efficiently.
The farmers need all the help they can get. By far the largest part of the population consists of smallholders, so the community is self-sufficient. The staple diet consists mostly of maize and beans. Although a relatively large quantity of water falls in the hills, 660 millimetres a year on average, water is nevertheless at a premium in the lower areas during dry periods. The problem is that as a result of the agricultural techniques used by the farmers in the higher areas, only a small proportion of the water manages to penetrate the soil to ground water level. Most of the water simply runs off the hills after each rainfall. And the ground water is of utmost importance, since it feeds the streams that farmers have used from ancient times to bridge the dry spells.

Tanks

Sitting at the edge of an old water basin, which the Oxfam Novib aid organisation raised a couple of years ago, Mul explains that fifty years ago the Makanya river still reached its namesake village. "There was less environmental pressure because there were fewer farmers. Today the river stops far short of the village. Farmers in the lower areas these days do whatever they can to collect water in tanks during the rainy season, but these can never hold enough water to irrigate all the fields for months on end."
Savenije, balancing on the narrow ledge and afraid to look down, nods. "A farmer needs only five hundred millimetres of rain to produce a crop

Photos: Tomas van Dijk

Smallholder Iddi (with cap), his thirteen children, and his two wives are participating in the SSI project. As a result they have harvested a bumper crop, the best in the area.

A dumb farmer is a dead farmer

When smallholder Iddi sees the white research jeep of the Smallholder system innovations in integrated watershed management (SSI) project approaching, he runs to his small patch of land. He is wearing a shirt sporting the SSI logo, and an Islamic cap covers his head. Iddi is one of five farmers testing new agricultural techniques for Savenije's supervisor, Zimbabwean Ir. Hodson Makurira.

The irrigation channels in his land and the deep ditches that retain the water much longer have done good service. With the surrounding fields still lying bare, this farmer's crop of maize is already sprouting. Iddi had the largest yield of the entire area. In addition to maize he is now growing more luxury crops, including bananas, sweet potatoes, and peas.

"He will soon even be able to sell products at the market," Savenije says. Mul laughs: "I don't think so. He and his two wives have thirteen children to feed. They can use all the food they can lay their hands on."

Makurira uses what is called the participatory approach, a term that has become the past decade's buzzword in development aid circles. Simply dumping high-tech innovations in poor countries does not work, is the conclusion of the development aid community after decades of disappointing results in Africa.

Savenije explains. "You need to be sparring partners for the farmers, developing new schemes together, and making sure they open their eyes to other options. Until recently, aid workers failed to take farmers seriously enough. There is no such person as a dumb farmer. A dumb farmer is a dead farmer."

"India abounds in examples where this approach really worked," says Dr Jayashree Pachpute, an Indian postdoc who is also on the SSI team. But what about success stories in Africa? Savenije ponders the question. "Some factors in this place are against us. For example, there's the social system in which family members hinder one another's development. As soon as somebody makes a bit of money, he has to share it with his brothers, sisters, and parents. And then there's the political climate, which doesn't stimulate development projects either. On the other hand, we mustn't give up on Africa. I refuse to do so."

Makurira bring money for Iddi. "To thank him for all his help," he says with a touch of sarcasm. He points to an irrigation trench running off a larger channel paid for by SSI. After passing through a culvert, the trench leads to Iddi's land. "All Iddi has to do is to make sure the culvert remains clear," Makurira says, "otherwise the road could be damaged. But Iddi just waits until we are forced to pay someone else to do the job." The person to gain is the test farmer himself, as the trench runs across his land.

"So far, the experiments with this farmer are satisfactory," Savenije says, "but sadly he regards the project as a money-spinner." Mul laughs. "He has also rented himself out for guarding the water gauge across the road, or at least that's what we suspect, for every time we ask where the guard is, Iddi replies that the man is away for lunch or has gone off to the market."

Savenije thinks that Iddi will continue to farm in the same innovative way once Makurira concludes his research project next year. In addition to interesting research publications, that is one of the main aims of the project. The researchers sincerely hope that other farmers will copy the new techniques. However, the doctorate student doubts whether Iddi will maintain all the trenches, and buy more expensive seed out of his own pocket, as the project implies. "Last year was a good season. Perhaps he thinks that he owes his success mostly to that."

PhD student Hodson Makurira checks the vaporisation meter in the field.

of maize. In a place like this the rainfall is about three hundred millimetres. He will need to get the remainder from somewhere else. For each hectare he will need at least an extra two thousand cubic metres (i.e. two million litres). Although during the rainy season this tank can be emptied and refilled about forty times, it is simply not enough. The crux of the story is that they need more ground water."
This could be achieved, Savenije believes, if farmers were to dig ditches in their land and plough deeper. This would make the water evaporate less quickly, so more would end up in the soil. The effect would be beneficial to both the farmers in the upper regions and those lower down. Another of the professor's doctorate students, Zimbabwean Ir. Hodson Makurira, is already experimenting with such techniques (see text box, A dumb farmer is a dead farmer).
For the time being the researchers can only guess at the exact effects of agriculture on the water situation. But to see exactly what happens to the water, Mul is recording the amount of rainwater entering the soil, how much the trees and crops absorb, and what percentage of the rainfall flows straight down the hillside or is lost due to evaporation.
The jam jar system next to the school is one of the techniques she uses for gathering data. Though it may seem rather primitive, it is anything but that. The water collected by the funnel is automatically distributed among the jars. Mul measures the proportion of heavy oxygen and hydrogen atoms in the water molecules. She then compares this isotope composition with the composition of the water that flows through the river later in the year. This enables her to track the water that fell high up the hillside, so she can determine how much of the rainwater reaches the river and how long it took to get there.

Water samples

Downstream, Joeli Gureni spends most of the day in his little hut next to the stream. He tinkers with his radio and now and then uses a bow and arrow to shoot at monkeys that come down from the tropical forest on the hills to sample his maize. His most important task however, is to take water samples for isotope analysis, and to maintain a set of equipment that monitors the amount of water that flows past. Ever since the measuring device was stolen from the river just over a year ago – it is said because someone begrudged Gureni his income – Mul has been paying him, his neighbour, and his son to take shifts to permanently man the position. As guards, the three men earn the average local daily wage, which is just under a dollar a day. But when the rains come, they hit lucky at ten dollars a day, for that is when they have to collect a sample from the river and number it, every hour.

Now and then he uses a bow and arrow to shoot at monkeys

Spread throughout her research area covering three hundred square kilometres, Mul has fifteen local employees like Gureni. Some measure the rainfall next to their house, others have to cycle miles along dirt tracks passing fields, monkey bread trees, and termite hills to measure the water levels in streams three times a day.
Even with this plethora of manpower, field research in Africa is far from easy. A month after Gureni was taken on, disaster struck again. In the past decade, 2006 was the year with the two wettest rainy seasons.

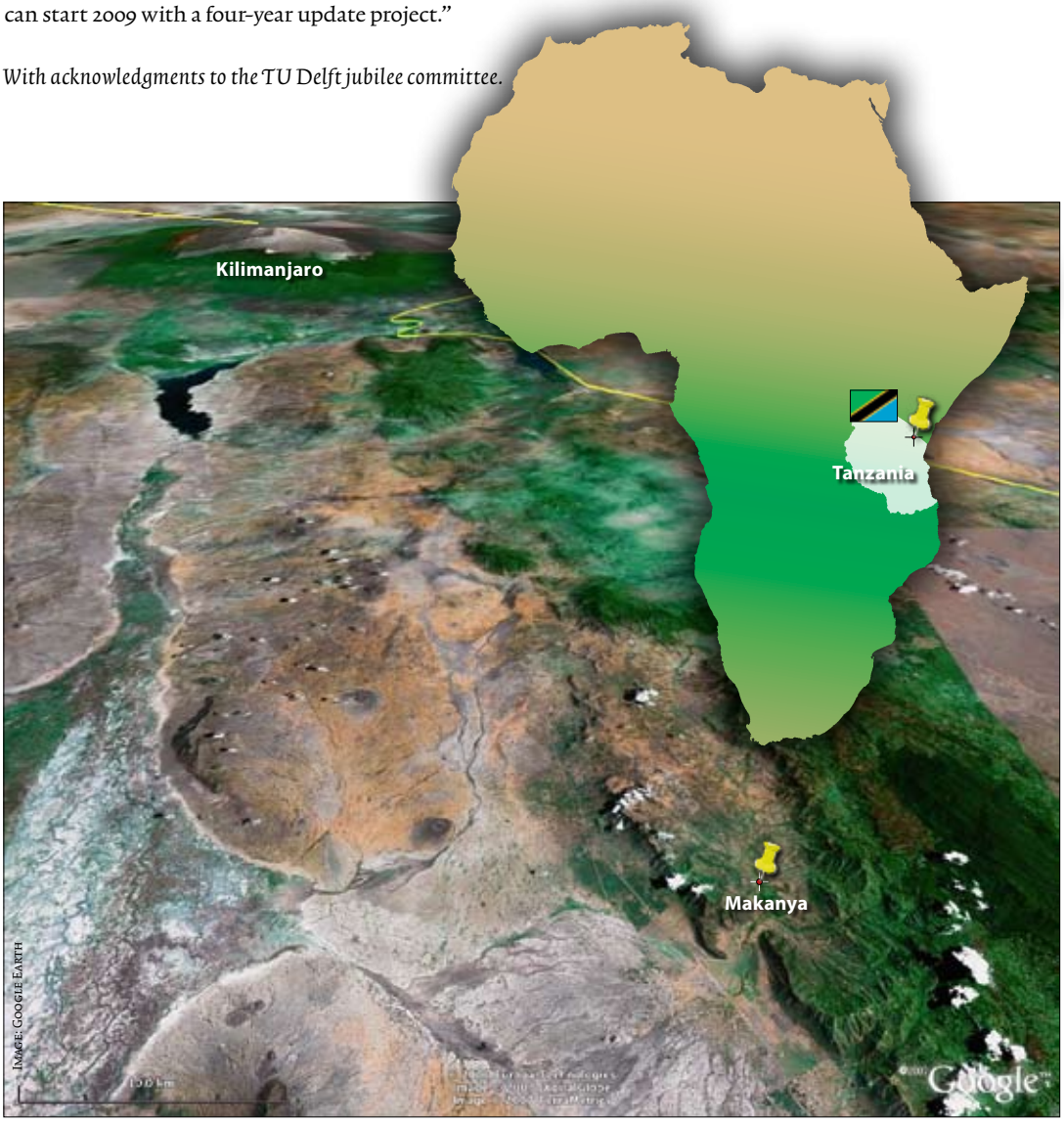
A torrent of water tore away the measuring device. The old man marked the trees on either side of the stream with white lines to indicate the water level at the time.

