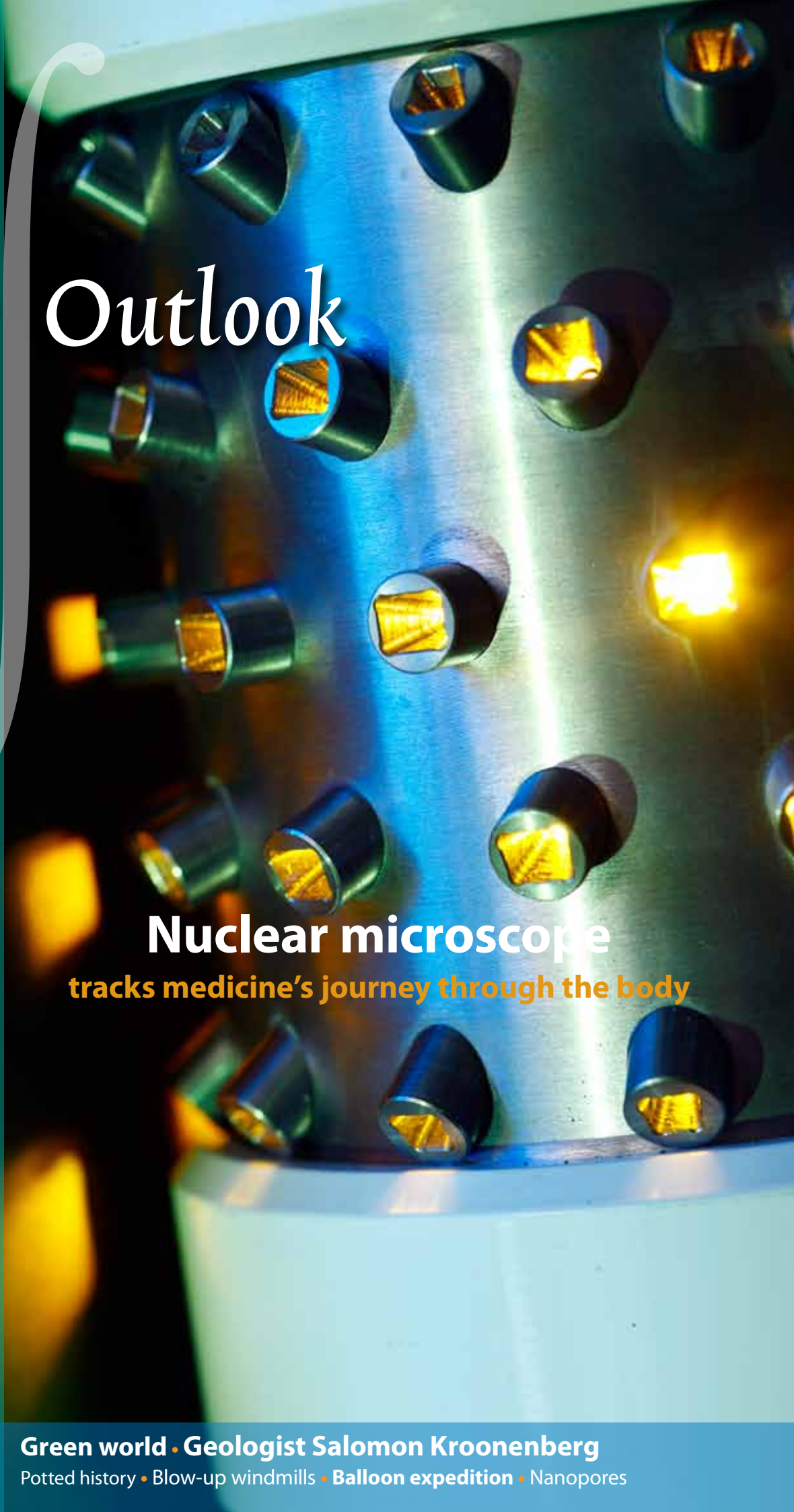
2010.3

Research and education at
Delft University of Technology

Delft Outlook



Nuclear microscope

tracks medicine's journey through the body

Green world • **Geologist Salomon Kroonenberg**
Potted history • Blow-up windmills • **Balloon expedition** • Nanopores

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Delft Outlook

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You can encounter engineers in unexpected places. In a hospital in Nijmegen for example, developing a device capable of pinpointing – with unprecedented accuracy – zones where biological or pharmaceutical substances are active within the body. Or in the faculty of Archaeology at Leiden University, analysing pottery that will hopefully fill a gap in the history of the Middle East. You can also encounter them in the wild, on a cruise ship, for example. Departing professor Salomon Kroonenberg, now something of a celebrity after several TV appearances on the popular Dutch nightly discussion programme, Pauw & Witteman, travelled with the NRC *Handelsblad* newspaper to inform those on board about climate change. As a boy, he felt he had to decide between possible careers in languages or geology. An opportunity to go on voyages of discovery ultimately transformed him into a renowned geologist, one who is currently plunging into the task of writing a book about the subterranean world. So don't be surprised if you see someone apparently staring aimlessly at the floor, they may just turn out to be an engineer.

Frank Nuijens
Editor-in Chief, Delft Outlook

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Anatomical seat

When designing a new car seat, physiotherapist and designer Dr Matthias Franz (Industrial Design Engineering) recruited a group of 25 test subjects, each of whom was asked to sit on a wooden chair covered with a special inflatable mat that retains an imprint of the body. He scanned the resultant body imprints, averaged them, and processed this data to create an anatomical mould. When covered with a layer of foam, this served as a basis for the seats in BMW's concept car. The process has been patented, and is registered under the name of Space Comfort Shell. These seats have the same comfort rating as those used in the BMW 3 series, but are 30 percent lighter.

Further details:
Prof. Peter Vink, p.vink@tudelft.nl

Gassy

Emissions of the greenhouse gases methane and nitrous oxide may have been substantially underestimated. This is the view of Dr Petra Kroon who conducted research at the Energy Research Centre of the Netherlands and the Faculty of Applied Sciences into an innovative method for measuring the emissions of these gases. Dr Kroon claims that the measured values involve an uncertainty of as much as 50 percent.
Agricultural activities are the main source of methane and nitrous oxide emissions. Dr Kroon performed measurements on an intensively managed peatland area, using a new, more accurate method. This involved the use of a spectrometer, suspended three meters above the ground.
Emissions have traditionally been determined by laying box-like devices on the ground and measuring the amount of gas that accumulates within them over time. "It sounds trivial, but if just one cow takes a poo somewhere your concentration shoots up by a factor of 100," says Dr Kroon's supervisor Professor Harm Jonker.

Alumni Symposium

Invitation

TU Delft cordially invites its former graduates and PhD students to the Alumni Symposium entitled 'Cross border Cooperation'. You will be able to gain new insights, share your expertise, and intensify professional relationships throughout the campus.
Are you interested in solutions for the availability of clean, dependable and affordable energy? Or in answers to environmental issues? In improvements in the field of safety and quality in health care? Developments in the field of infrastructure and mobility? These are some of the topics covered by the symposium, alongside issues of sustainability and economic viability.
Your alma mater will ask you to share your thoughts on various research topics and ways of cross border cooperation. You will meet experts from within and without the university, and a host of alumni for you to network and share experiences with.
I am looking forward to welcoming you on Friday 8 October to a programme full of variety and exchange. Each one of you is an expert in your own field; together we make up a unique treasure of knowledge innovation.

Dirk Jan van den Berg
President of the TU Delft Executive Board

www.alumni.tudelft.nl/alumnisymposium2010

COLOPHON

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editorial staff
Frank Nuijens (*editor-in-chief*)
Dorine van Gorp, Katja Wijnands (*editors*)
Saskia Bonger, Tomas van Dijk, Erik Huisman, Sam Rentmeester (*picture editor*), Connie van Uffelen, Jos Wassink

office
P.O. Box 139
2600 AC Delft
The Netherlands
T +31 (0)15 278 4848
F +31 (0)15 278 1855
www.delftoutlook.tudelft.nl
e-mail delftoutlook@tudelft.nl

contributing writers
Auke Herrema, Maaike Muller, Joost Panhuijsen, Angèle Steentjes, Eric Verdult, Robert Visscher, Rik Wuts

translations
Taalcentrum VU

design & typesetting
Saskia de Been, Media Solutions TU Delft

subscriptions
delftoutlook@tudelft.nl

photography
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Millions for wind research

Duwind can start work on its study, now that the Dutch government has made 19.5 million euros available for research into offshore wind farms. The goal of the Far and Large Offshore Wind (FLOW) programme is to develop large-scale offshore wind energy. Its participants include Duwind (the Delft Institute for Wind Energy), energy producer RWE, the ECN research institute, and a number of industrial partners.

The money will enable 16 PhD students to be appointed in various faculties. Research will be carried out into other wind turbines, new foundation techniques, maintenance strategies, and installation techniques that are suitable for wind farms located far out at sea. The question of how to integrate the power generated into a dynamic, Europe-wide grid will also be investigated.

Photo: Google

Further details:
www.flow-windpark.nl

Strong stuff

The National Aerospace Laboratory (NLR), together with TU Delft, has applied for a patent for a composite material with enhanced impact resistance. That is good news for the aviation industry, which is increasingly replacing aluminium with plastic to reduce weight and cut CO2 emissions. However, impacts on a plastic fuselage can cause the composite to separate ('delaminate') on the inside. A PhD student, Martin Hagelsmit (Aerospace Engineering), has found that the risk of delamination is greatly reduced if the resin-soaked fibres are arranged in a particular pattern. The initial results are encouraging, and the material can be 10 percent lighter than the traditional layered structure.

Further details:
Martin Hagelsmit, M.H.Nagelsmit@tudelft.nl

TN•BRIEF

Transparent research

Water flows in drinking water treatment plants are not fully understood. So says Dr Bart Wols, who obtained a PhD for his research into such flows. Accordingly, water treatment plants are less well designed than they might have been if their designers had calculated such flows numerically. Dr Wols thinks the technique, which is known as computational fluid dynamics (CFD), can be useful in improving the UV reactors and ozone-systems used to disinfect drinking water.

Dr Wols has made his PhD thesis freely accessible online, including all of his research results. "My research was largely financed with public money, so making the results accessible is actually an entirely logical step," he reasons. Dr Wols' thesis, entitled 'CFD in drinking water treatment', is available at data.3tu.nl using the search string 'Wols'.

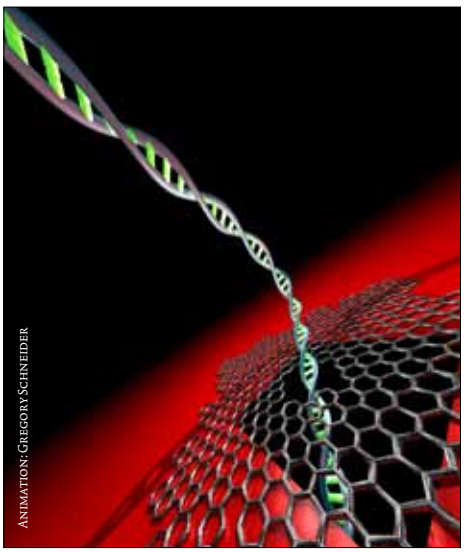
Further details:
Prof. J.C. van Dijk, j.c.vandijk@tudelft.nl

Animation: Bart Wols

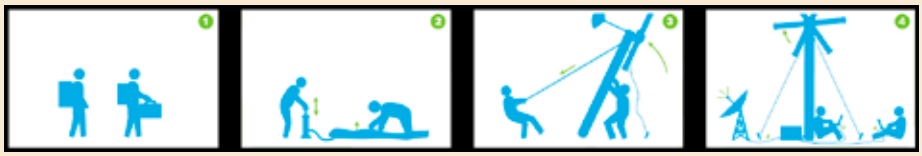
Nanopore

Researchers from the Kavli Institute of Nanoscience (Applied Sciences) have managed to pull a DNA molecule through a hole (nanopore) in a single layer of carbon (graphene). The nanopore measured about half a nanometre from one end to the other - the thickness of a single atom. Dr Gregory Schneider and his colleagues hope to use this system to read the genetic code of a DNA strand as it glides through the nanopore one base at a time. That would be a much faster and cheaper way of reading the base sequence than current techniques.

Further details:
Prof. Cees Dekker, c.dekker@tudelft.nl



Animation: Gregory Schneider



Inflatable windmills

It is intended to be a sustainable alternative to the petrol-driven generators that relief workers often must resort to. Calculations show that the 10-metre high Portable Wind Energy Rucksack ('Power'), which was designed by ten third-year Aerospace Engineering students, can generate 330 watts in a moderate breeze (Beaufort 4). The design includes an inflatable mast and inflatable rotor blades. An overpressure of 0.8 bar should give the ultra-rigid plastic (which is also used in the sails of modern yachts) sufficient strength to function effectively. Other unusual features are the cylindrical shape of the rotor blades and the fact that they rotate on their longitudinal axes. That rotation exerts a force on each of the six blades perpendicular to the wind direction. This 'Magnus effect' is also popular with ball-sport players, who use spin to achieve a curved trajectory. The jury has awarded this team the Jury Prize.

Light-resistant solar cells

The efficiency of thin-film solar cells falls by up to 30 percent during their first few hours in sunlight. Dr Gijs van Elzakker has managed to cut this to 11 percent.
Thin-film solar cells are much cheaper than regular solar cells, also less energy and fewer materials are used in their production. They are relatively inefficient compared to conventional solar cells, however.
In his study, Dr Elzakker (Electrical Engineering, Mathematics and Computer Science) used hydrogen to dilute the silane vapour (SiH4) from which amorphous thin-film solar cells are deposited. He showed that a twenty-fold increase in dilution leads to fewer defects in the material. Dr Van Elzakker has the opportunity to pursue his research at Inventux Technologies in Berlin.

Further details:
Prof. Miro Zeman
M.Zeman@tudelft.nl

Delft's solar boat out of luck

This summer, the Delta Lloyd Solar Boat finished third in the Frisian Solar Challenge. The student team had high hopes for this boat, partly because of its underwater wings, a new adaptation that reduces drag by lifting the boat out of the water. This disappointing result was due to appallingly bad luck. In Leeuwarden, a person who was being chased by the police tried to escape by taking to the water. In the process, he ran along the Delft solar boat. As a result, according to the Delft team, "some of our newest and best cells" were damaged. The winner of the biennial Elfstedentocht for solar boats (which follows the route of the Dutch Elfstedentocht ice-skating marathon) was the Privat Energy Solar Boat Team from Leeuwarden.
On 31 July and 1 August, Delft's solar car - Nuna5 -finished third in the Suzuka Dream Cup, held at the Formula 1 circuit at Suzuka, Japan. It was the first time that the Nuon Solar Team had taken part in this competition. In recent years,


Photo: Delta Lloyd Solar Boat

this solar car also participated in the World Solar Challenge in Australia on five occasions, finishing first four times in a row. Last year the car crossed the finishing line in second place.

Further details:
www.deltalloydsolarboat.nl
www.nuonsolarteam.nl

Energetic tumbler

A group of ten third-year Aerospace Engineering students designed a teardrop-shaped buoy to generate energy from passing waves. They claim their design can generate as much as 45 watts from waves just 10-centimetres high. A full-scale model would generate 60 kilowatts in 3.5-meter-high waves.
The teardrop-shaped float is completely sealed. Inside, a heavy flywheel spins round at several hundred revolutions per second.

When passing waves tip the float sideways, a smart mechanical system causes the flywheel (which is actually a gyroscope) to spin faster. The wheel is connected to a generator, which converts the extra spin into electricity. The students need another 20,000 euros to fund the construction of a demonstration model.

Further details:
Joris Melkert, j.a.melkert@tudelft.nl

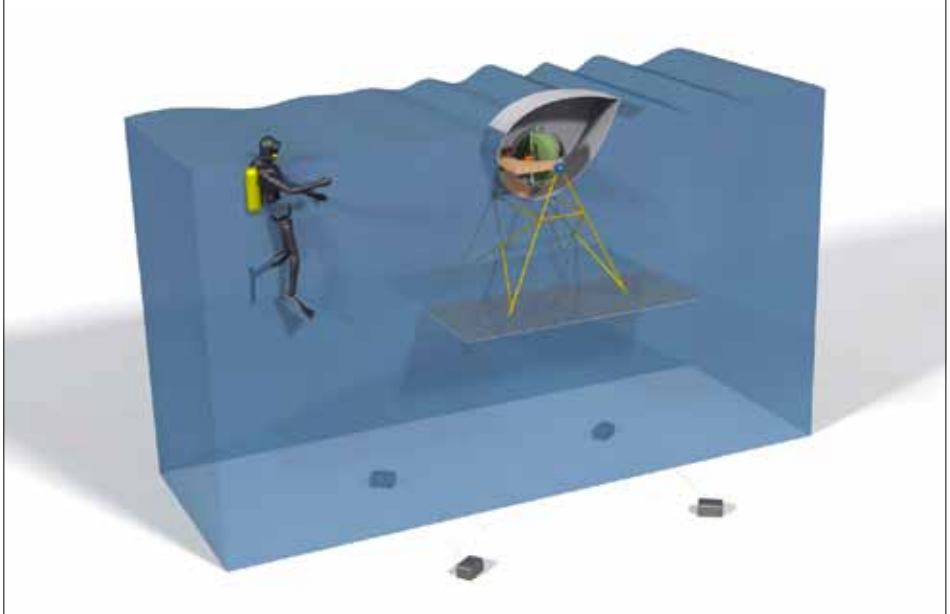



Photo: Hollands Hoogte

Sky high

Last summer, mechanical engineering student Tim Zaman captured images of the province of Noord-Holland in a most unusual way. On 1 August, at Heiloo, he launched a helium balloon beneath which dangled a silver box that was to record details of the trip.
Photographs from the three onboard cameras show how rapidly the balloon gained height and headed off in a north-easterly direction. GPS receivers relayed details of the balloon's position to an onboard computer, which then broadcast this data via a radio transmitter.
The balloon burst when it reached an altitude of 30 kilometres, its cargo crashing into the IJsselmeer lake. Zaman recovered the silver box close to its last transmitted position. The onboard computer was still operating, and the final 20 pictures were a uniform green – the colour of the IJsselmeer lake. Zaman, who started his Master's in September, looks back on this project with some satisfaction. "You learn a lot here, but for the first time I had the feeling that you really can use it to achieve something."

Further details:
www.hollandshoogte.nl

Foto's: Sam Rentmeester/Fmax

Nuclear microscope

Professor Freek Beekman and his team have developed a device that shows with unprecedented accuracy precisely where biological or pharmaceutical substances are active in a living animal. The U-Spect, more than ten of which have already been sold worldwide, can dramatically reduce the use of animals in research.

Jos Wassink

The nuclear chemist proceeds with caution. His hands in the fume cupboard are hidden behind a wall of lead bricks. He observes his work through a thick plate of yellow-tinted stained glass. Everything here in the nuclear medicine research group is focused on radiation shielding. Using a mixing tube, the analyst combines miniscule quantities of antibody (as the key functional proteins) with a solution of radioactive indium. By a chemical reaction, the volatile metal atoms attach themselves to the protein molecules, after which the mixture is labelled and ready for use.
Here at the Radboud University Nijmegen Medical Centre (UMC St. Radboud), mice are used in breast cancer research. A mouse with a tumour under the skin is given a tiny injection of the radioactive-labelled antibodies. The animal is then placed under general anaesthetic in the U-Spect, a device developed by TU Delft professor of radiation detection and medical imaging, Professor Freek Beekman. After a time, you are able to see exactly where the antibodies are binding to tumour cells, as the camera reveals where the radioactivity has accumulated.

'The goal of this research is personalised medicine'

"The goal of this research is personalised medicine," says Dr Peter Laverman, researcher in nuclear medicine. The treatment of patients with antibody therapy costs tens of thousands of euros and is not guaranteed to work for everyone. It would, therefore, be very useful if we were able to determine in advance whether the antibodies will bind to the tumour. If they do not, there is very little point in administering antibody therapy. It would also be useful if we were able to determine the effect of the therapy by using a Spect scanner to see if the tumour is shrinking or disappearing (see text box: Visible radioactivity).
U-Spect is a Spect scanner specially designed for small animals. U-Spect makes radioactive-labelled molecules within the animal visible with the use of gamma rays emitted by the unstable nuclei in radioactive decay. The technique is universally applicable and only requires suitable biological molecules ('tracers') to carry the radioactivity to the appropriate organs. The passage of drugs through the body, flushing out cocaine from the brain, the growth of insulin-producing cells – this can all be captured in images with a resolution of 0.35 millimetres and to dynamic effect. In other words, allowing us the same visual quality as a short film. "Scans would only be used to measure developments in time," says Laverman. "We could save dozens of animals this way by no longer having to kill a group of five mice for the sake of research every five minutes, hour, two hours and four hours." Animals are currently still used and dissected for determining the exact dose absorbed in different organs, a process known as biodistribution. Further development of the U-Spect should, however, enable us to detect even these values from camera images.

Hobby

Professor Beekman of Applied Sciences admits he was a bit of a late bloomer. Growing up as a teenager in the 1970s in Twente, in the east of Holland, he was a huge fan of motorcross and the local rock group sensation, Normaal. "You didn't have to study to have fun," the spirit of those halcyon days still resonating in his voice. Studying physics came later, while working as a technician in a chip manufacturing plant for Philips in Nijmegen. He was 26 at the time and started studying "as a hobby". At the same time, he was offered a part-time job in the department of nuclear medicine at what was then the St. Radboud Teaching Hospital in Nijmegen. He was initially employed to take care of computer problems and oversee quality control. However, conversations with the lung specialist with whom he shared a room led to a growing interest in the technology behind gamma cameras and the reconstruction process – the complicated calculations used to reconstruct the spatial distribution of radioactivity from different images. In 1992, the Netherlands Organisation for Scientific Research (NWO) awarded Beekman a grant to develop an image reconstruction of a rotating gamma ▸▸

Peter Laverman: "We could have dozens of animals this way."

camera. It is somewhat unorthodox for a student to write his own research proposal, but Beekman saw no alternative: "Nobody wanted to hire a 30-year-old PhD student." Professor Max Viergever from Utrecht University was, however, interested in supervising him. Beekman developed a computational technique that he claims works a thousand times faster and ten times better than anything previously in existence. In 2003, Beekman received a Vidi grant to develop the U-Spect at Utrecht University – a Spect device for small animals with a multi-pinhole collimator and three fixed detectors.

'It will be the first scanner to depict virtually the entire electromagnetic spectrum'

In 2008, Beekman moved to TU Delft: an environment that he believes was conducive to enabling his group to be one of the few in the world to design systems from A to Z in-house. This recently led to a remarkable expansion in the U-Spect's capacity: the device can now also yield PET images (see text box). The problem until recently had been that some of the high-energy PET radiation would fly through the collimator, creating blurry imaging. To solve this problem, the group developed a collimator with a greater wall thickness and four smaller channels for each pinhole. This cluster collimator allowed us to create PET images with a resolution of 0.7 millimetres.

"I've reached my first milestone at TU Delft. And it feels good!" says Beekman. The PET and Spect devices have been combined in a machine called the Vector (Versatile Emission Computer Tomography), which is also able to provide CT (computed tomography for 3D X-ray images). The next stage is to build a 'dark room' for integrating bioluminescence. "It will be the first scanner to depict virtually the entire electromagnetic spectrum," says Beekman. "This will allow us to detect dozens of processes simultaneously."

With his new machine, Beekman has become the David of molecular imaging, pitting his strength against the Goliath of Bioscan, a company with an extensive market history and – according to their claims – ten times more devices under their belt than anyone else. Beekman is not allowing this comparison to intimidate him: "Just last week our technicians were installing devices in both America and China at the same time."

The vector prototype combines three techniques: PET Spect en CT.

Visible radioactivity

A gamma camera makes high-energy electromagnetic radiation (gamma rays) emitted by radioactive decay visible through a special crystal, which emits light when a gamma photon is taken. The camera captures the position of the light pulses. The device has been in use in hospitals since the 1980s for the medical imaging of radioactive-labelled tumours, amongst other things. An iron plate full of holes (the collimator) works as a primitive lens by only imaging perpendicular incident radiation. This gives a projection of the distribution of radioactivity. A spatial image, or an arbitrary cross-section, can be made by rotating the camera around the patient and filming the distribution from all angles, or by using multiple cameras positioned around the patient. A computer then reconstructs the images from the different spatial distribution. This technique is known as Spect (Single Photon Emission Tomography) and is used, for example, in myocardial perfusion imaging. With a resolution of 1 cm, the images are not particularly sharp.