In a tributary of the stream, the research team are dismayed to discover that the stream has simply eaten away the soil on either side of a concrete measuring installation, bypassing the calibrated measuring duct. "We're having all kinds of trouble taking our readings," Mul recalls. "In 2005 we were prevented from taking proper measurements because the rainy seasons turned out to be the driest in 35 years. Then, a lot of our equipment got stolen. And last year there was too much water."

Even so, Savenije remains cheerful. "Fortunately we can reconstruct the peak flow using clues such as the white markings on the trees," he says.

Mul has already collected data for three consecutive years. Little is known about the years before she arrived. "Hydrologists usually work with data that can cover periods of up to fifty years," she says. "All you have to do is change a few parameters in your model, for example the type of crop or the type of irrigation, and you can instantly see how they affect the waters flows in the area. If we want to be able to do the same here, we will need years and years of additional readings," she concludes. "Let's hope we can start 2009 with a four-year update project."

With acknowledgments to the TU Delft jubilee committee.



Plastic bottles for an old man

Mzee Mshitu grins as he nods. "Is everything still as it should be? Of course, go and have a look," he says to Savenije. At the end of a dirt track lies a basin about twenty metres long. Terrapins scuttle when they hear the grass rustle. A smile appears on Savenije's face. "Right, let's have a picture for the boys back home," he says.

Shreds of plastic are hanging from ropes strung across the water all along the length of the basin. They are the remains of an experiment conducted by four hydraulic engineering students ('the boys'), who earlier this year came up with a system to reduce the evaporation of the collected water, by stretching a plastic sheet across the basin.

The scene looks like an area struck by a tornado. "I did warn them that it would get ripped apart in the wind," Mul says. Mzee — Swahili for old man — joins them, leaning on his cane. "He did not believe that evaporation causes the water level to drop two metres each year," Savenije says. "He was convinced the reason was simply that he collected water from the basin every now and then. The boys even demonstrated the facts for him. They used wash basins to show that water evaporates much less rapidly when covered with a tarpaulin or plastic bottles. The thing is, instead of giving the demonstration on the man's land, they did it in their own garden," the hydrologist says, disappointed.

The students wanted to cover Mzee's basin with plastic bottles, since they work the best by far, but they simply couldn't collect enough of them. So they decided to stretch a tarpaulin across the basin. "If they had conducted the experiments on the man's own land, you might have seen some bottles of Mzee's floating around by now," Savenije says. "Mzee refused to believe that we would be able to prevent his water level sinking, and he's been proven correct."

Photo: Sam Rentmeester/

‘It can be done, because I want it to be done’

These days Professor Dr Ir. Leo Kouwenhoven can find little time to conduct his own experiments. He is fully occupied by other matters, such as deciding what to do with the money of the Spinoza Award, which he was awarded earlier this month. Nonetheless, he remains closely involved in the research. Sometimes it even keeps him awake at night.

Christian Jongeneel

The Kavli Institute of Nanoscience, where you work, could well be the best-financed part of Delft University of Technology. So you probably weren’t fazed by the 1.5 million euro that comes with the Spinoza Award.

“We usually manage to find funding for everything we come up with in this place. In that sense I wasn’t in dire need of the money, but hey, it’s still a lot of money. And I’m also free to spend it the way I like, which makes it effectively more than 1.5 million. Other research always comes with strings attached that limit your scope for using the money. I have an idea that I would like to spend the money on a joint project with Harvard, where I also hold a chair, but it hasn’t reached the stage yet where I can tell you anything about it.”

As a professor most of your time is spent on matters other than the actual research. Do you miss the hands-on part of science?

“I’d love to be able to spend one week a year just on experiments, but unfortunately it hasn’t worked out that way the last couple of years. I would have to plan a trip, and then never book it, in order to take a week off. The fact that I don’t says that my priorities lie elsewhere. What’s more, a week like that would also mean asking a doctorate student to give me instructions. After all, I can’t just walk into a laboratory and start twiddling knobs. I would have to have the equipment and the software explained to me first. And it wouldn’t do to have a doctorate student spend time fixing things just because I couldn’t stay away from the lab.”

The way you tell it, you appear to be far removed from the realities of research, but your doctorate students tell stories that indicate your close involvement.

“The doctorate and postdoc students do the actual work. I just help them along every now and then. This can be very effective. I spring into action whenever there are problems, for example when some piece of equipment breaks down, or when an idea turns out not to be so hot after all. I really try to get involved in the intellectual process: reflect, start the discussion, organise work meetings, etc.
By attracting the right kind of people I also hope that people will pull one another along, even though it is very difficult to select people for this purpose. In your heart you still hope that the quickest people will determine the tempo of the group. The pressure is immense in an environment in which the general level of achievement is high.
My philosophy as a supervisor is to join in. Rather than acting the educator, I like to ask people to explain the problem, so I can think along with them. In many cases I recognise what’s wrong. It’s not that I can instantly put my finger on the problem, but I have some idea of the direction in which the solution can probably be found. That is the result of years of experience in research, conferences, and articles I’ve read, all of which now forms part of my system.”

The nature of this recognition process, is it deductive or associative?

“You cannot separate the two in real life. There is always a deductive part. After all, what you’re seeing are experimental data, and you’re having to translate them into the behaviour of electrons. That is the level at which an association occurs.”

These associations, are they images or formulae?

“They are images of electrons going about their business, in the quantum-mechanical sense. I don’t see electrons, but wave functions, and then I think to myself, this wave function could never be so pronounced, so the chances are it will do a dogleg and cause interference. I’ve always done it that way. My penchant for translating insights into images outweighs my leaning towards formulae. That is also where my greatest theoretical contribution lies.”

▸▸

Who is Leo Kouwenhoven?

Leo Kouwenhoven (1963) studied physics at Delft University of Technology, and in 1992 received his doctorate, with honours, for his research on a subject that combined quantum mechanics and nanostructures. He subsequently spent two years as a postdoc at Berkeley before returning to Delft to work for the Royal Academy of Sciences. In 1999 he was offered a chair by Harvard, but he preferred a professorship in Delft. He did spend a year at Harvard though, and he holds a minor appointment there that enables him to maintain close contacts with Harvard nanoscientists.
Kouwenhoven has published dozens of articles in leading physics publications. On 4 June 2007, NWO (the Dutch organisation for scientific research) awarded him the Spinoza Award, the most prestigious scientific award in the Netherlands, for his breakthrough research in the field of quantum transport in semiconductors.

"It's a bit like trying to make a frog communicate with a monkey"

Can you give an example?

"In 1991 I converted a model for electron transport, which before then had only been available in the form of formulae, into an image. That image has become the standard in our field."

The moment when you first see something like that, is that a real eureka moment?

"Yes. When we first discovered that you can arrange different kinds of quantum dots, which are boxes in which you lock a single electron, in the same way in which we arrange atoms in the periodic system of elements, it was a fantastic moment. We had been given these dots by a Japanese visitor, with whom we had been studying the properties. After he had gone home, we noticed a slight bend in the experimental data. We delved deeper into it and at one point everything simply came together. There are other research projects I can look back on with much pleasure. But they're all part of the past now. They don't keep me awake at night anymore."

And current research does?

"Certainly."

When you sketch out a new research project, do you base it on images that come into your head? In other words, do you visualise new avenues to explore?

"I did visualise our current research project to be able to present an image to others. Visualising usually works pretty well. The image is so clear that everybody can see what we are trying to achieve. The more theoretically inclined are then stimulated to elaborate certain aspects that appear to be impossible at this point."

What can you tell us about this research project?

"It's about linking two fields, electronics and optics, at the level of single electrons and photon. The image is a futuristic

device. Along the length of a nanowire we have two entangled electrons. This means that their quantum-mechanical properties have been manipulated in such a way that they form a unit even at greater distances. If you change the spin of one, the spin of the other automatically changes with it. If you then open a gate in the nanowire, you send one electron along the wire into a slightly different material, where it is converted into a photon with the same quantum-mechanical properties."

It all sounds pretty impossible.

"Well, in a sense it is just a LED, in which an electric current is converted into light. The difference is that in this case a single electron is being converted into a single photon. The question remains under what conditions the quantum-mechanical properties are also transferred. After all, these are entirely different kinds of particles. An electron is a fermion, a mass-carrying particle. A photon is a boson. It's a bit like trying to make a frog communicate with a monkey, although that might be stretching things a bit."

And why should it work?

"Because I want it to. The idea came about purely because I wanted it to be possible. There are of course practical reasons for wanting it to happen. Certain kinds of measurements are very difficult to do on electrons, but easy on photons. If you have two entangled electrons, and you can convert one of them into an easy-to-measure photon, you end up knowing the property of the remaining electron.
The quantum-entangling of particles forms a major part of our national research programme on quantum information processes. For example, what will happen to the entangled state of two particles when you conduct them through a solid? It would be nice if the entanglement were to become visible at a more complex level with multiple particles. Something else we're working on is the lifespan of quantum states. A quantum state usually changes after a few tens of microseconds. Several concepts exist for extending this period, to perhaps a few seconds. We intend to try that as well."

As entangled electrons become easier to control, they become more useful as qubits, the calculation units used by quantum computers. It seems that your mentor, Professor Dr Ir. Hans Mooij, no longer believes in the type of quantum computers that exists in theory. Do you?