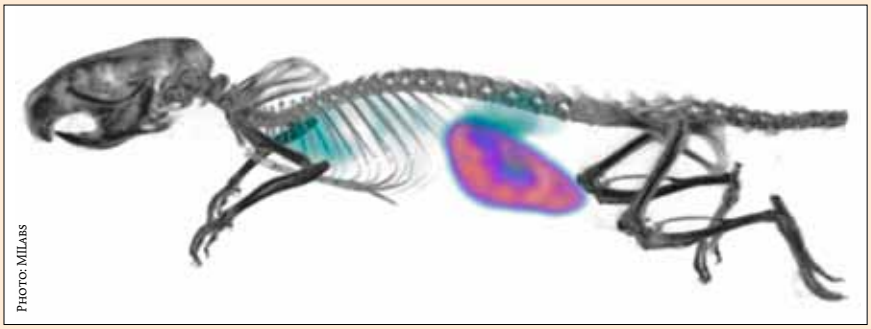
PET

PET (Positron Emission Tomography) also produces spatial images using the gamma camera but does not require a collimator due to the properties of the positron – a particle which collides with an electron in the body and merges into two high-energy photons, which are emitted in opposite directions. Electronics in the camera, therefore, only count two simultaneous pulses at opposite positions. The line between these two positions gives the approximate location of the radioisotope. PET is widely used for locating tumours, which are distinguished from other tissues by their high consumption of glucose. When using PET imaging, glucose is labelled with Fluorine-18, an isotope that emits positrons as it decays. This makes the accumulation of glucose within a tumour visible to the gamma cameras.

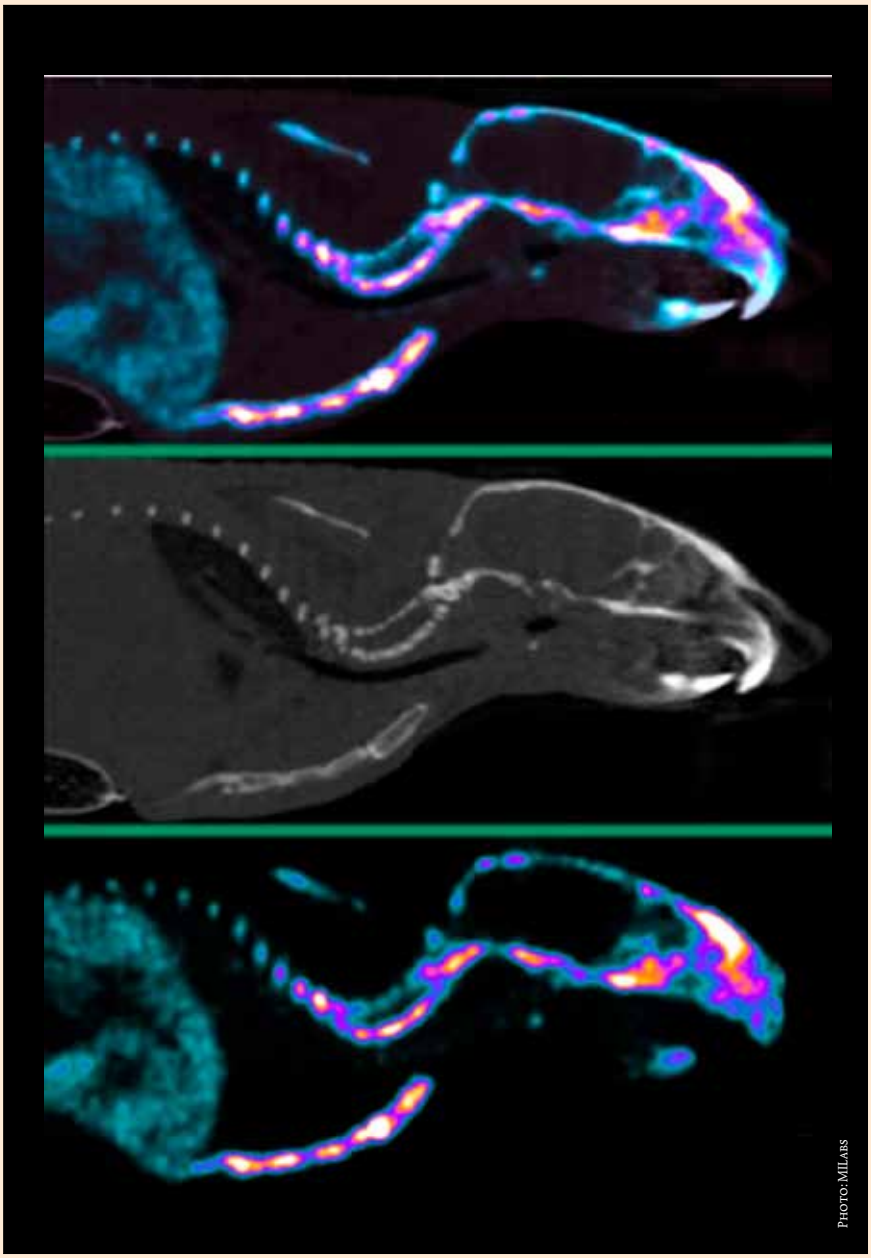
U-spect

U-Spect is an 'ultra-precise' form of Spect for use with small animals. The technique uses a sophisticated collimator in the form of a cylinder with five rows of 15 very narrow channels ("pinholes") surrounded by three planar gamma detectors (see infographic). The device can display images of up 0.35 millimetres. Beekman began developing his nuclear microscope in 2003 at Utrecht University with the aid of a Vidi grant. His product is aimed at research laboratories and is being launched through his company MILabs (Molecular Imaging Laboratories).

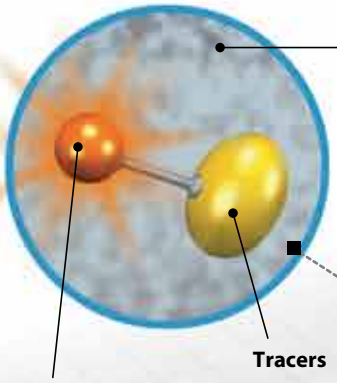
Further information:
Professor Freek Beekman
F.J.Beekman@tudelft.nl
www.milabs.com



Combination of CT and Spect imaging shows the location of a subcutaneous tumour (orange/purple) in a mouse. The green trace is the remaining unbound antibody in the vicinity of the heart and kidneys. This is a frame from a 3-D film made by Wim Bleeker, Genmab BV, in collaboration with the University Medical Centre (UMC) Utrecht.

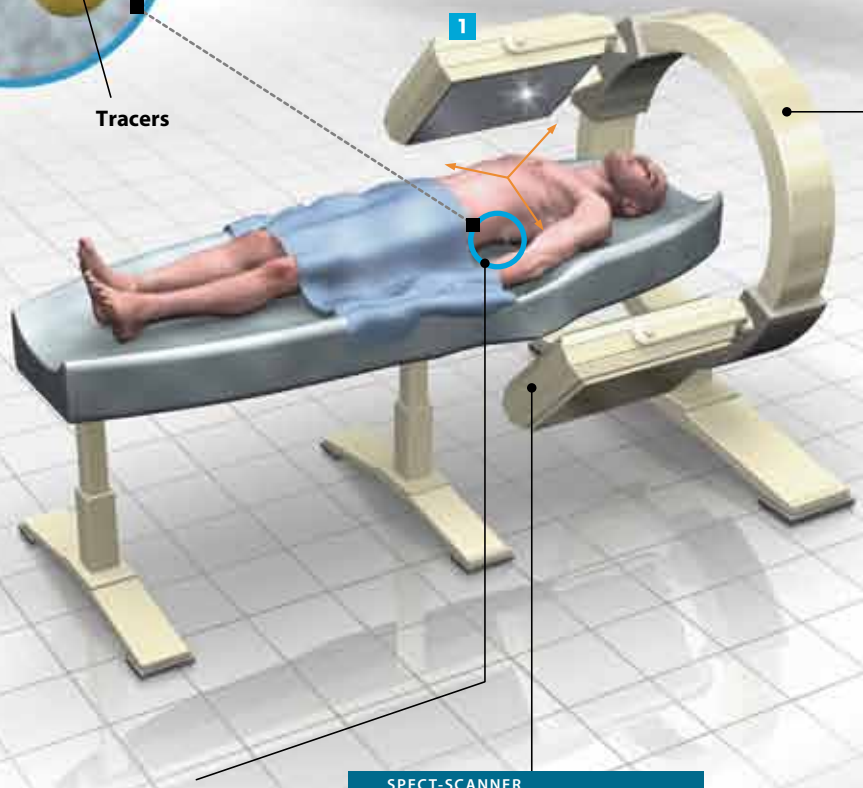


Injected technetium-99m detects bones in a mouse torso. Mouse looking right. The above image is a combination of Spect and CT with the individual components below. The photo gives a good impression of the high-resolution of the Spect image.



Radioactive labels
Tracers (which bind to tumour cells or heart tissue, for example) are linked to a radioactive isotope. They are given a radioactive 'label', as it were, that is detectable within the body.

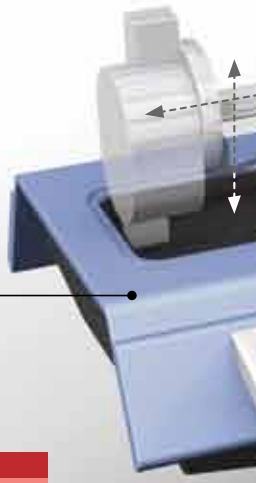
Gamma detector
A gamma detector 1 consists of a large crystal that emits light when it is hit by gamma rays. An array of photo-detecto at the back records the location of each flash of light in the crystal.



Three-dimensional radiation image
If gamma detectors are placed around t patient (or rotated), a computer can cor a three-dimensional image of the radioa substance's distribution throughout the

Injecting a radioactive label
The patient (or a mouse) is injected with a small amount of radioactive substance (or this is administered with the food). The substance disperses throughout the body. A scan can be made about one hour later.

SPECT-SCANNER
Scanner used to examine patients



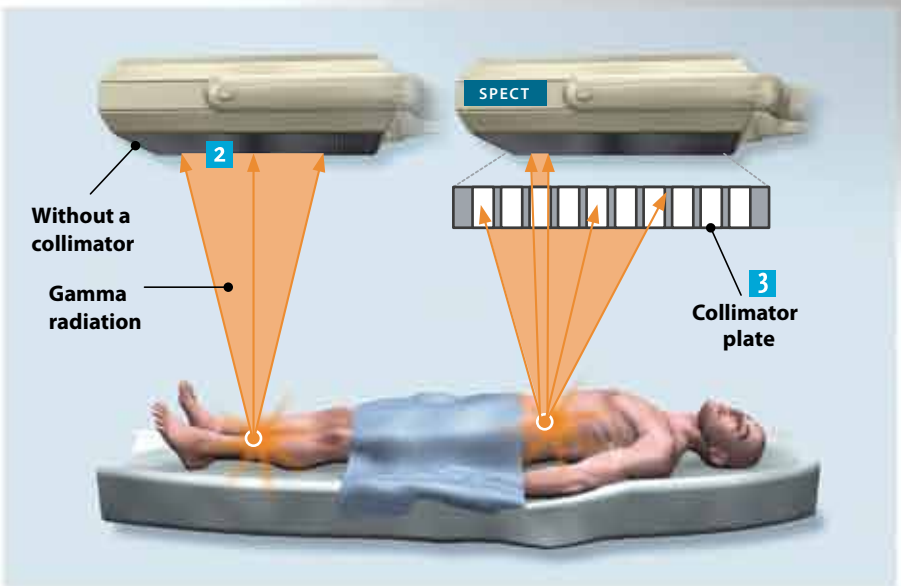
U-SPECT
Special scanner for small animals

Detecting radiation
Radioactive substances decay, emitting ionising radiation in the process. This radiation can be measured using special scanning devices, known as isotope scanners. The radiation reveals where the radioactive labels, hence also the tracers, are concentrated in the body. Cells (for example) at these sites in tissues or organs are taking up more nutrients from the blood than normal healthy cells. This may indicate the presence of tumour cells. Isotope scans can reveal metastases that are not visible on a traditional CT scan.

Spect (Single Photon Emission Computerised Tomography) scanners are designed to measure a single gamma photon. Isotopes that are suitable for use in Spect (e.g. technetium or iodine) decay with the emission of a single photon. Spect isotopes have half-lives ranging from a few hours to several days. This technique has a measurement uncertainty of approximately 10 mm.

Spect scan images have an uncertainty of about 10 mm. While this uncertainty permits effective scans to be made of humans, it is too large for studies of tumours in the brains or livers of mice. U-Spect was developed to produce pin-sharp scans of even very small animals.