"What's unique about quantum computers is that although hardware does not yet exist, algorithms for them have already been written, to factorise very large numbers, for example. I think it's going to happen. I also think that the quantum computer will be able to perform all kinds of simulations. But, as Mooij says, other applications will no doubt emerge. Quantum information is such a fundamentally new phenomenon that it will certainly turn out to be a source of new applications."

You have published a string of articles in Nature, a feat that many of your colleagues can only hope to emulate. Is there any motivation in publishing yet another paper in a leading periodical?

"Well, of course the novelty tends to wear off. Nature is perceived as dealing with imagery physics. I happen to be good at that, but it has to remain a means to an end. To be totally honest, I've had articles published in Nature that today make me think, nice to look at, but it wasn't all that special. These days I take pride in writing an article for Physical Review Letters, for example. When you've been published in so many leading periodicals, there comes a point at which the content starts to become more important again, more important than the journal in which it is published."

Harvard would have given you a full-time chair, but you still opted for Delft, a name with less international acclaim. Why?

"It's where my roots are. Knowing your institute helps motivation. At Harvard I had this uncomfortable feeling of, why should I work my guts out for this place? I'd rather do that in Delft."

Professor Dr Ir. Cees Dekker, with whom you share the reputation of pioneering nanotechnology in Delft, often speaks of the possible effects of nanotechnology, in the ethical sense for example. You don't very often. Is that deliberate?

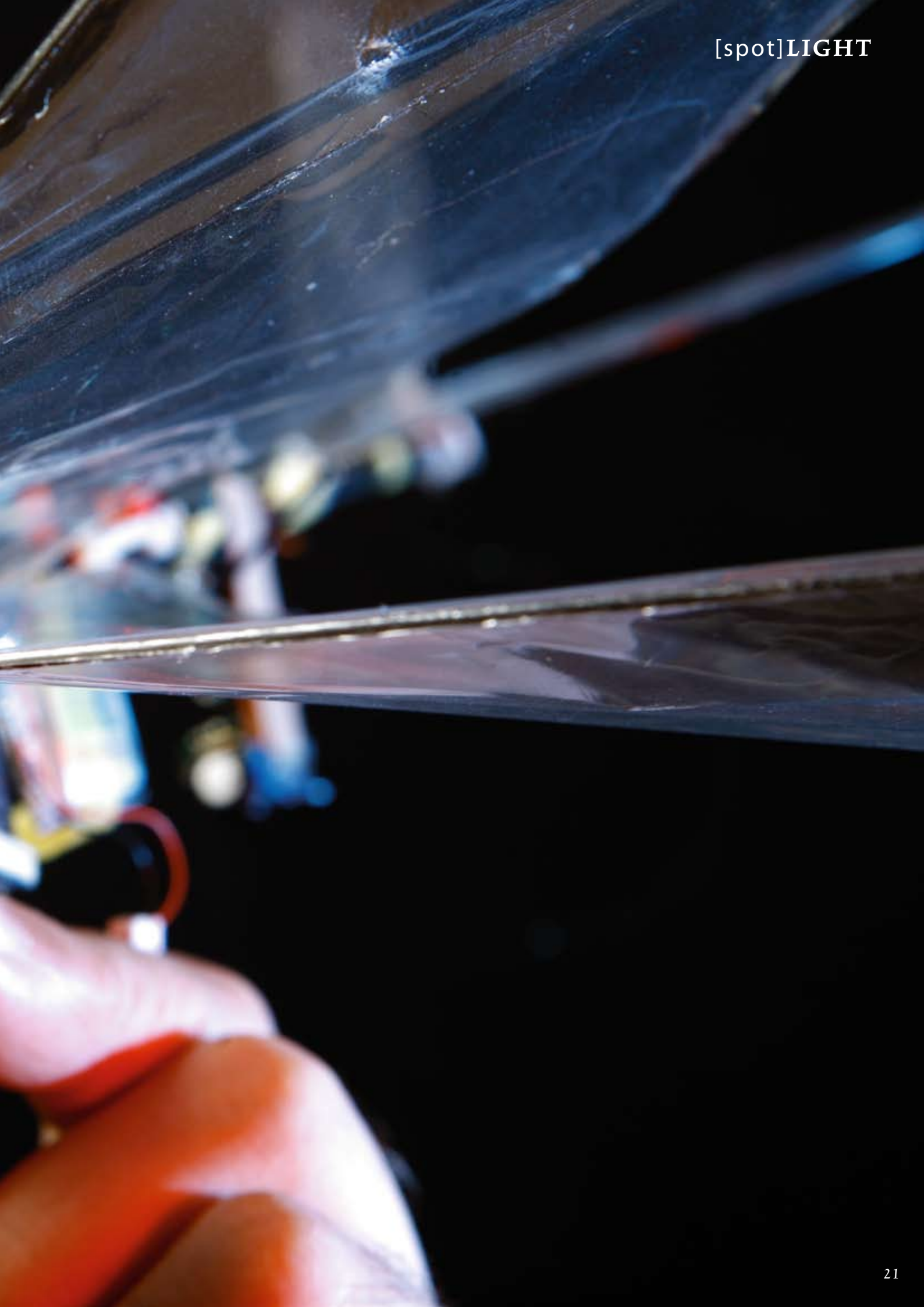
"I do share my views. It's just that people don't ask for them very often. It doesn't mean that it's not important to me. I am fully aware of the social import of our field, and the matter is never far from my thoughts. I also discuss matters with the ethics lecturers of the Faculty of Technology, Policy, and Management, and I do presentations at meetings for journalists.
Our message is that you need to take a good look at what kind of ethical problems you have, and whether they are new. Some problems with nanotechnology, toxicity for example, are important of course, but from an ethical point of view they are far from new. On the other hand there are new ethical problems too, but they haven't become urgent yet, simply because the technology hasn't arrived yet. Take for example a brain extension using an implanted hard disc drive, which would instantly enable a person to read Chinese. One would do well to wonder what there is to be gained from that. Cees Dekker speaks as a person of Christian persuasion. That is not to say that a non-Christian like myself has no views on ethical matters. We could even share the same views."

Finally, are you going to keep this up until you retire?

"I don't know, but I could well do."

Want to see what's up in that building over there packed with hazardous chemicals? Send in Delfly II. With the pilot remaining at a safe distance, the mechanical fly buzzes in and uses its camera to send pictures back to base. Delfly II has a wingspan of only twenty-eight centimetres and weighs in at sixteen grams. But the limit hasn't been reached yet. Researchers at the Faculty of Aerospace Engineering intend to see Delfly Micro, spanning only ten centimetres, fly this year, to be followed in three years' time by the nano version, measuring only five centimetres across.

Photo: Sam Rentmeester/FMAX



Climate change – clouds remain the misty factor

Clouds are the great unknown quantity in predictions about climate change. For aeons they have been drifting quietly across the sky, but scientists still don't know exactly how they are formed and why they eventually come down again as rain. High time to take a closer look at clouds, say researchers at Delft University of Technology. "Politicians worry mostly about greenhouse gases."

Maaike Muller

In his room at the Faculty of Applied Physics, Dr Harm Jonker plays with clouds. From the sea of clouds on his computer screen he picks a large cloud and flies through it. Virtually, of course. In the screen's lower left-hand, a graphical display appears showing the cloud's status. "I can use the computer to track a simulated cloud from the moment it is formed right up to when it falls as rain or evaporates," Jonker explains.

His 'clouds, climate and air quality' research group is using these computer simulations in an attempt to come to grips with the way clouds are formed. For although clouds are an everyday phenomenon, scientists are still at a loss to explain the way they work.

We do know roughly how clouds are formed, though. In the tropics, for example, the process follows a steady cycle. In the mornings the earth heats up, causing water to evaporate and form small cotton wool-like cumulus clouds in the sky. These clouds become bigger and bigger until they form a thunder cloud. Each day around the same time, it starts to rain. "The thing is, in our computer simulations it always starts to rain a few hours later," Ir. Thijs Heus says. Together with Jonker he is researching the computer clouds. "We can change a few values in the model, but we don't know which and why."

Greenhouse gases

According to Jonker, this lack of fundamental knowledge is the reason why politicians and the media tend to ignore clouds in the ongoing discussion about climate change. They should think again, says Jonker and his colleague, Dr Ir. Herman Russchenberg of the International Research Centre for Telecommunications and Radar (IRCTR) of TU Delft. "Politicians worry mostly about greenhouse gases," Russchenberg says. "They may be able to do something about the amount of carbon dioxide being produced, but the relationship between clouds and climate change has not yet been substantiated." Jonker puts it in stronger terms: "We simply haven't a clue how clouds will react to a changing climate. And, vice versa, how the climate is affected by clouds."

Little is know about the way clouds are formed, but the effect on global warming may be substantial. Clouds are also the largest unknown factor in predictions about climate changes. The Intergovernmental Panel on Climate Change (IPCC) this year published a series of reports about climate change. Using various climate models, the UN organisation calculated that this century would see a rise in temperature of between 1.1 and 6.4 degrees. The spread is due to the uncertainty about the future production of greenhouse gases and the limited knowledge about the climate system in general, and clouds in particular.

Reinforcements

"It is a peculiar fact that there is so little funding in the Netherlands for cloud research," Jonker says. "TU Delft should step into this knowledge gap immediately." He says that he knows enough interested students who would like to come and get their degree with his group. "And I could certainly use them, but we do not have the staff to supervise them."

This autumn he will be expanding his research group with at least one part-time professor from

Photo: Sam Rentmeester/FMAX

Researcher Harm Jonker: "It is a peculiar fact that there is so little funding in the Netherlands for cloud research".

the KNMI (Royal Dutch Meteorological Institute), one lecturer, and two doctorate students. This will double the strength of his group in one fell swoop. Russchenberg also hopes to reinforce his small team, consisting of himself and three doctorate students. "We need to have more continuity, which means permanent researchers. Our climate is a subject for the long haul."