Collimatorplaat
The radioactive isotope inside the body emits radiation in all directions, so this will intersect with a large area of the detector 2. This makes it impossible to localise the source of the radiation. For this reason, a collimator (a perforated lead plate) 3 is placed just in front of the detector crystal. Only radiation travelling on a path perpendicular to the surface of this plate can pass through the apertures. A flash of light in the crystal can only be generated by a radioactive source in the patient perpendicularly below that spot in the detector. A single detector cannot measure the depth of the gamma source in the body.

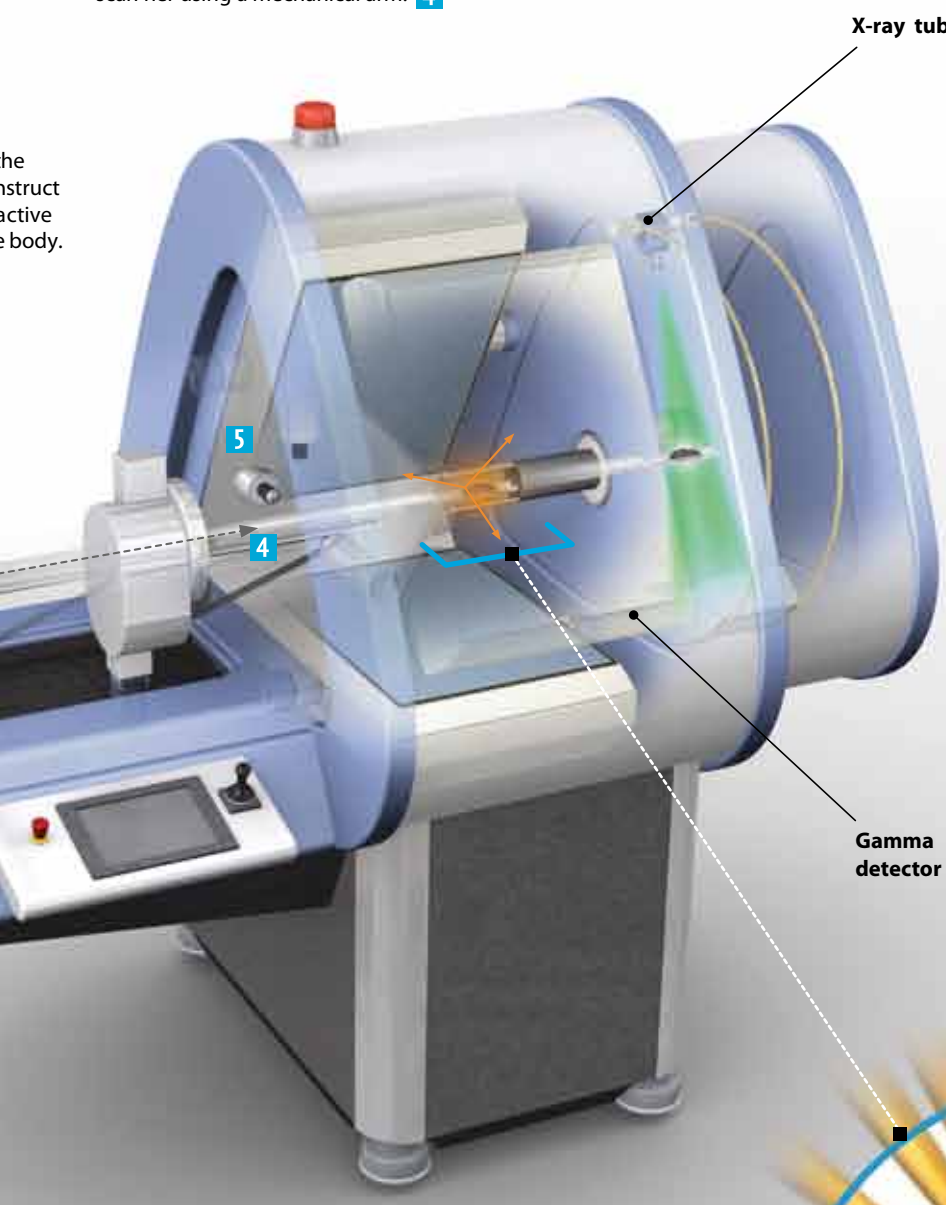


Tumours

The efficacy of new drugs is tested using mice. For example, the mechanism by which medications bind to tumour cells while ignoring healthy tissue. In order to study this linkage, tumour cells are injected into mice. These animals are later injected with radio-labelled antibodies, which bind to the tumour. An isotope scan will then show whether the antibodies have actually concentrated at the tumour's location (which is known).

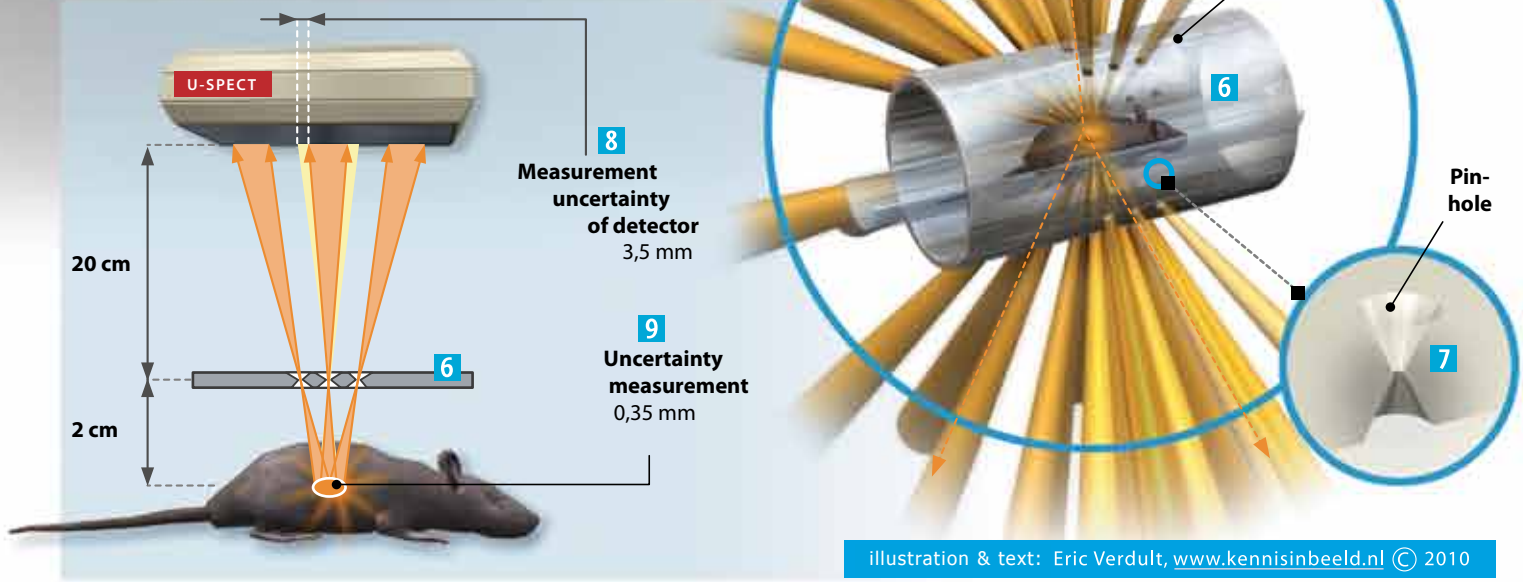
a Measuring U-Spect: Animal
A mouse is first injected with a radioactive substance and then anesthetised. The animal is laid on a heated bed in a container, which is then inserted into the scan ner using a mechanical arm. 4

b Measuring U-Spect: Measurement area
The attendant uses three cameras 5 to determine which part of the animal is to be scanned. Each measurement focuses on a cylindrical space measuring 12 mm (diameter) by 8 mm.



c Measuring U-spect: Collimator acts like a magnifier
In order to increase measurement certainty, the flat collimator plate is replaced by a cylindrical collimator 6 with holes in the sides. Only radiation emitted from a specific area can pass through these 'pinholes' 7. Each hole functions as a 'camera obscura', projecting the radiation onto one of three fixed detectors with a measurement uncertainty of 3.5 mm. The magnification factor (about 10) is determined by the ratio of the distances between the animal, the wall of the collimator, and the detector. In this way, the resolution of the U-Spect has improved from 3.5 mm 8 to 0.35 mm 9. If the position of the mouse is changed relative to the collimator, the radiation in a larger measurement area can be determined.

d Measuring U-Spect: CT-scan
The U-Spect has a built-in CT scanner (a rotating X-ray tube that produces 3D X-ray images), to create a 3D anatomical image showing the location of the radiation.



Another green world

Architect Winy Maas heads a research group known as 'The Why Factory'. According to them, while cutting consumption is all very well, we are too focused on individual 'green' behaviour. We need to think bigger to solve our problems. Big cities are the key to a greener future.

Joost Panhuysen

Winy Maas

Photo: Sam Rentmeester/Fmax

Ulf Hachauf

They look like spaceships that landed silently, in the dead of night, in the main thoroughfares of Barcelona. Long rows of identical, elongated greenhouses, three stories high, and constructed across the roofs of houses, block after block. They are lined up neatly in rows, as if their arrival was as logical as it was self-evident.
This vision of the future, known as 'The Hanging Gardens of Barcelona', was created by The Why Factory, part of the faculty of Architecture. But while these white greenhouses do not conceal any shuffling Martians, they can grow enough crops to meet a large part of the population's food requirements. A helium balloon is used when harvesting these crops.
The major feat of urban planning featuring in this green dream is literally and figuratively hanging over the heads of Barcelona's residents. Big problems require big solutions? It clearly takes an astonishingly large area of land to feed an affluent Western city. The following is one of the numerous 'Eco Factoids ' in the 'Green Dream', a book published this year by The Why Factory. 'An area of land 150 times the size of Manhattan would be needed to grow enough food for all the residents of that borough.' There are many good reasons for moving food production into the city: it involves less waste, less transport (so less CO_2 is emitted), and has less of an impact on surrounding areas of land. In short, Barcelona is reducing its ecological footprint. But where can a city find sufficient space to grow enough crops to meet its own food requirement? The Hanging Gardens of Barcelona were conceived by Master's students Nicola Placella and Magnus Svensson, who have done their best to reduce the spatial impact of food production. Meat has been banned. Barcelona will rank among the 'Self-Sustaining Cities of the Totalitarian Vegan Order', assert Placella and Svensson with a wink. Yet even such 'Vegan Cities' would not be able to achieve full food autarky. A harsh conclusion for plucky urbanites practising urban farming on balconies and in back gardens. 'Green Dream' smashes many more green illusions to smithereens. Did you know, for example, that the 26,000 trees in Central Park compensate for the combined CO_2 emissions of no more than 37 of Manhattan's 1.6 million residents?

Future fantasies

The Why Factory's first publication was entitled 'Visionary Cities' (2009), in which architects were required to develop their own vision of the cities of the future. Winy Maas pointed out that architects often avoid major projects, for fear of going down in history as the mastermind behind an urban planning disaster of terrifying proportions. 'Visionary Cities' called upon architects to return to creating vast future fantasies, pleading for honour to be restored to collective and to large-scale endeavours.

'The 26,000 trees in Central Park compensate for the combined CO_2 emissions of only 37 of Manhattan's 1.6 million residents'

The book was a sample sheet of themes to be worked out in detail in subsequent volumes. Its style was quite striking. Brief, sleek chapters that get straight to the point. The statements are supported by copious amounts of numerical data, often rendered into incisive visual forms. Much of the story was told using images.
'Green Dream: How Future Cities Can Outsmart Nature' continues in the same vein, but with a more in-depth treatment. The sub-title alone is provocative. You can almost hear some sustainability gurus sighing about the desire to outsmart Mother Nature, the same old arrogance that has led ever-destructive mankind to cause one environmental disaster after another. Maas and co-authors Ulf Hackauf and Pirjo Haikola deny this, claiming

Stations for solar energy, shaped as waterlilies.

that technology and innovation are essential for true sustainability. Nature will therefore continue to change, as a result of human intervention.
They also see 'natural', as a tricky concept. Why shouldn't big cities be a more natural setting for 21st century Homo sapiens than a pristine area of wilderness? After all, man is better able to survive in urban surroundings. "Perhaps we should abandon our romantic ideals about the countryside, and embrace the science and innovation that cities have to offer," the authors suggest.
Cities may be a solution rather than a problem. Green metropolises may actually be one way to reduce humans' adverse impact on the climate and on the natural environment. The Why Factory urges the use of new, sustainable technology in this setting, on an unprecedented scale.
While they are concerned about climate change and diminishing biodiversity, the Why Factory's researchers are pushing ahead with the development of progressive concepts. They place great emphasis on technology and innovation. There are also massive infrastructure projects such as 'Green Dream', which shows how a network of magnetic levitation (maglev) trains could be used to link all European cities together.
We are too focused on our own eco-sins, say the researchers. Major interventions such as new transport and energy networks and stricter laws are more effective than cutting consumption and sorting household waste, praiseworthy though these measures may be. Green consumers are also being misled by marketing ploys in which unrealistic claims are made about the sustainability of certain products. Experts have neatly categorised these methods as the 'seven sins of green washing'.