The earth is slowly heating up, there appears to be no doubt about that. As the temperature rises, water in the world's oceans, lakes, and rivers will evaporate more easily. More water in the air means more white clouds blocking out the sun, which means that the earth will cool down of its own accord. Sounds great, as this would mean that the carbon dioxide-

Most models underestimate the effect of the white clouds on the temperature change

fuelled greenhouse effect could be reversed very simply. However, the clouds also prevent heat from escaping, and at the same time there is a different factor affecting global warming. As air warms up, it can retain more moisture. Since the water vapour in warmer air condenses less rapidly, it will inhibit the formation of clouds. Fewer clouds mean more sunlight, which will make the earth a hotter place. "Both effects play a role, and we don't know which of the two is stronger," Jonker says.

Recent research at an American observatory indicates that the number of clouds hasn't changed much in the past decade, whereas the temperature has increased somewhat. "We haven't by any means been measuring long enough to enable us to draw conclusions about the climate from these figures. The question is, how much will the reflective capacity of the clouds, or albedo, increase or decrease?" The albedo is something mankind can influence considerably.

Factory chimneys and car exhausts send dust particles into the atmosphere. "Airborne particles, known as aerosols, can be natural in origin, as with desert sand or sea salt," Russchenberg explains. On the other hand, human activities also send large quantities of aerosols into the atmosphere. Some of these particles absorb sunlight and so cause the surrounding air to heat up. Then again, the dust also has a cooling effect, as it causes whiter clouds to form that last longer. On his laptop computer, Jonker points to a picture of a large transparent cloud with thick white stripes running across it. "This is a good example of the effect. Where ships have passed, they leave behind tracks of airborne dust particles. The clouds are much whiter in those places." Whiter clouds like these can also be spotted over areas with concentrations of industry.

Marbles

Once the air becomes saturated, water vapour condenses into droplets. However, the process does need a nucleus to get started. In clean air, this can be an existing droplet, but aerosols can also provide nuclei. Droplets form much more readily around dust particles, which are also smaller than the droplets in a clean cloud. Clouds containing many small droplets are whiter than clouds in clean air. They also last longer. The droplets in the 'dirty' cloud are so small that they don't collide easily to form larger nuclei. "It is very difficult to make marbles hit each other when you throw them up in the air," Jonker explains, "but large footballs make it much easier." So, droplets containing a dust nucleus remain small for longer periods, too small to be

"Then how do they make computer models of the climate?", Evans said.

Kenner smiled. "As far as cloud cover is concerned, they guess."

"They guess?"

"Well, they don't call it a guess. They call it an estimate, or parameterization, or approximation.

But if you don't understand something, you can't approximate it. You're really just guessing."

From 'State of fear', a novel by Michael Crichton

pulled back down to earth as rain.
Russchenberg: "We must find the link between human activity, the clouds, and the amount of sunlight that reaches the earth's surface." Suppose the wind carries with it dust particles from the Ruhr. Will this greatly affect the amount of radiation that will pass through the cloud, or will the effect be negligible?"
The many different climate models currently in use do not provide a conclusive answer. Most models underestimate the effect of the white clouds on the temperature change, as French scientist Sandrine Bony discovered in 2005 when she compared the results from fifteen climate models. The models also differ in the way they estimate the climate change caused by cloud formation.
"The climate models are our best guess at the moment," Jonker shrugs. Climate models used to create a prognosis for the entire earth look at cloud fields in a fifty by fifty kilometre square, or in some cases, a hundred by hundred kilometre square. They do not consider the separate clouds, just the extent to which the square is covered. These simplifications are necessary if we are to keep the size of the calculations within reasonable limits. However, the assumptions are based on an inadequate knowledge of the climate system. "We are trying to improve the assumptions of the larger models by looking at the way clouds are formed at a lower level of scale," Jonker says.
Both Jonker's and Russchenberg's research groups are scaling down from dozens of miles to metres and even to particles measuring less than a micrometre. "The great thing about the small scale is that you can see with the naked eye what is happening," Jonker says. He creates his own clouds, in the computer or in a laboratory, exactly how he wants them, which is handy for scientific research into the mechanisms affecting clouds. "All real clouds are different, which makes it hard to draw conclusions for clouds in general. My clouds are reproducible."

Cabauw

Russchenberg will just have to wait and see what comes along. To his mind, a well-spent working day is a nice and cloudy day. Using his teleobservation equipment he is trying to map real clouds as accurately as possible. "It may look easy, researching clouds," the researcher says. From his room on the twentieth floor of the faculty building he points

Herman Russchenberg: "We must find the link between human activity, the clouds, and the amount of sunlight that reaches the earth's surface"

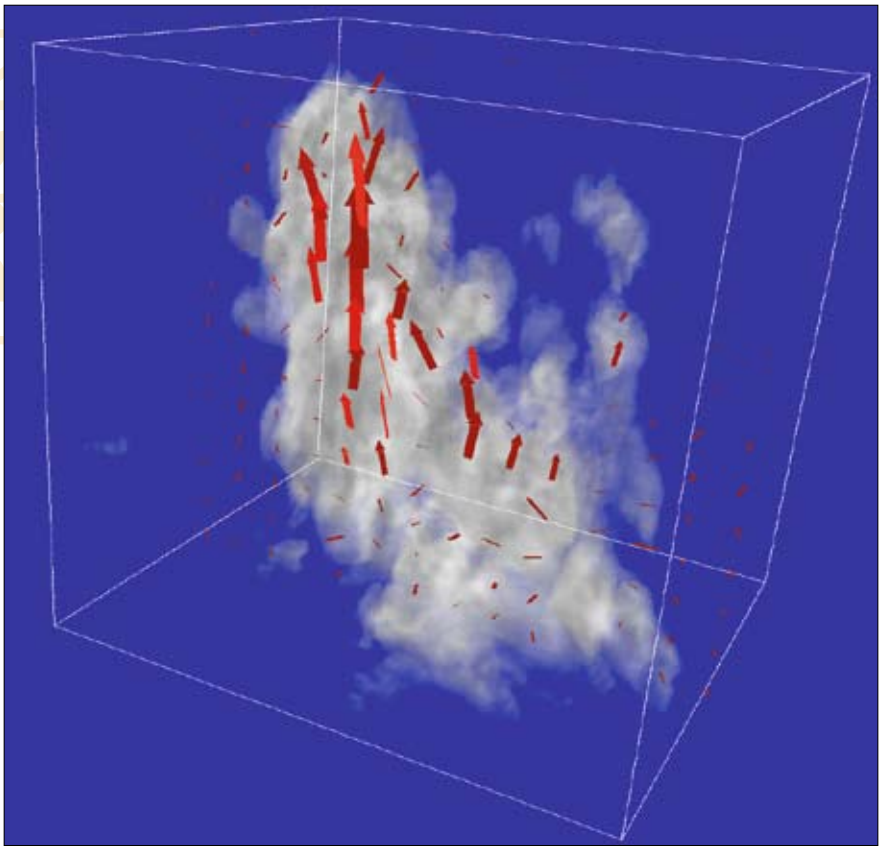
Dust shield

Air containing lots of aerosols — small particles of salt, sand, or pollutants from industry and transport — will cause different types of clouds to form than clean air does. In polluted air the clouds become whiter and stay up longer. The result is that they reflect more sunlight than 'clean' clouds do, and they do this over longer periods. "In this sense, purely from a climate point of view, it might even be harmful to act against the emissions of small particles by the industry in China," says atmosphere researcher Harm Jonker. This applies even more so if the factories continue to produce carbon dioxide. This greenhouse gas causes the earth to heat up, whereas the dust particles would help to cool it down.
Dutch Nobel Prize winner Paul Crutzen goes one step further. Last year he came up with the idea of releasing five million tons of hydrogen sulphide high up in the atmosphere. This would cause small particles to form that reflect the sunlight and would help prevent the earth from heating up.

Photo: Hans Stakelbeek / FMAX

Polluted air results in whiter clouds.

outside. "You can see them floating along, but how does one get close up to them?" An aircraft can fly through a cloud and measure the number of droplets and their size, but this is a very expensive process, and statistically unreliable because a plane can only take a limited number of readings during its short flight.
This is why Russchenberg has been studying clouds from the ground for over a decade. "We didn't have a systematic approach before 2002."
Russchenberg is the instigator and scientific leader of Cesar, the Cabauw experimental site for atmospheric research. This is a joint effort of the universities of Delft, Eindhoven and Wageningen, and research institutes such as the KNMI. In Cabauw, a village near the town of Lopik, advanced equipment is used to observe the atmosphere twenty-four hours a day, seven days a week.
The site boasts a weather tower over two hundred metres high in which a chemical analyser determines the nature and size of airborne dust particles. However, the tower is not tall enough to study low cloud cover properly, which can go up to an altitude of two kilometres. This is where the radar, lidar, and microwave radiometer come in. Water droplets reflect radar waves. This is why a cloud of fog can make an airplane disappear off the radar screen. Russchenberg uses the reflection to look into the cloud from the ground. It enables him to see the shape of the cloud, the number and size of the droplets, and how they move about inside the cloud.
The radar can easily see right up to the top of the cloud, but it is not sensitive enough to also see the small droplets at the bottom of the cloud. On the other hand, lidar, a type of radar that uses light waves, can only see the small ones at the bottom. Another type of device, the microwave radiometer,



Computer simulation of a cloud.

"Water in a cloud forms clusters of twenty droplets"

produces even more accurate readings, measuring the radiation in the atmosphere. “Everything with a certain temperature radiates energy. Using the right kind of analysis methods, the radiometer data will enable you to deduce how much water there is in a cloud,” Russchenberg explains. “The different instruments together give a pretty accurate picture of the cloud.”

The picture does not always match the theory. The plot of the radar reflection readings always differs from the results the theory would lead us to expect. This got Russchenberg thinking. Together with some fellow scientists he ran through all the possible causes. “We managed to cross them all off, one by one, until we had a single option left. The theory that has been in use for decades to calculate diffusion proved to be wrong.” According to Russchenberg, rather than occurring in the form of separate droplets, the water in a cloud forms clusters of ten to twenty droplets. “Turbulence in the cloud keeps the droplets separate from each other, but on a small scale the wind does not have enough energy to drive the droplets apart.” These clusters do not reflect the radar waves as readily as lots of separate droplets.

Russchenberg has not yet been able to convince all the other atmosphere researchers of his new theory. Nonetheless, the plot produced by his theory is a much better fit for the radar reflection readings than the old plot is. Using readings from experiments conducted in the German Black Forest this summer he hopes to lay a better foundation for his theory on clustered droplets.

The white stripes in clouds show where ships have sailed.

Smoke, clouds and tracks left by ships.

Since January the cloud expert has also been investigating the effect of clouds on the amount of radiation. In other words, how warm does it get? “We already have some results, but they are not sufficient enough to allow us to make any statistically reliable statements about the average decrease or increase of radiation due to aerosols.” In any case, the Cabauw readings will not suffice for predictions about the worldwide climate change. Everywhere around us the climate is different. “In the southern hemisphere for instance, the air is cleaner, and so the clouds have fewer and larger droplets in them than do clouds formed over the industrialised areas of Western Europe.” In Cabauw, Russchenberg and his colleagues aim to develop a simple, relatively cheap measuring technology equally suitable for taking measurements elsewhere in the world. “This is the only way we are going to get a better understanding of the climate system. However, it’s going to take a lot of money and political willpower.”

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Photo: Hans Stakelbeek/fmax

Prof.dr.ir.drs. Hester Bijl

"I believe in mutual inspiration"

Enthusiastic

Professor Dr Ir. Drs. Hester Bijl (1970) studied Applied Mathematics at Delft University of Technology, followed by English Literature at Leiden University. After completing her doctorate degree in numerical mathematics she spent eighteen months as a consultant with The Boston Consulting Group. In 1999 Bijl returned to Delft to become a lecturer in the Faculty of Aerospace Engineering's dynamics department. Since 1 April 2006 Bijl holds the Antonie van Leeuwenhoek chair, a position awarded by the university to scientists of exceptional merit in their field. Bijl is currently investigating mathematical techniques for simulating flows and interactions between flows and structures. In the autumn of 2005 she was awarded a Vidi grant, which enables young, excelling scientists to develop a research path of their own during a five year period.

Saskia Bonger

In this series, a professor and a student each answer the same questions to create a double portrait. In this edition: Hester Bijl en Sander van Zuijlen.

How would you describe one another?

Bijl: "Sander is intelligent, comes up with new ideas, and thinks around corners. He is a very stable kind of person, you can't throw him off balance. If the building were on fire, he'd walk on very calmly."

Van Zuijlen: "Hester is very enthusiastic and passionate. It's very catching. I'm the exact opposite as far as the outward signs of enthusiasm are concerned. Hester also knows exactly what can be found in existing literature."

What makes the other person stand out?

Bijl: "The combination of clever ideas and extreme stability is very special. Sander tries out new things and then publishes about them. He came up with a new method for linking equations for flows and equations for structures with great accuracy. This has speeded up the calculations on flow-induced structural deformation in things like aircraft wings. Sander has a calm, pleasant style. If we're struggling to make a deadline, he works on very calmly. That's valuable, although he might allow himself to get worked up a bit from time to time."

Van Zuijlen: "Hester once received a students' award for best lecturer. She has a talent for picking exactly the right things from the subject matter to make students understand what it's all about, without overdoing things, and without leaving things out. That is very difficult. If you've been working on a subject for any length of time, it becomes so obvious that you forget to incorporate it in a lecture. Hester can see what people know, what they can understand."

What did you learn from one another?

Bijl: "That self-control can be a good thing from time to time. That there is no point in worrying too much, which I tend to do. When Sander had just started his doctorate research, I was the one working long nights to make a deadline."

Van Zuijlen: "Subject-wise, Hester has taught me a lot about numerical methods. I've also learned how to give presentations using slides. I used to simply state the facts, with the conclusion at the end of the slide. I now know that it's better to put the conclusion in a heading at the top."

What's the essence of a good teacher-student relationship?

Bijl: "I don't like it when the teacher dictates and the student takes notes. I believe in mutual inspiration. In doctorate research one party brings experience, and the other contributes a fresh outlook. Both must be open to one another. A teacher should stimulate a student to discover new solutions. In Sander's case there was no need for that."

Dr.ir. Sander van Zuijlen

"It's a good thing when a student has a certain admiration for a teacher"

Helpful

Dr Ir. Sander van Zuijlen (1976) was Hester Bijl's first doctorate student. He graduated in Aerospace Engineering, and remained with the department. Van Zuijlen is now a postdoc student, and will remain so for another year. Van Zuijlen is conducting research on the relationship between flows and structures. A computer simulation of the process takes small steps in time, which takes a lot of time. Reducing the number of steps can increase the processing speed considerably.

Van Zuijlen: "It's a good thing when a student has a certain admiration for a teacher. If you have, you automatically start to learn and absorb what's being discussed."

Was your relationship more like that of a mother and son, or like a married couple?

Bijl: "A married couple. We were, and remain, equal partners in discussion. I don't always have the answer, and neither does he. Sometimes discussing things will get you where you'd never get on your own."

Van Zuijlen: "Hester likes to give me some slack, whereas a mother would call you in for supper, or tell you to clear up your room. At first, Hester was someone who gave me support most of all. She helped me with my first conference. At one point I went my own way, but we still work very closely together."

Are you ever at odds about the direction your research should take?

Bijl: "We never fall out. It's very hard to have words with Sander. Of course there are times when we disagree, and we bring different points of view to a discussion, but the outcome always remains open. Sander was already very independent during his doctorate research period. He'd carefully think matters over before we met. Many doctorate students wouldn't."

Van Zuijlen: "We don't have conflicts, we use arguments to try and convince the other about the better route."

Can you recall an incidence of good or bad luck that stuck in your mind?

Bijl: "I'm impressed by the way Sander not only developed a method, but also applied it to an actual wing. It takes a lot of time, and I had not expected it. Nevertheless, he managed to do that too."

Van Zuijlen: "I was hard for me to change from a student doing assignments with known outcomes into a researcher who doesn't even know whether his efforts will yield results. I was lucky to discover that my method actually worked. It keeps you going for a while."

Do you socialise?

Bijl: "No, we don't often do that in our department. We do socialise as a group though, for things like barbecues."

Van Zuijlen: "Not as a rule. I've been to Hester's place three times; once to discuss work, and the other times were when her sons were born."

Name one another's best habit.

BIJL: "Sander is always there for people. He is always willing to lend a hand. He also prepares himself very well when we go somewhere like attending a conference or visiting a company. He'll read up on it down to the last detail."

VAN ZUIJLEN: "Hester doesn't hesitate to step up to people, and manages to establish all kinds of collaborations. She's also very good at keeping together all the different kinds of research going on within our group, so that we all keep steering the same course."

And the worst?

BIJL: "Always lending a hand keeps Sander so busy that his diary gets fragmented."

VAN ZUIJLEN: "I sometimes think that she overloads her diary. Her meetings have a habit of ending late, so appointments keep getting shifted."

What is the other person's significance in professional terms?

BIJL: "Sander has made a significant contribution to the acceleration of complex calculations."

VAN ZUIJLEN: "Hester does all kinds of things within our profession, from looking into the dynamics of insect flight to improving calculation methods. She is also very good at finding scope for new research. Research trainee projects always hit a niche in which we can make a useful contribution."

What is the target the numerical mathematics department should be setting itself for the next few years?

BIJL: "We intend to accelerate our current calculation speed at least tenfold, and hopefully a hundredfold. We also want to be able to increase the number of calculations we can perform, and include the effect of uncertainties. My doctorate students are each working on a single building block. When the time comes, we are going to fit all their research results together. Hopefully it will yield more efficient wind turbines and aircraft. However, that will take another ten years or so."

VAN ZUIJLEN: "I can see the research trainees' work slowly merge into one. That will be very useful. For example, it will enable us to calculate the flow of blood in veins, so we can find out more about how our blood vessels age."

Marital status:

BIJL: Live-in partner, two children.

VAN ZUIJLEN: Single.

Favourite book:

BIJL: None.

VAN ZUIJLEN: 'Noodlot' (Footsteps of Fate) by Louis Couperus.

Favourite newspaper and magazine:

BIJL: NRC Handelsblad, BBC Good Food.

VAN ZUIJLEN: Spits, Kijk.

Invention you'd like to be yours:

BIJL: None.