Masdar City

Not back to nature then, if The Why Factory has anything to say about it, but onward to a new green world in the big cities. What would this world be like, and have such high-tech eco-cities already been built?
With regard to the latter, it remains to be seen. In recent years, China and the United Arab Emirates have generated a great deal of favourable publicity with their plans for relatively small but sophisticated eco-cities. Dongtan was to have been the ecological jewel in Shanghai's crown. A city running entirely on renewable energy, where everyone would be within walking distance of public transport. After five years the worldwide enthusiasm had turned to cynicism – Dongtan was simply never built.

'It takes an astonishingly large area of land to feed an affluent Western city'

After this debacle, the construction of Masdar City was followed more critically. This was certainly the case when ▸▸

the completion date for this eco-city beside the airport in Abu Dhabi was postponed from 2016 to 2020. However, this project still appeals to the imagination. Masdar is not only intended to be the first CO_2-neutral, zero waste city in the world, it will also have a university of its own, and will be able to serve as a testing ground for scaled-up technologies for various types of renewable energy.
According to the authors of 'Green Dream', Masdar is an unsuitable example for eco-cities in cooler regions. " The city has been specially designed for a hot, dry and sunny location." This involves a strong focus on solar energy, and an urban design with considerable emphasis on shade and natural cooling. The construction of Masdar City will cost around 22 billion U.S. dollars, a sum of money beyond the wildest dreams of developing countries with similar climates.
Nevertheless, they see the city as an interesting test case. " The combination of renewable sources of energy and energy-efficient planning can be a very promising example. The city will be free of cars. An automated personal rapid transport system [involving electric taxis – ed.] will be introduced, the first time this has been done on a city-wide scale. Once the technology has proven itself, other cities will be more inclined to use the system too."
If they are to achieve the benefits of scale, green cities like the one The Why Factory has in mind must have at least 1-million inhabitants. On an abstract scale, researcher Haikola has identified ways in which green cities of this kind, located in tropical climatic zones, might work. Rough sketches, as it were, but based on simple calculations of things like food production and energy supply.

Compact city

Haikola first looked into the number of square kilometres of agricultural land required, and the total amount of waste, which is modest compared to rich countries.
She conceived a very compact city, with narrow streets (for shade), and buildings mostly 25 stories high. Cooling wind flows are generated by differences in elevation between the buildings.
Haikola's green city is linked to other regions and

The Hanging Gardens of Barcelona.

Luminescent bacteria make the Amsterdam canals glow blue.

countries by a fast maglev train system, which makes travelling by air less attractive. Maglev trains are also used for freight transport, thus reducing CO_2 emissions.
When designing the food production system, Haikola also encountered the space-shortage problem. Hydroponics involves growing crops in water with added nutrients (including minerals), rather than in the soil. This method of cultivation potentially uses only one third of the agricultural land required by other methods. This technique could conceivably be used in green-roofed city flats, but it does have a number of drawbacks. For instance, it tends to boost the heat-island effect, which makes cities significantly warmer than the surrounding areas, even at night.

'Perhaps we should abandon our romantic ideals about the countryside'

This can be solved by creating four artificial hills around the city, each 135 stories high. Together, they cover an area of 22 square kilometres. Here, not in the city but close to it, there is room for food production. Haikola has also sited the energy supply system close to the city. There is a solar power station covering an area of well over 100 square meters, a wind farm covering 379 square kilometres (using the largest wind turbine in the world, the German Enercon E126) and some third-generation nuclear power plants. All to supply energy to a vertical city that takes up less than half the space of Delft, but which nevertheless has one million inhabitants.

Green City Calculator

If both old and new cities are soon to form the vanguard of sustainability, we will need an instrument capable of measuring and comparing the green performance of entire cities, rather than individual homes. The Why Factory is attempting to develop just such a 'Green City Calculator', which must also be able to calculate the effects of new policies on a city's green goals.
Here too, The Why Factory stresses the importance of reason and hard data in the sustainability debate. At the same time, this think-tank occasionally dreams up some outwardly enticing visions of the future. In one of these, luminescent bacteria are used to make the canals of Amsterdam glow blue. Giant water lilies around the Thai island of Phuket attract tourists and provide solar energy. Taipei is bathed in white light during the day and in green light at night. A new aesthetic is emerging.
But those cold frames above Barcelona will take some getting used to. ◂◂

Further details:
The Why Factory, 'Green Dream, How Future Cities can, outsmart Nature', NA publishers, 408 pages, 35 euro

Photo's: Sam Rentmeester/fmax

‘I don’t need power, but I do want influence’

As a small child, Salomon ‘Salle’ Kroonenberg was unable to choose between languages or voyages of discovery.

As professor emeritus he now writes and talks about what he sees and thinks.

On 19 March 2010, he bade farewell to TU Delft.

Jos Wassink

One side of the corridor in the Civil Engineering and Geosciences faculty building is covered with an enormous map of the world. On the other side hangs a row of photographs depicting mountains, ice floes and deserts, salt flats and marshlands. Salle has been on a trip. A large box, stuffed full of rolled-up maps, stands in the corner of his room. Beside the box is a crooked pile of compartmentalised wooden trays, each containing stones of various compositions and sizes, together with small pieces of paper bearing handwritten text.

Who is Salomon Kroonenberg?

Salomon Kroonenberg is best known as a climate sceptic, although he prefers the term ‘climate relativist’. His award-winning book, The Human Scale, has sold 25,000 copies since it was published in 2006.

Salomon Kroonenberg was Professor of Geology at the Faculty of Civil Engineering and Geosciences from 1996 until 1 September 2009. He held the post of Professor of Geology and Mineralogy at Wageningen University from 1982 to 1996. From 1979-1982 he lectured in remote sensing at the University of Bogota in Colombia. Prior to that (1978-1979) he taught physical geography at the University College of Swaziland, and from 1972-1978 he was employed by the Geological and Mining Service of Surinam as a petroleum geologist. Salomon Bernard 'Salle' Kroonenberg was born in Leiden on 13 March 1947, and attended grammar school (science-based, pre-university stream) at Middelburg. He studied geology at the University of Amsterdam (1965-1971), and obtained a PhD in 1976.

How many languages do you speak?

“That rather depends on what you include, but let’s say around ten. These include Spanish, Italian and Russian – I have just been awarded an honorary professorship from Moscow State University. That is my ‘sideline career’. There came a time when I was forced to choose between languages and geology.”

So why did you opt for geology? Because of the travelling?

“That certainly had something to do with it. One of my uncles was a biologist. He collected crabs, lobsters, shrimps and woodlice from all over the world. I was keen to accompany him on his travels, but nothing ever came of it. He sent me envelopes covered with stamps. In those days, that was my way of giving structure to the world. He also brought me stones from America, stimulating my interest from an early age. I was given his geology textbook.”

Is that how it started?

“Yes. When I was ten I used to visit my grandmother in Leiden, but I would also call in at the National Museum of Geology and Mineralogy, which was situated on the Garenmarkt. I thought that the minerals were quite beautiful – geometric figures shaped by nature. These beautiful crystals, and King Willem the First’s smoky topaz. I’ve always been fascinated by minerals, more so than by fossils in fact. I love their geometry and structure.”

You set out on a voyage of discovery, like a latter-day 19th century scientist.

“I left after graduating in Amsterdam. I wasn’t the least bit interested in doing a PhD – I just wanted to go! Then I got that job at the geological service in Suriname, and still managed to get a PhD, on the basis of my work there.”

What did that job entail?

“I drew up most of the southwest quadrant of the map of Suriname, partly based on information that was already available. We also travelled into Suriname’s uninhabited interior with koraal boats and hammocks.”

Do people still do this sort of work, or has every part of the world now been mapped?

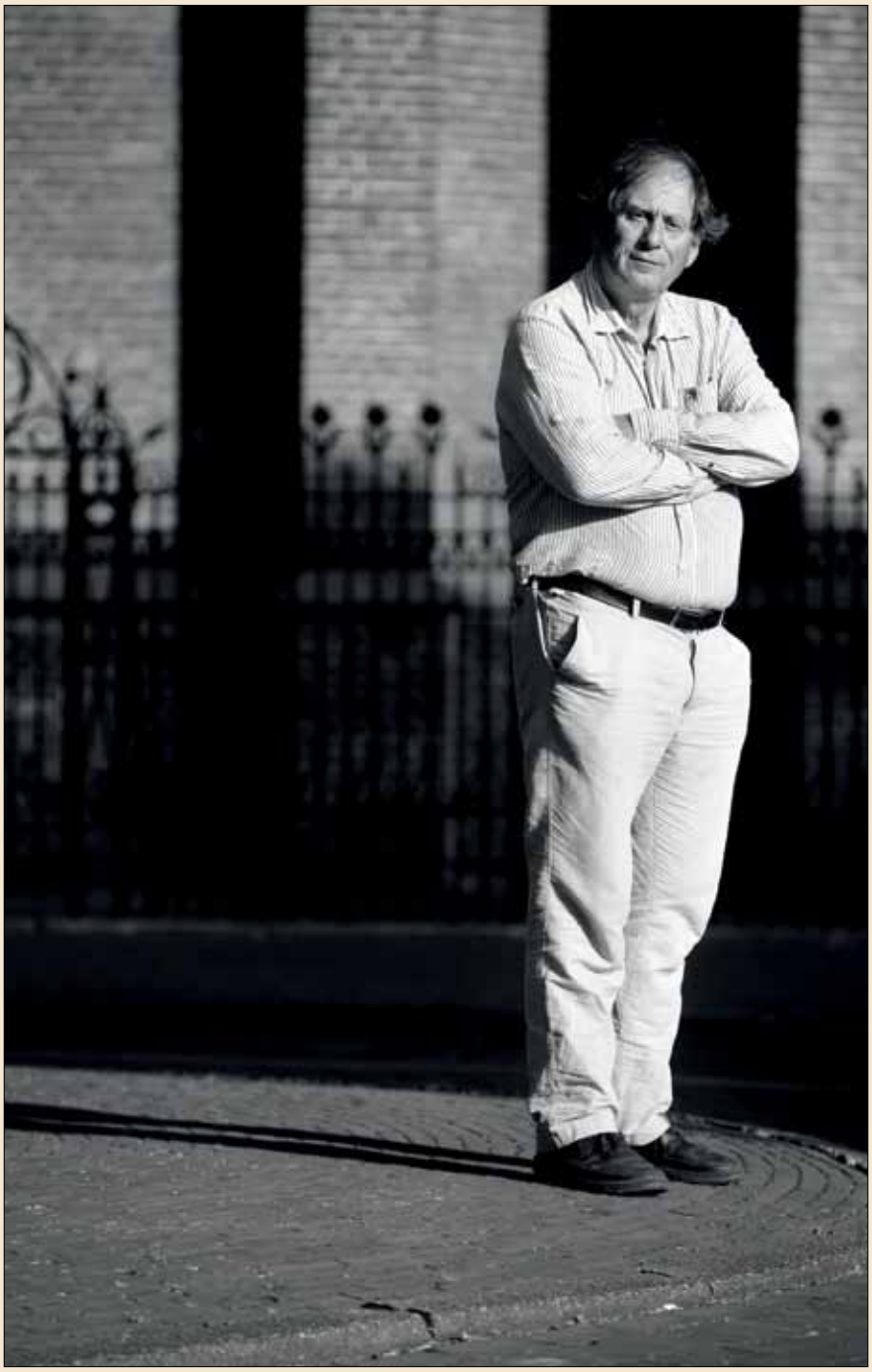
“Not any more, actually, aside from specific exploration. These days, for example, people are exploring for gold. But there is no more map-making to be done.”

Three-quarters of your book, ‘De menselijke maat’ (The Human Scale) deals with geology, yet it is widely seen as a statement about the climate. Was that your intention?