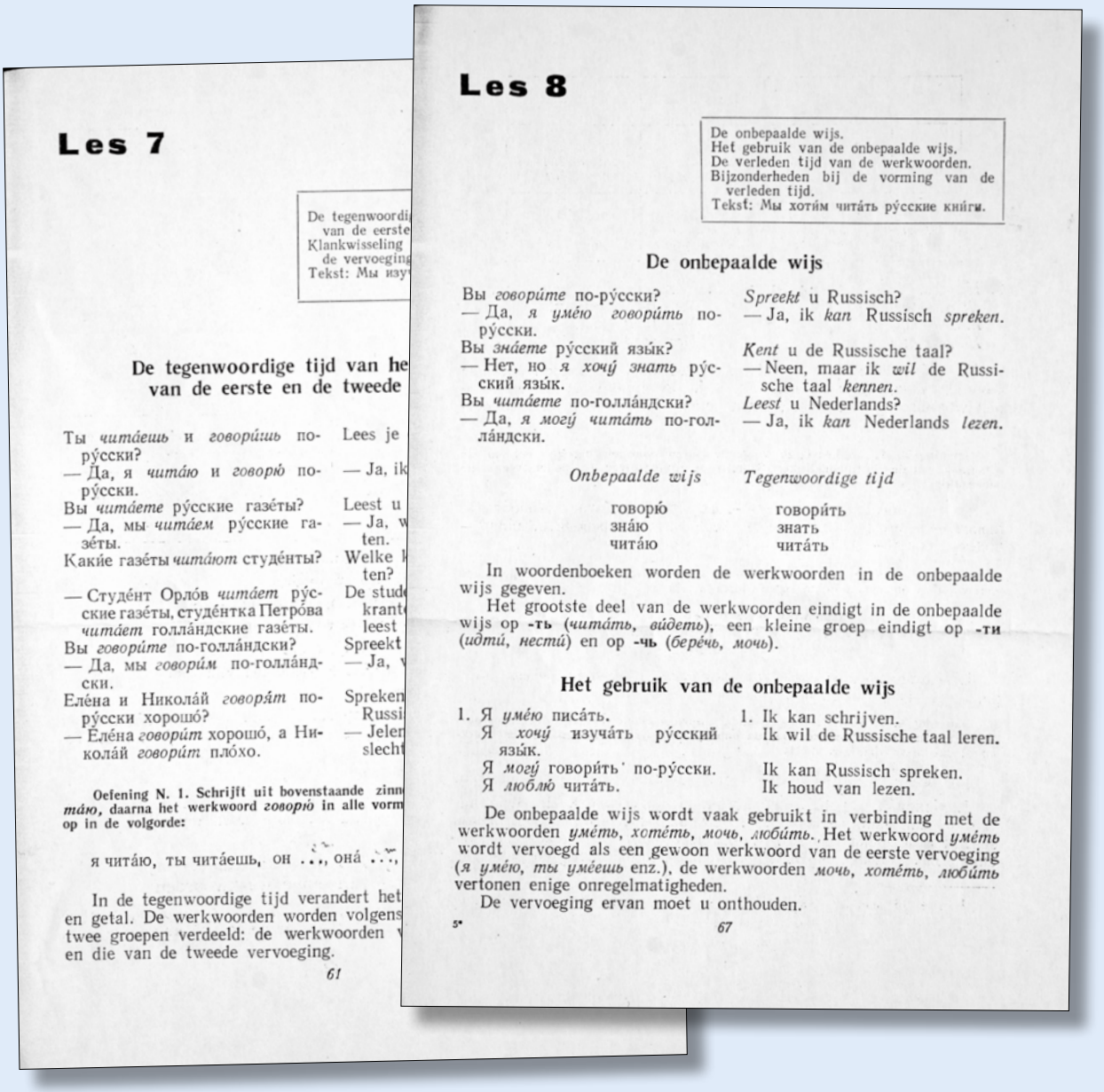
VAN ZUIJLEN: Lego.

The Delft method

Language course starts at the deep end

One of the more unexpected innovations to come out of Delft is an unconventional method for teaching a second language. Developed 25 years ago by the applied linguistics section, the 'Delft method' has proved highly effective, provided, that is, the students do their homework. "You learn a language by talking. The more the better. Just let them talk, never mind the rough edges."

Henk Makkink



Les 7

De tegenwoordige tijd van he
van de eerste en de tweede

Ты *чита́ешь* и *говори́шь* по-ру́сски?
— Да, я *чита́ю* и *говорю́* по-ру́сски.
Вы *чита́ете* ру́сские газе́ты?
— Да, мы *чита́ем* ру́сские газе́ты.
Каки́е газе́ты *чита́ют* студе́нты?
— Студе́нт Орло́в *чита́ет* ру́сские газе́ты, студе́нтка Петро́ва *чита́ет* голла́ндские газе́ты.
Вы *говори́те* по-голла́ндски?
— Да, мы *говори́м* по-голла́ндски.
Еле́на и Никола́й *говори́т* по-ру́сски хорошо́?
— Еле́на *говори́т* хорошо́, а Никола́й *говори́т* пло́хо.

Oefening N. 1. Schrijft uit bovenstaande zinn
та́ю, daarna het werkwoord *говорю́* in alle vorm
op in de volgorde:

я чита́ю, ты чита́ешь, он ..., она ...,

In de tegenwoordige tijd verandert het
en getal. De werkwoorden worden volgens
twee groepen verdeeld: de werkwoorden
en die van de tweede vervoeging.

61

Les 8

De onbepaalde wijs.
Het gebruik van de onbepaalde wijs.
De verleden tijd van de werkwoorden.
Bijzonderheden bij de vorming van de verleden tijd.
Tekst: Мы хоти́м чита́ть ру́сские кни́ги.

De onbepaalde wijs

Вы *говори́те* по-ру́сски?
— Да, я *уме́ю* *говори́ть* по-ру́сски.
Вы *зна́ете* ру́сский язы́к?
— Нет, но я *хочу́* *знать* ру́сский язы́к.
Вы *чита́ете* по-голла́ндски?
— Да, я *могу́* *чита́ть* по-голла́ндски.

Spreekt u Russisch?
— Ja, ik *kan* Russisch *spreken*.
Kent u de Russische taal?
— Neen, maar ik *wil* de Russische taal *kennen*.
Leest u Nederlands?
— Ja, ik *kan* Nederlands *lezen*.

Onbepaalde wijs	*Tegenwoordige tijd*
говорю́	говори́ть
зна́ю	знать
чита́ю	чита́ть

In woordenboeken worden de werkwoorden in de onbepaalde wijs gegeven.
Het grootste deel van de werkwoorden eindigt in de onbepaalde wijs op **-ть** (*чита́ть*, *ви́деть*), een kleine groep eindigt op **-ти** (*идти́*, *нести́*) en op **-чь** (*берёчь*, *мочь*).

Het gebruik van de onbepaalde wijs

1. Я *уме́ю* писа́ть.
Я *хочу́* изуча́ть ру́сский язы́к.
Я *могу́* говори́ть по-ру́сски.
Я *люблю́* чита́ть.

1. Ik kan schrijven.
Ik wil de Russische taal leren.
Ik kan Russisch spreken.
Ik houd van lezen.

De onbepaalde wijs wordt vaak gebruikt in verbinding met de werkwoorden *уме́ть*, *хоте́ть*, *мочь*, *люби́ть*. Het werkwoord *уме́ть* wordt vervoegd als een gewoon werkwoord van de eerste vervoeging (*я уме́ю*, *ты уме́ешь* enz.), de werkwoorden *мочь*, *хоте́ть*, *люби́ть* vertonen enige onregelmatigheden.
De vervoeging ervan moet u onthouden.

5*

67

Fragment from J.P. Cheraskowa, 'The Russian language', Moscow, 1960s.
Textbook 'Russian for beginners' used by teacher, Drs. B.G. Karpiak.

With the introduction of the bachelor/master system in 2002 Delft University of Technology switched to English for its master courses. The bachelor courses are still given in Dutch, although the Aerospace Engineering faculty has been experimenting with English-language courses for junior students. Now that the number of foreign students is increasing, even the lecturers have to pass their English tests. Curiously enough, language courses once formed a standard part of the Delft curriculum. A century and a half ago, the compulsory curriculum of the precursor of Delft University of Technology, the Royal Engineering Academy (1842–1864), included several languages such as French, German, and English. This may well have had something to do with the varying levels of mediocrity of the students' previous training. Malay and Javanese were compulsory for students who after graduation went to work in the Dutch East Indies as engineers, as most of the trainees were, or to work in the East-India civil service.

However, when the Royal Academy was transformed into the Polytechnic School in 1864, the language courses were ditched together with the rest of the East India civil service curriculum. The teaching of language skills was relegated to secondary school level, while the Polytechnic focussed all attention on technical and scientific training.

Even so, in due course, it became a well-known fact that language skills were not an engineer's forte. The lack of expressive skills and inadequate reporting abilities were a thorn in the side of many professors. In 1902 J. Kraus, the director of the Polytechnic School, attempted to have language reintroduced into the curriculum: "The training

Malay and Javanese were compulsory for students who after graduation went out to the Dutch East Indies as engineers or to work in East-India civil service

should not be limited to material aspects. I should like to include not only applied mathematics and physics, but also philosophy, history, and the Dutch language in our list of subjects." Although the board of governors allowed a few cultural subjects to be added, languages failed to establish a foothold.

Language committee

The irritation about the lack of language skills of the engineers from Delft peaked after the Second World War. The Polytechnic School, which in the interim had become Delft Technical Academy, eagerly picked up the educational thread and began to prepare students for the real-world in a new society. The Technical Academy, accepting its responsibility, in 1955 established a language committee.

In 1958 the Dutch linguist J.A. Veering was appointed academic supervisor and took on the daily running of the language committee. In practice, the committee partially functioned as an

The educational establishment looked on the new method as an attack on existing methods

editing board, removing errors from students' (and staff's) reports and providing translation help for foreign-language articles.

In addition language courses were given to help students planning to go abroad for internships or for exchange programs at foreign universities. Professor Dr J. Terlingen of the Catholic University in Nijmegen was prepared to help the Delft academic community on Fridays, teaching Spanish. After the launch of Sputnik in 1957 Drs. B.G. Karpiak was appointed to provide Russian translations and to set up a course in Russian. Professor Vittorio Gozzer of the Istituto Italiano di Cultura handled the Italian side of things, and Mr. S. Lainé of the Maison Descartes in Amsterdam came to give French conversation lessons. For English, the Technical Academy had engaged J.K. Michon, who also taught English at Haarlem Polytechnic, and for a number of years the Technical Academy even provided lessons in Swedish, given by D R.B. ten Cate-Silfwerbrand.

The language committee also supervised the Dutch language skills courses, 'Speaking in public' and 'Oral and written reporting and presentation'. For this purpose, Veering even wrote a highly successful textbook, 'Spelenderwijs Zuiver Nederlands' (Correct Dutch Made Easy). "We

Photo: drs. P.J. Meijer

Computer screen of the Dutch language for foreign speakers beginners course on CD-ROM.

Dr H.J.A. Duparc, professor of theoretical and applied mathematics and mechanics at the department of general sciences (1956-1984). He was involved in recruiting the first foreign language teachers in the late 1950s.
Photo taken in 1965.

Photo: Onze Taal

Professor Dr A.G. (Bondi) Sciarone, professor of applied linguistics and computer linguistics at Delft University of Technology from 1980 tot 2004. Together with Drs. F.J.P. (Frans) Montens he laid the foundations for the 'Delft method'. Around 1970 Sciarone set up the Delft language lab.

have Veering to thank for the fact that language courses at the Technical Academy reached the level that their successors can now build upon," said mathematician and language purist Professor Dr H.J.A. Duparc, one of the people involved in attracting the first batch of foreign language teachers.