“It was the climate debate that prompted me to put pen to paper. The debate about the hockey stick curve [a temperature curve which also shows a controversial warm period in the Middle Ages, ed.] started in 2001, so that was already under way. The book is about geological time, not the climate. Nevertheless, the climate debate was a useful way of giving people a feeling for geological time. Many of those who read my book now know the climate is constantly changing.”

By publishing this book you have acquired a reputation as a climate sceptic. Was that the intention?

“No. Moreover, the term had not yet been invented. Al Gore’s film brought matters to a head. It turned climate change into a



'It is absurd to dispose of CO_2 by pumping it into the ground'

global issue, with supporters and opponents. From then on people referred to me as a climate sceptic, although I prefer the term 'climate relativist'. This is because while I'm convinced that the climate is changing, I doubt that we humans are currently the main cause."

In your view, are claims that mankind has destabilised the climate based on an overestimation of our importance?

"You can say that we have released more CO_2 into the atmosphere than it has contained for ages past. That's quite right, there is no denying it. However, is this really triggering a response from nature? The big problem is that there are numerous feedbacks. How do the oceans respond to higher concentrations of CO_2 in the atmosphere, how do plants react? There are so many feedback effects that you can justifiably express doubts about the net effect. Nevertheless, politicians are united in the view that we need to cut CO_2 emissions to save the climate. The fact is, however, nothing bad is actually happening."

Not yet at least. Many climate researchers believe a temperature rise of more than 2 °C will accelerate global warming by natural processes such as melting ice and the release of methane from the tundras. Why do you not mention the positive feedbacks?

"The book was written in 2004-2005, before there was any discussion of a 2 °C maximum. I'm also not convinced that those feedbacks will occur. The best match for climatic fluctuations during the 20th century is mainly the variation in solar activity. Far more so than the CO_2 concentration."

That hasn't been the case since 1980.

"I do not accept the IPCC's [the Intergovernmental Panel on Climate Change, Ed.] projections of a 2 °C increase! Our CO_2 fixation may simply be an irrelevant distraction, when we should instead be allowing for the possibility of cooling rather than warming."

Do you use green power at home?

"I don't think so, but then again I don't have a car. With reference to your previous point, I favour a reduction in the consumption of fossil fuels, not to cut CO_2 emissions but simply because these resources are running out. I also think it is absurd to dispose of

CO_2 by pumping it into the ground. You need the energy output of an entire power station just to store the CO_2 produced by four other power stations. Rather than saving energy, CO_2 storage actually boosts energy consumption. In my view, those in favour of this approach are barking up the wrong tree. We should instead be using our money to develop new solar cells or to build dikes in Bangladesh, where farmland is flooded every three years. Then you can be certain you are doing something useful."

At 63, you are rather young to be retiring. What are you planning to do?

"I'm currently working on a new book about the subterranean world - which is also the subject of my valedictory address – entitled, 'Why hell stinks of sulphur'. The book is not just about the subterranean world as such; it also examines long-held views on the subject. Why is the subterranean world seen as terrifying, and the sky paradisiacal? The subterranean world always seems to get a bad press. The urge to tell that story is greater than the compulsion here to dot every last 'i' and cross every last 't'.
That was in mid-March. My next encounter with Professor Kroonenberg was well over three months after his valedictory lecture, which had the cheerful title of 'Beneath the green turf is just the beginning'. This time we met in his apartment, close to the Nieuwe Kerk (New Church). White walls and a wooden floor. There is a huge pile of unread magazines in the corner next to the couch, as Salle has just arrived back from Spitsbergen where he acted as one of the tour guides.

What was Spitsbergen like?

"Great. This was a climatic education trip organised by the NRC *Handelsblad* newspaper. They had invited me along to act as the official geologist, to give talks on board about the climate."

Were you expected to adopt the role of climate sceptic?

"That was undoubtedly the intention, but I did much more than that. I had never been to Spitsbergen before, but it has an incredibly interesting climatic history. For instance, it is the place that gave rise to the concept of Snowball Earth. A British geologist, Brian Harland, found traces of glaciation on Spitsbergen dating back 600 million years. Other continents have similar traces, so Harland interpreted this as evidence of a period of worldwide glaciation. American geologists later developed this idea into the concept of Snowball Earth, where the entire planet was encased in ice, from the poles to the tropics. I visited the places on Spitsbergen where these traces are found and showed the participants how much the climate has changed. I also told them how Spitsbergen was pushed from the equator to the pole over the course of geological time. I told the entire story in a series of lectures aboard the Plancius, an old naval vessel that has been converted into a floating hotel."

How did the passengers respond? Were these all people who were worried about climate change?

"The majority of the audience were above the age of 55, fairly well off and approaching retirement. Such people tend to be rather sceptical about climate change. I was there with Heleen de Coninck, who works on energy policy at the Energy Research Centre of the Netherlands (ECN). To some extent, she represented the other side of the story. There were also scientists on board with twenty years of research experience. They can see signs of warming on Spitsbergen."

Spitsbergen is considered to be on the front line of climate change, isn't it?

"The effects of climate change are certainly noticeable there. Researchers there have observed the reappearance of mussels that have been absent from the region for the past 6,000 years. So it's not the first time that such changes have taken place. I used this theme as the basis for my talks. We can see warming taking place, but it's not the first time this has happened, nor is it excessive compared to other periods of human history."

Your image is increasingly that of an itinerant geologist and speaker. Has this always been an ambition of yours?

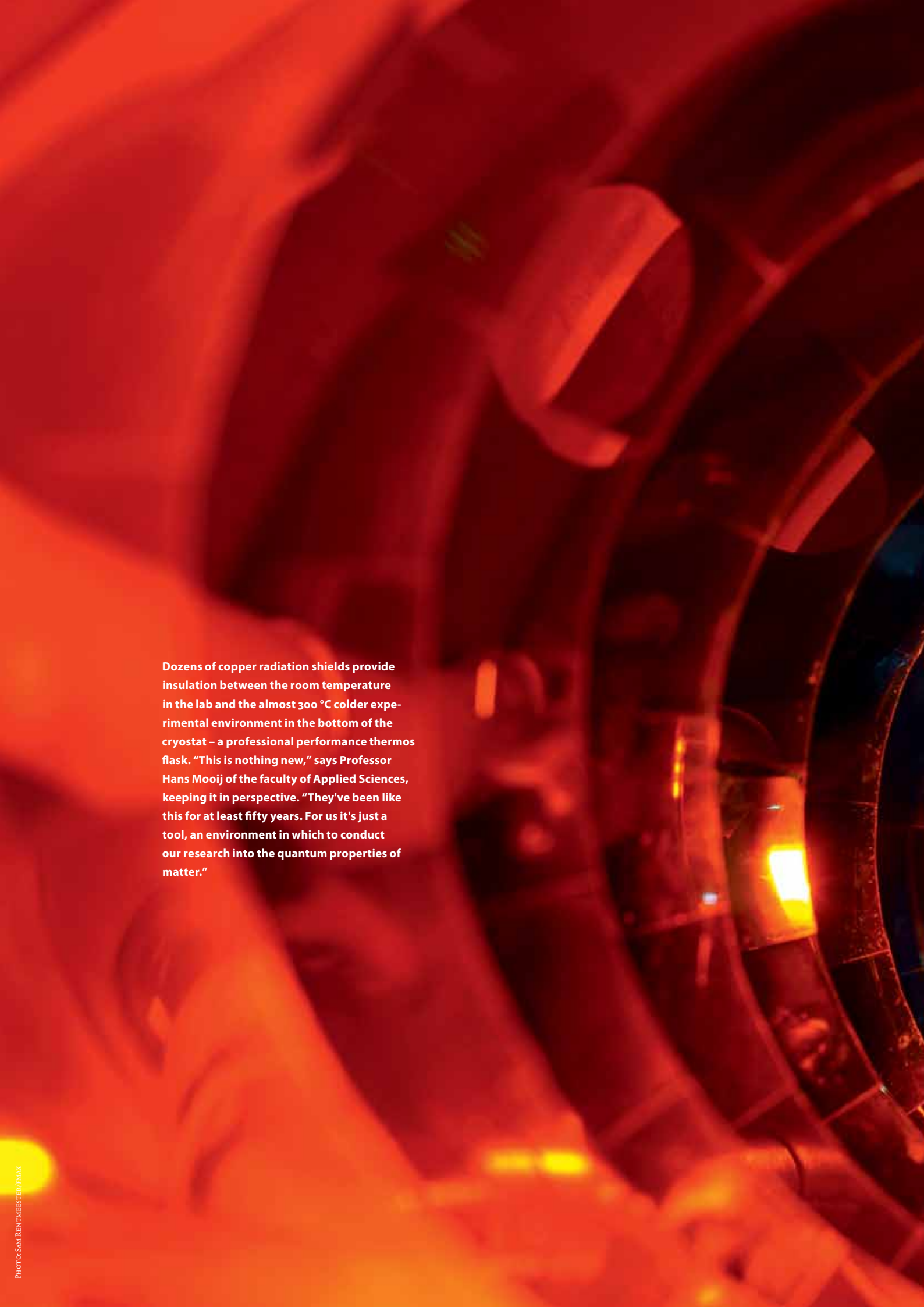
"I took early retirement because I wanted to work on my second book. I have had little opportunity to do so lately, however, due to my travels, my work for the Netherlands Organisation for Scientific Research (NWO), and inspection visits. You don't pass up an opportunity like this trip to Spitsbergen, of course. I had been playing with ideas for that first book for quite some time. Following its publication, the sheer scale of the response convinced me that it was more important to pursue this line than to carry on with my research at TU Delft, which can just as easily be done by others. However, others cannot write the book that I have in mind, only I can do that. This is the choice that I made."

It also gives you access to a larger audience than you have in the scientific world.

"This is all spin-off from my first book. Wim Brands discussed this at the time, in his programme, 'Boeken Etcetera'. That discussion produced a sort of snowball effect, which still rolls on. This was well over four years ago, in 2006, but my diary is still full of engagements. I enjoy this, and I also think it's very good for geology. After all, to the best of my knowledge, no other geologist has ever appeared on the Pauw & Witteman show. A day after the broadcast, a headline in the NRC Handelsblad newspaper quoted Camiel Eurlings (caretaker Minster of Transport, ed.) as saying that while vulcanologists were having a ball, it was all very inconvenient for air traffic. He and I had appeared together in that programme. He had at least understood that vulcanologists were very excited about the ash cloud. It gradually takes root in people's minds. I really get a kick out of that."

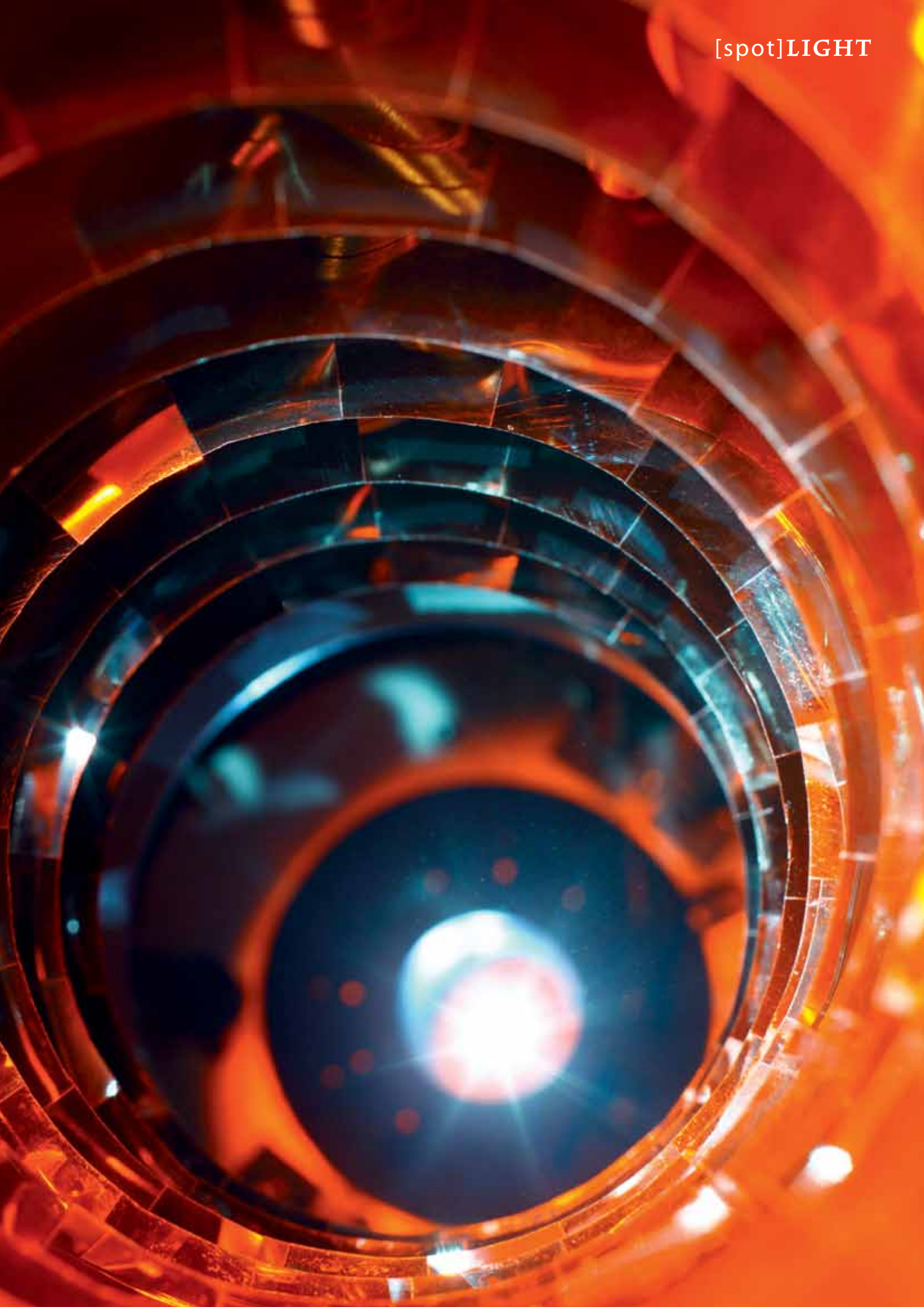
Are you planning on becoming a sort of ambassador for geology?

"I don't want to make too much of it. I enjoy... let me put it this way - I do not like power, but I do like influence. I don't need to lord it over others. I'm not tied to any organisation, and that's great. I can just be myself. Yet, at the same time, people are taking my ideas on board."



Dozens of copper radiation shields provide insulation between the room temperature in the lab and the almost 300 °C colder experimental environment in the bottom of the cryostat – a professional performance thermos flask. "This is nothing new," says Professor Hans Mooij of the faculty of Applied Sciences, keeping it in perspective. "They've been like this for at least fifty years. For us it's just a tool, an environment in which to conduct our research into the quantum properties of matter."

Photo: Sam Rentmeester/FMAX



Potted history

The Jordan Valley was once populated by a people, now almost forgotten by historians, with whom the pharaoh of Egypt sought favour. That is the conclusion reached by Niels Groot, the first researcher to take a PhD at the Delft-Leiden Centre for Archaeology, Art History and Science.

Tomas van Dijk

Photo's: Sam Rentmeester/fmak

Niels Groot thinks there might have been a wealthy elite who had luxury tableware made to suit their own tastes.


Photo: Niels Groot

Archeologist Gerrit van der Kooij (left) at the excavation site.

It is about 1300 to 1200 BC, at the end of the Late Bronze Age. The Egyptian empire is expanding its sphere of influence as never before, subduing many rebellious city-states in Palestine and making them its vassals. Further north, the Hittites from Anatolia hold sway. The two great powers have the Levant (the area comprising modern Syria, Lebanon, Israel and Jordan) firmly in their grasp.
Sandwiched between these powers and the great Arabian Desert to the east is an area that may have retained its independence. "Biblical texts make little mention of this spot in the Jordan Valley, which is why historians and archaeologists disregarded it for so long," says archaeologist and materials scientist Niels Groot. "We know hardly anything about the people who lived there, their culture, commerce and industry."
Groot is trying to fill this gap in the history of the Middle East by analysing pottery from the area. He hopes to obtain his PhD from the faculty of Mechanical, Maritime and Materials Engineering (3mE) this autumn.
Groot thinks that the people who lived in the Jordan Valley during the Late Bronze Age were not ruled directly by the major powers. No objects or structures have been found to suggest otherwise, says the researcher. Nevertheless, archaeologists have unearthed many remnants of chic-looking pottery found nowhere else in the Middle East.
Might there have been a wealthy elite who had luxury tableware made to suit their own tastes? In collaboration with researchers from institutions such as the Reactor Institute Delft and the Kavli Institute of Nanoscience, Groot has deployed a large arsenal of materials analysis techniques in an attempt to find out.

Excavations

Groot's PhD supervisor is the pigment expert, Professor Joris Dik, of 3mE, the Delft-based coordinator of the Centre for Archaeology, Art History and Science (CAAS).
CAAS is a collaborative venture between TU Delft and the faculties of Archaeology and Art History at the University of Leiden. While this institute has officially been in existence for about two and a half years now, there is a much longer history of collaborative ventures between the two universities.
Groot began his PhD research nearly four years ago, with one foot in Leiden and the other in Delft. He will be the first researcher at CAAS to obtain a PhD.

The archaeologist is building on the work of Professor Henk Franken (now deceased), who was attached to Leiden University's Palestinian Antiquities Department. From the early 1960s onwards, Prof. Franken led an impressive series of excavations at the Tell (mound) Deir Alla in the Jordan Valley. People have been building and later demolishing houses on that spot since 1700 BC. This activity has created a 30-metre high mound, which is a treasure trove for archaeologists, as it is packed with household goods and scraps of precious pottery from temples. The excavations are now being

'These shards are really interesting'

directed from Leiden by archaeologist Gerrit van der Kooij and pottery expert Bram van As.
Some scholars believe Deir Alla to be the Biblical Sukkot, where, according to the Old Testament, Jacob founded a town or village of temporary dwellings after wrestling with the angel (Genesis 33:16–17). "But until such time as we find a text in the mound that makes reference to this, we cannot say it is one way or the other," sighs Groot.
The researcher admits to being slightly troubled by archaeologists who carry out excavations with a copy of the Old Testament in one hand, and who attempt to fit all findings into the biblical story. "Fortunately, I'm researching the period immediately preceding the biblical events and an area lying just outside the main biblical sites, otherwise I really would have to walk on eggshells."
In the basement of the faculty of Archaeology at Leiden, dusty wooden crates and cardboard boxes ▸▸

are stacked up to the ceiling. Scrawled on their surfaces in pen are designations such as "Deir Alla 1978", "Deir Alla 1982" and a whole range of other dates. There is a shelving unit holding hundreds of potsherds.

Groot picks up a small jar that has miraculously remained intact for nearly four millennia. "What an ugly thing. In Deir Alla, they also tried to imitate Mycenaean pottery [from Greece, ed.]. However, their efforts were not always entirely successful," he notes with a crooked smile. Lifting some fragments out of a small box, he says, "But now these shards are really interesting. See those black, shiny patches? That is faience."

Groot is particularly interested in faience, a luxury product that is midway between earthenware and glass. "Twenty objects with faience were found in Deir Alla, far more than at any other excavation site in the Southern Levant. Given the presence of this material, the Jordan Valley was probably a prosperous region."

The archaeologist wants to know what raw materials were used in the production process, where those raw materials came from, and how the shiny pottery was made. Such knowledge would reveal something about the desires of the elite and about the structure of the court, as well as details of the requisite industry and commerce.

"During the Late Bronze Age there was a flourishing trade in faience," Groot explains. "Tableware played a major part in sacred rites. It was used in temples, and in Mesopotamia it was buried with the dead. Rulers also donated faience to temples to show how powerful they were. In this way, they attempted to expand the reach of their political influence."

The greater part of this material was mainly produced in Egypt and Mesopotamia. Remarkably, some was also produced in the small town of Deir Alla. In the early 1960s, Prof. Franken found two identical small dishes there (measuring about 10 by 15 centimetres), between the remains of two temples.

'We had never seen anything like this in pottery from that period'

This was a first, as small dishes of this kind had never been found before. Groot: "I subjected them to chemical analysis, but could find no similarities with faience from other regions. It seems the local elite were able to get their craftsmen to produce faience tableware, or that they attracted such craftsmen from elsewhere."

Metallic colour

Another discovery may be even more important. This consisted of four fragments of a bowl, once again shaped like nothing the archaeologists had ever seen before. The fragments are coated with a copper glaze and a chromite glaze. The use of chrome-containing pigments gave the bowl a sparkling metallic colour.

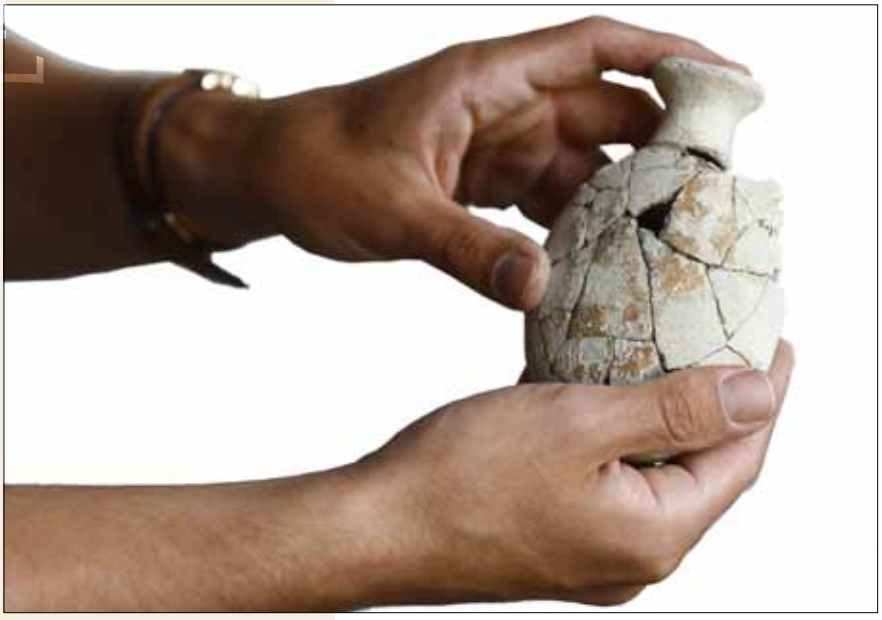
"We had never seen anything like this in pottery from that period," Groot says. "It had been assumed that chromium-containing pigments were first used in Roman times, about 1200 years later."

Chromite (an ore of chromium) is found only in northern Syria and Anatolia. Groot asks: "Did the residents of Deir Alla import the bowl? It's a possibility. Yet we find no bowls of this shape in the surrounding areas. Perhaps they just imported the pigment and made the bowl themselves."

Transmission electron microscope studies revealed another important function of the chromium-containing pigment chromite, aside from the colour and brilliance it confers on pottery. The chromium-containing pigment particles also act as nuclei against which the molten quartz crystallises, creating exceptionally fine spherically shaped crystals as it cools.

The researchers combined electron microscopy with energy dispersive X-ray spectroscopy to accurately identify all of the heavy elements in chromite. In

Mesopotamian pilgrim's bottle 1200 BC.



Niels Groot: "The craftsmen of Deir Alla were rather innovative."

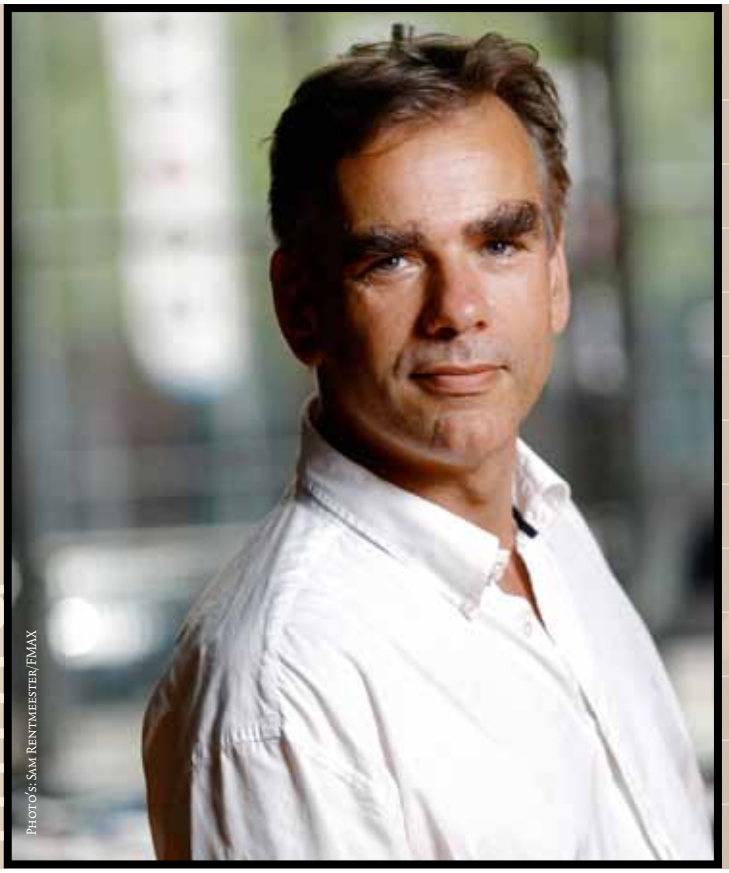
energy dispersive X-ray spectroscopy, researchers bombard a sample with highly energetic X-rays or gamma rays. Next, they measure the radiation emitted by the excited atoms.
Using this technique, the researchers discovered that the glaze layer consists partly of the silicate-containing mineral augite. This is a remarkable find, as it is very difficult to get this material to crystallise properly.