China

It wasn't until the early 1980s that the really innovative work started, with the introduction of the 'Delft method' for teaching a second language. The seeds of the teaching method were sown in 1979, when a group of students arrived from China to continue their studies at Delft Technical Academy. At the time there was no suitable course to teach them Dutch in a short time span, so they had to make do with existing teaching materials, albeit augmented by some local teaching knowledge. Gradually, the applied linguistics section led by Professor Dr A.G. Sciarone managed to develop a six-month course that was to enable foreign student applicants to master the Dutch language to a level sufficient for attending lectures and expressing themselves adequately in Dutch.

"It teaches students a foreign language the natural way, the way young children learn their own language"

In the Delft method the participants are thrown in at the deep end. From the very start they are expected to read Dutch, listen to Dutch, and speak Dutch. The structure of the language method is simple, clearly defined, effective, and highly text-oriented. The method focuses on reading and understanding texts, and training students to listen and hold a conversation. The lessons are conducted entirely in Dutch, with English as a backup language, or if even that doesn't help, miming. During the lessons, the teacher provides

Photo: drs. P.J. Meijer

Dutch language course for foreign speakers, Faculty of Technology, Policy, and Management, 2004. A group consists of about fifteen students. Today students come from all over the world (Canada, Italy, Russia, Columbia, etc), whereas they used to come mostly from Turkey and Arab-speaking countries. The course is also attended by foreign doctorate students and professionals from outside the University, such as medical doctors coming to work in the Netherlands.

Custom courses

The language institute of the Delft University of Technology also develops courses on demand for target groups outside its own walls. In 1996-1997, in collaboration with the Regional Enterprise for Professional Qualification (ROB), it developed a course on CD-ROM, "Dutch in the metal industry" for foreign-born students with a language deficiency. The courses focus on the acquisition of Dutch in both professional and general contexts, and works interactively, combining text, images, and sound. This makes the CD-ROM much more versatile than the cassette tape used in the language lab of yesteryear. For the healthcare services the Delft institute developed the textbook, "The language of healthcare".

Student applicants attending the Dutch language course for foreign speakers. In the language lab, the students wear headphones while working on listening tests. They hear a Dutch sentence, which they are then asked to reproduce on the screen. After each sentence the computer program shows which words are incorrect. At the conclusion of the test the computer displays the original text and the transcription showing the mistakes.

feedback about the students' pronunciation. The text subjects are to do with the Netherlands, with things that are of interest to foreign visitors.
The complete set of four courses takes six months on a full-day basis. Students with a Germanic mother language can suffice with an extra intensive two-month summer course.
Linguistics Professor Sciarone, who has since retired, still has every belief in his brainchild. "It teaches students a foreign language the natural way, the way young children learn their own language," he says, explaining the philosophy underlying the method. "Words and grammar are learnt through repeated reading and frequent listening to texts. The students are confronted with the full grammar right from the start instead of encountering gradually more difficult steps, and there is no learning by heart. Foreign student applicants starting the course find themselves unable to express themselves at all, which is a bit unnatural. In order to overcome this, they are forced to learn the most common words in a minimum of time. You learn a language by doing a lot of talking. So, let them talk, never mind the dodgy grammar."

Chinese for Dutch speakers

It wasn't long before the Delft method came under attack, ignoring as it did the conventional method of learning grammar, cramming lists of words, and doing endless word exercises. The educational establishment looked on the new method as an attack on existing methods.
On the other hand, the Delft method does work, as can be seen from the fact that those that successfully complete the course manage to keep up pretty well with academic teaching. The average success rate of all the Dutch language courses for foreign students taking their first exam is seventy percent.
Additional courses using the Delft method have been developed to teach English, French, Spanish, Italian, and Chinese to Dutch speakers. French, Spanish, and Italian are optional. Foreign participants in the Delft master course can now take Dutch as an optional subject, which is an option that is in high demand. The number of participants for the two optional Dutch courses for foreigners from within Delft University of Technology itself is about three hundred.
The Delft method is continually being improved and updated. Grammar exercises have been all but dispensed with, and a major role has been given to the computer, which entered service as a language-teaching aid around 1990, mostly for ▸▸

"Thanks to a test program on CD-ROM, there is more time for supervising free conversation"

Supplementary education

When Delft Technical Academy was founded in 1905, the full range of supplementary education (mathematics, physics, law, economics) was combined in a separate department, general sciences. Around 1960 linguistics was added. Five years later the languages section was transferred to the newly-founded sub-department of philosophy and social sciences, thus ending the pioneering work of the Delft language committee, which up to then had looked after language matters.
These days language education comes under the Institute for Technology and Communication of the Faculty of Technology, Policy, and Management. The Institute, with 25 lecturers, comprises six fields, communicative skills (oral and written presentation), didactics and education development (teacher training and coaching), Dutch for foreign speakers, foreign languages (English, French, Spanish, Italian, and Chinese), courses and workshops for doctoral students and researchers, and an English unit.

An overview of the most important awards, appointments and other remarkable personal milestones at TU Delft

Dr Nynke Dekker of the Kavli Institute for Nanosciences is to receive 1.2 million euros from the European Science Foundation to fund research on molecular motors for manipulating DNA and RNA. This year, a total of twenty young European researchers were given the European Young Investigators Award, which they will use to set up their own research groups over the next five years.

Last July, three researchers from Delft University of Technology received Veni grants from NWO, the Dutch Organisation for Scientific Research. Materials scientist **Dr Ir. Erik Offerman** of the Faculty of Mechanical Engineering, Maritime Technology, and Applied Materials Sciences has been using the money, 600,000 euros, to study nano particles in steel with a European supercomputer. **Dr Ir. Marnix Wagemaker** of the faculty of Applied Physics will be investigating the atom-level processes that occur in ultra small lithium ion electrode particles, and **Dr Ir. Ronald Hanson** of the Faculty of Applied Physics will be using the material properties of diamond in an attempt to find out whether quantum mechanical calculations are possible at room temperature.

On 15 August 2007 the University's Governing Body appointed **Dr Ir. Jacco Hoekstra** as the new dean of the Faculty of Aerospace Engineering. Since 1991 Hoekstra (40) has held a post at the National Aerospace Laboratory in Amsterdam, where he is currently leading the Air Transport division, working among other things on flight simulation, air traffic management, and human factors of the cockpit. Hoekstra succeeds Professor Ben Droste, who was dean for the past four years.

The Delft University Fund has awarded the 2007 UfD Leermeesterpijs (Teacher Award) to **Professor Dr Ir. Jan Buijs** of the Faculty of Industrial Design, where Buijs has been professor of the product innovation management since 1986.
The teacher award is awarded annually to a Delft University professor who has excelled in teaching and research and thus has inspired students. This is the first time an Industrial Design professor has received the award. The award was presented to Buijs at the meeting preceding the official opening of the 2007-2008 academic year on 3 September.

Professor of geology **Dr Salomon Kroonenberg** of the faculty of Civil Engineering and Geosciences received one of the 2007 Eureka Awards for his book 'De menselijke maat: the aarde over tienduizend jaar' (The human dimension: the earth in ten thousand years). The Eureka Awards are presented annually by the Dutch Organisation for Scientific Research in recognition of the three top achievements in the field of science popularisation.

Designer of visual information **Professor Paul Mijksenaar** of the faculty of Industrial Design, also known as 'the man who signposted Schiphol Airport', has left Delft University. Mijksenaar's work, which included signs for Schiphol, the Dutch railways, and the New York airports, is internationally acclaimed. Mijksenaar has plans to tackle Schiphol once again, and will be looking at new signs for the Amsterdam zoo, Artis.

Quantum physicist **Professor Dr Ir. Leo Kouwenhoven** of the faculty of Applied Physics has received one of the four Spinoza Prizes for 2007. Kouwenhoven was awarded the 'Dutch Nobel Prize' for his fundamental research on quantum mechanics. He is investigating the behaviour of qubits, the building blocks that may possibly be used in future quantum computers to store information. Kouwenhoven is the third Delft professor to receive this honour. Nanotechnologist Professor Dr Cees Dekker preceded him in 2003, and in 1999 the distinction fell to Professor Dr Ir. René de Borst, who until recently was professor of applied mechanics at Delft University.

This summer, **Professor Dr Ir. Hugo Priemus** left the faculty of Technology, Policy, and Management, where he was dean, to take up an appointment at the OTB research institute, where until 2003 he had been the managing director for eighteen years. Priemus is a scientist who has kept close tabs on politics. He was the investigation coordinator of the Duivesteijn committee, which looked into the budget overruns of large infrastructure projects.

Cont. from page 37 ▸▸

taking tests. It greatly improved the efficiency of language education. In addition, software has been developed to enable students to take tests and do exercises without the help of the teacher.
Sciarone: "The sophisticated test program – which has been available on CD-ROM for the past ten years or so – tests all students on every aspect of the curriculum, and informs them about the learning results and the effect of their learning method. It shows them the mistakes they make, forces them to immediately repeat learning tasks that were insufficiently completed, informs the teacher about their progress, and provides the teacher with a basis for specific advice. It enables the teacher to find out which group of students – with Roman, Germanic, or non-Western backgrounds – profit most from extra help on a certain subject. It also leaves more time for supervising free conversation, which is the teacher's real work."
Even so the Delft method has never managed to occupy more than a niche position in the language education field. It is hardly used at all in further education. The method only works when student and teacher both believe in it, and if the students diligently do their homework. The latter is where things often go wrong. The reason why the Delft method never caught on in a wider field is also to do with teachers and teacher trainers refusing to abandon their traditional language methods. Nevertheless the Delft method was adopted by a number of other organisations during the nineteen 1990s. Commercial language institutes were quick to embrace it, followed soon afterwards by other universities, regional training centres, and adult education. The method is also being used abroad, in particular at a number of universities.

With acknowledgments to Drs. P.J. Meijer and Professor Dr A.G. Sciarone.

Cover of the Green Book, the beginner's book of the Dutch language course for foreign speakers. The book comes with a CD-ROM.

COLUMN

[LOKHORST]

Ethics in Delft

There was a time when I studied medicine. In those days, the issue of ethics never came up at all. At Delft University of Technology however, ethics is a compulsory subject for all the faculties. This is not as peculiar as it may seem.
Ethics is the part of philosophy concerned with such issues as what should we do, what is morally acceptable, desirable, or objectionable? In our part of the world, ethics used to be closely tied in with the Christian religion, but these days it is trying to get by on its own because non-Christians also want to know what is and what is not desirable. Contemporary literature on ethics hardly mentions the words God or the Bible.
Ethics could well be the solid core of philosophy. Other parts of philosophy tend to become separate sciences the moment they become successful. This is how natural philosophy transcended into physics, and how logic became mathematics and information technology. However, this won't work with ethics, since whatever the facts may be, and however good we may be at reasoning, we will always be wondering what we should be wanting, doing, and not doing.
Delft University isn't the only university of technology where ethics is a compulsory part of the curriculum. Other countries also recognise its importance. Canadian engineers wear an iron or steel ring on their little finger to remind them of their social responsibilities. The story has it that the original rings were made from the material of a bridge that collapsed in Quebec, killing almost all the construction workers. The ring is to remind its wearer that one cannot deliver slipshod work without worrying about the consequences. It is a good thing that this message is rammed home during engineers' training.
Ever since I came to Delft I've known why it is that technical education values ethics higher than medical training institutes do. In medicine your responsibility is fairly limited. As a doctor all you have to worry about is the fate of individual persons. It's different with technology, which often involves the well-being of hundreds of people. In January of this year the readers of the British Medical Journal voted for what they considered to be the most important medical breakthrough of the last 140 years. What they chose as winners were piped drinking water and sewer systems. In other words, technical solutions. The readers were right, of course, since technology affects society far more than medicine does. An engineer therefore carries a much greater responsibility than a doctor, and so it is hardly surprising that while medical training ignored ethics, the engineering courses in Delft do not.
And there is something else going on. Doctors work on creations of nature, whereas engineers deal with man-made objects. As a result, the latter embody our insights, standards, and values. Why do cars have safety belts, and why do nuclear power plants have lead shielding? Not because of any laws of nature, but because of our innate desire for safety. The entire world of engineering is imbued with the essence of ethics. It pervades every aspect of our technical artifacts. It's just as well to be aware of the fact. I'm glad that by playing my part in education and research I can contribute in my own way to upholding the standards of ethics in Delft.

Dr Gert-Jan Lokhorst studied medicine and philosophy and works with the philosophy section of the Faculty of Technology, Policy, and Management. He is a member of the 3TU Centre for Ethics and Technology.

looking BACK

[HORA·EST]

Propositions

Dutch outdoor cafe waiters should be working on the basis of individual tips.
Eelke S. Focke
Civil Engineer

Military spending is inversely proportionate to diplomatic capability.
Kees Hindriks
Mining Engineer

If the world's best invention is sliced bread, the toaster must come second. Any idea needs the right environment to toast.
Filip Mileti?
Electrical Engineer

Many parents have children to get the family they never had themselves.
Maria Stella Fiorenzo-Catalano
MSc Computer Science

There is at least one solution to each problem. The point is that this solution will not always be the one we want and expect.
Dessislava Atanassova Koleva
Chemical Technologist

The fact that education experts and politicians took ten years to discover what the average secondary school pupil could have told you in advance, i.e. that the current primary and secondary education system is based on rather doubtful principles, only goes to show that previous types of education could not guarantee bright minds either.
Jeroen de Ridder
Policy Engineer

Free day care will not add to the level of labour participation in the Netherlands.
Eelke S. Focke, Civil Engineer

[Sound]BITES

"A shortage of labour can lead to rising inflation and a deteriorating export position. But there is an upside too. People can have a choice. They go for better employers. Substandard employers, the small fry operating on the fringes of the market, will probably be hit hardest by the shortage. It has a cleansing effect."
Professor of innovation economics Dr Alfred Kleinknecht in NRC HANDELSBLAD

"The permanent occupation of holiday homes is another of those issues. I don't object to it. Together with Denmark we are the only EU country to make the distinction. The law says no. I'd be inclined to say, right, let's stop building houses in areas of natural beauty, then legalise the permanent occupation once and for all. It would also create a useful housing buffer. We've now reached the point where the government sends along a civil servant to record license numbers and count toothbrushes. That makes the remedy worse than the disease."
Professor emeritus of public housing Dr Ir. Hugo Priemus in DE VOLKSKRANT

"The architect occupies an intermediate position, between the principal and society as a whole. In simple terms, most of the Dutch people would like to live in spacious surroundings, preferably with a view or in a woodland setting. If architects were to design new housing to cater for these tastes, the unique Dutch landscape would soon be completely built-up. The public interest outweighs the desires of individuals."
Architect and town planner Hans Teerds in TROUW


Photo: Sam Rentmeester/fMAX

"Paternity claims for scientific success are legion, but many would fail the DNA test"

Defence

"Many people think that science is driven by interest, but in reality it is driven by scientists' honour, pride, and ego. The positive effect of this is that it advances science, but there are negative side-effects. We have a publish-or-perish culture. Too often publications carry the names of people whose interest in the research was only marginal. The credit often goes to the people with the loudest voice rather than the bright idea. A collaborative effort often results in an article carrying the name of the professor, even though he didn't actually work on it."

Ruurd Keizer
Physics Engineer

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

We all remember the first piece of furniture we ever made, a seat, a picture frame, or even a tree house. It was such an achievement for a child to have created something. If you hadn't done so, it wouldn't have existed! I simply continued to make furniture when I grew up. After I graduated as a mechanical engineer, my hobby started to become a more serious enterprise.

To make sure my furniture-making projects didn't take forever, I reduced the time I spent at my daytime job – a job I liked very much – by one day a week. Of course the thought had crossed my mind how it would feel to really go for it. Life is all about making choices. To postpone really taking up my hobby until after my retirement didn't appeal to me. And so came the time to take an illogical step, both financially and career-wise. I listened to my heart, changed course, and become a furniture maker.

My word, what a decision, what a break with everything I had been doing until then, a fantasy come true! You know what? I absolutely loved being able to do hands-on work as a full-time job, to create things. After you have figured out for yourself what a cabinet or a fitted kitchen should look like, it is all the more satisfying to actually make it. A satisfied customer eating off your table every day feels worlds apart from completing a glossy report for some industrial client. You never know what happens to those. And is anybody the happier for it?

In three years as a full-time furniture maker I have learned a lot. I can run a small business, I understand the way wood works, I make beautiful joints, I try to understand my customers' wishes, and I get great pleasure from finished products. I also love the freedom of being my own boss. But.

While I'm enjoying my furniture maker's dream, the engineer inside me is pining. My hands are having a field day, but my mind is growing soft. Complex problems to get stuck into, to stimulate the grey matter, things like that did feel good when I worked as an engineer. I'm also starting to miss working in a team with people who can challenge my technical and intellectual abilities, act as sparring partners. In addition to that, the demand for handmade furniture is clearly on the wane.

So, I'm seriously considering relegating my chisels and clamps to a hobby status, and taking up a day job as an engineer. The life of this furniture maker and engineer will probably remain a never-ending battle between the heart, mind, and hands.

Anyway, life is about making choices. What a luxury it is to be able to choose!

Michiel Mol (35) studied mechanical engineering at Delft University of Technology from 1991 to 1998. He is a self-employed furniture maker.

Mol passes the pen to aerospace engineering alumnus Ir. Paul Everts, who works at the Ministry of Defence.

More information: www.molinhout.nl.

Balloon stems blood

Photo: Nout Steenkamp/FMAX

Surgical removal of the rectum can sometimes lead to severe haemorrhaging. To stem the flow of blood, industrial designer Noortje Naber invented a balloon with three compartments.

Connie van Uffelen

The normal procedure to stop haemorrhaging after this kind of surgical procedure is to apply surgical gauze. The gauze is pressed firmly into place to form a wad that closes the blood vessels.

"However, the bleeding can be so profuse that the operation has to be suspended," says Naber. "The surgeon then closes the abdomen with the gauze still in position, and the patient is returned to the intensive care unit for up to 24 hours. This is followed by more surgery, as the gauze, which is foreign to the human body, can cause infections."

All in all, the risk to the patient is considerable. As an industrial designer, Naber was asked by St Catherine's Hospital in Eindhoven to find an alternative that would help stem the bleeding.

Naber's initial ideas varied from mechanical contraptions that unfolded to materials that expanded on contact with a liquid. Searching existing literature, Naber discovered a number of earlier emergency measures. One of these was a bag containing a saline solution, used to create space for breast implants.

"The shape of that bag did not at all fit the cavity that remained after removing the rectum," Naber says. "In fact, when I started my graduation research, that shape wasn't known at all. So, I looked at a series of MRI scans to determine the shape of the average rectum. It turned out to be shaped rather like a funnel. I then created foam models of the shape, which I used to test different balloons."

Ultimately, a thin silicone balloon containing three compartments filled with a saline solution turned out to be the best fit. "The balloon has three zones that can each be filled with more or less solution to adapt it perfectly to the cavity," Naber explains. "I was able to test the balloon on a corpse at the Erasmus Medical Centre."

"There is a strip attached to the balloon that can be used to manoeuvre the balloon into position, fill it, and empty it. The device is called a Haemostatic Rectal Cavity Balloon, or HRC balloon. The patent was granted four months ago, and the people at St Catherine's Hospital are very excited about it. I just hope I can help save some lives."

More information: Ir. Noortje Naber, noortjenaber@yahoo.com.

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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Central Library

Delft University of Technology Library (dutl) supplies information and provides services, particularly in the area of the technical sciences. It comprises a central library and twelve sub-faculty libraries housed at the respective sub-faculties and institutes.
The dutl is intended for students and staff at the Delft University of Technology. However, as the task of the library is to provide scientific and technical information at a national level, its facilities are also available to the general public. As well as all areas of technology and natural sciences, the library also contains a general collection in the social sciences, economics etc.
This relates not only to books or periodicals, but also to standards, reports, reference works and congress proceedings.
Literature not in the collection or not on hand can be obtained through Delft University's Central Library from other libraries in the Netherlands or abroad.

For further information:
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General information on university education in the Netherlands:
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