'We have tried to reproduce this faience, but without success'

"We have tried to reproduce this faience, but without success," Groot says. "There are many critical factors, such as the rate at which you allow the molten mineral to cool, the exact composition of the augite, and the chromite concentration in the mixture. These craftsmen's ability to produce faience shows that they were very innovative. The secret of their art has since been lost."
How did Deir Alla become sufficiently wealthy to acquire an elite capable of having faience made locally to suit their own tastes, and to generate a demand large enough to inspire artisans to develop many new technologies? "This area may have been very strategically located on a trade route between Egypt and Mesopotamia, making it very prosperous," Groot suspects.

Gone forever

Another clue to the importance of the area is the presence of a faience vase bearing the insignia of the female pharaoh Tausert, who reigned from about 1191-1190 BC. Egypt may have donated this vase to a temple in Deir Alla as a token of goodwill. With its empire on the brink of collapse, Egypt may have seen this as a way of boosting its crumbling influence in the region. The Philistines entered the Levant from the Aegean region (Greece). Although the Western part of the Levant passed into Philistine hands, the Jordan valley and Deir Alla did not. Or not in a literal sense, anyway. Shortly after Pharaoh Tausert donated the vase to Deir Alla, the town was destroyed by an earthquake. Afterwards, according to the evidence of the shards, the wealthy court culture never returned. ‹‹



Photo's: Sam Rentmeester/FMAX

Professor Eric Luiten

'Eric embodies the importance of cultural history'

Inspirational

Professor Eric Luiten studied landscape architecture at the Agricultural University Wageningen (as Wageningen University was formerly called). He graduated in 1985. One of his final projects involved designing a landscape plan for land consolidation in the Dutch province of Brabant. The demands of his career at the Ministry of Agriculture, Nature Management and Fisheries, H+N+S Landscape Architects, and the Academy of Architecture in Amsterdam meant that he never got around to taking a PhD. At one stage in his career he also worked as a Spatial Design Quality Initiative consultant. In mid 2005, the Faculty of Architecture appointed him part-time Professor of Cultural History and Design (Belvedere Chair). Since September 2009, he has occupied the post of Provincial Spatial Quality Consultant in the Dutch province of Zuid-Holland. He also runs his own Delft-based consultancy, Eric Luiten Landschapsarchitect BNT.

Saskia Bonger /
Connie van Uffelen

In the **Masterpiece** series, a professor and a student or PhD student (present or past) answer the same questions, creating a double portrait in the process.

Describe the other person.

Eric Luiten: "Just off the cuff, I think of him as enthusiastic, curious and ambitious, someone who really knows his stuff. One challenging characteristic is that he is easily distracted. In the course of his research, he tends to get side-tracked. He has a wealth of practical experience. His long career in education is balanced by a confidence gained from hands-on construction and design work. Research work is not something that comes naturally to him. He took it up later in life, but is keen to make his mark."

Kees Geevers: "Eric has tremendous enthusiasm and is truly inspirational. He has an immense store of knowledge, and I can learn a great deal from him. What we have is more like friendship than a teacher-student relationship. But he doesn't go easy on me. We dig deep and go for gold. We first met in the early 1990s, at the start of discussions about Belvedere, the programme for the conservation of cultural history during spatial transformations."

What have you learned from the other person?

Eric Luiten: "Elasticity in my thought processes. Kees is constantly taking detours en route to a researchable question. I'm always having to put him back on track. I'm not an authoritarian at heart, so I always tend to look for reasons why a given side-track is unproductive. This therefore helps me to think systematically. My ability to instil order is always honed by discussions with him, in my role as his supervisor. My encounters with Kees are always interesting."

Kees Geevers: "How I must grow within the task that I have been given. Your initial observations are based on a limited view of the literature and of everyday practice. Eric has taught me to think along broader and more abstract lines. I'm learning to distinguish between surveying the field and an in-depth approach. When you've worked in this field as long as I have, you feel an urge to deepen your knowledge."

Does your relationship allow you to be completely candid with one another, or does hierarchy get in the way?

Eric Luiten: "We're completely candid with one another. There is mutual respect. I have enormous respect for his extensive teaching experience. I don't think he views me as a superior."

Kees Geevers: "I imagine there are professors with whom you could not be completely candid, but Eric is not one of them. I'm older than he is, so it would be awkward if I was unable to feel at ease with him."

Should teachers be at their student's back and call, or should the latter deal with substantive issues on their own?

Eric Luiten: "Students have to find their own way. I help to create an ordered structure, without undermining or taking over the student's own area of responsibility."

Kees Geevers

'Kees is great at putting things into perspective'

Self-mockery

Kees Geevers (MSc) graduated from the Tilburg Academy of Architecture in 1986. He then started work as a research associate at Eindhoven University of Technology, before moving on to work at his own architectural firm, largely independently, and as a lecturer at the Hogeschool Utrecht University of Applied Sciences, where Geevers has worked for almost 25 years and has since exchanged his teaching duties for a curriculum development role. In 2006 he received his second Master's degree in 'Architectural History and Conservation'. "This was also the period when the notion of research as the core business of universities of applied science (HBO) first arose. I was then given an opportunity to take a PhD. I commenced these studies in September 2008." Kees Geevers is studying for a PhD in 'Valuing industrial heritage in urban planning'.

Kees Geevers: "As a PhD student you are in charge, and it's good to know your supervisor routinely makes time for you. We meet every month. Eric directs the focal area of my work, but the approach used and the choice of case studies are mine. I'm given plenty of scope as regards content, and I'm doing my own research - not the professor's."

How could your relationship be improved?
Eric Luiten: "Possibly by reducing the frequency of our meetings. He is so enthusiastic that he sees even small steps forward as a reason to head straight for Delft. Otherwise the feeling might gradually creep over me that I'm on a 'Mission Impossible'."
Kees Geevers: "I'm incredibly satisfied, both with Eric and with TU Delft. They show me great hospitality."

Do you visit each other's homes?
Eric Luiten: "No, not yet. One of our appointments was at my house, but only because I had to be at home in connection with my three young children. Aside from that, I have occasionally accompanied him to the Utrecht University club. This is situated behind the Dom Church (St. Martin's Cathedral), behind a modest castle door like one of those in an Ollie B. Bommel cartoon strip. A doorman in a black suit ushers you in and leads you up the stairs into a real club. It's a very special place indeed. Kees' domain."
Kees Geevers: "No, nor do I think that will ever happen. Nor is it necessary. Ours is a purely professional relationship."

Which of the other person's habits do you like best?
Eric Luiten: "Laughing in the face of his own impotence. He is great at putting things into perspective. Marvellous self-mockery."
Kees Geevers: "Eric is always in a good mood. He's cordial and relaxed."

And which ones do you like the least?
Eric Luiten: "He looks up to science, and is unduly serious about science and research. He interprets the standards he is required to meet as being gravely important, like a sort of quest. This hampers him to some extent. I wish that he was able to occasionally project his self-mockery onto science."
Kees Geevers: "He hasn't written a single book yet. I hope he will eventually write a book containing more detailed versions of the stories he tells and the experiences he describes in lectures. But I think he has already secretly started work on that."

What is the other person's most important achievement?
Eric Luiten: "That, at a relatively advanced age, after a career spent working in the building sector and in an institution of higher professional education, he came ▸▸

Photo: Nout Steenkamp/fmax

Geevers and Luiten worked together on the renovation of Strijp-S in Eindhoven.

Married/cohabiting/children
Eric Luiten: married, three children
Kees Geevers: married, three children

Relaxes by
Eric Luiten: reading a paper in the train, watching World Championship football
Kees Geevers: roaming round big cities

Favourite website
Eric Luiten: ns.nl for the train timetables
Kees Geevers: Formula 1 site

Would like to have invented
Eric Luiten: the cash dispenser, thanks to them you can now get money even in the middle of nowhere in Namibia
Kees Geevers: the Volkswagen camperbus Westfalia

up with the idea of obtaining an academic title. In other words, that he hasn't dozed off."
Kees Geevers: "Due to the sheer quantity of his publications, Eric embodies the importance of conserving cultural history. This is an important matter because, as my own research also shows, redevelopment plans take insufficient account of the cultural history argument. Structures lacking historic building status receive no protection whatsoever, while it is vital to identify those historical traces that need to be conserved."

What was your greatest blunder?

Eric Luiten: "My problem is the sheer scope of my interests. I'm something of an omnivore in the field of landscape architecture. I enjoy working in everyday practice, while teaching, doing research, reflecting and supporting others also give me great pleasure. This gives rise to an extensive curriculum. Consequently, my output seldom matches what they expect from me here, which is to write an article that really matters, instead of all that irrelevant nonsense in specialist journals. However, I'm currently working on two books, so there is something in the works."
Kees Geevers: "The biggest surprise for me was that my initial observations as a PhD student were so naive, which I quickly discovered when I dived into the literature. I felt that very little research had been done in my field, and I was going to help rectify this situation. But then I discovered that a great deal had indeed been written on these topics."

What is currently the greatest challenge in your field?

Eric Luiten: "Landscape architecture has developed rapidly in recent years. There are a growing number of contracts, firms and professionals, resulting in a lack of suitably educated individuals. This problem is taking on worrying dimensions, and I'm concerned about the core issue. What is its present nature, and will this be recognised? As regards the application of this field, the challenge lies in renewal in the Netherlands in response to climate change. The water system must be completely overhauled. We must all make every effort to save what can still be saved."
Kees Geevers: "To find out what allowance development plans make for history. Of course, developers will always say they give all due consideration to history, but is that actually the case?"

What would you consider to be a resignation issue?

Eric Luiten: "If those around me were to make it clear that they no longer valued my presence and my contributions."
Kees Geevers: "If it becomes clear to me that I cannot complete a given step, one that I could reasonably be expected to handle. For instance, if during my review someone had said that my research question was seriously awed, then I would have resigned."

What will the other person be doing in ten years' time?

Eric Luiten: "Enjoying his retirement. I sincerely hope that he'll have been able to complete his thesis. I can imagine Kees sending text messages from various parts of the world saying: 'You'll never guess what I've just seen....'"
Kees Geevers: "By that time he'll be running his own landscape architecture bureau."

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

On 1 July 2010, **Professor Wytze Patijn** was reappointed Dean of the faculty of Architecture for a period of two years. The term of this appointment is shorter than usual as Prof. Patijn will reach retirement age in May 2012. In view of the short period involved, the Executive Board has decided to start the process of finding a successor immediately. If a suitable candidate is found before Prof. Patijn has completed the term of his appointment, he will relinquish the post of dean before his term expires.

This summer, Maria Van der Hoeven, the Minister of Economic Affairs, appointed **Professor Tim van der Hagen** to the Dutch Energy Council. The Dutch Energy Council (in Dutch Algemene Energieraad, or AER) is an independent advisory body for the government and parliament. The members of the Council – never more than ten – are not elected but appointed by Royal Decree. Tim van der Hagen is director of the Reactor Institute Delft, chairman of the Delft Energy Initiative, and dean of the faculty of Applied Sciences. He is full professor of Reactor Physics and chairman of the department of Radiation, Radionuclides & Reactors.

Professor of Traffic Safety, **Fred Wegman**, received the Edmund R. Ricker Transportation Safety Award on 10 August in Vancouver, at ITE 2010. The professor received the award, which is presented each year by the Institute of Transportation Engineers, in recognition of his work in the field of road safety. Fred Wegman is also director of the Dutch National Road Safety Research Institute (SWOV). Professor Wegman gave his inaugural address at TU Delft last January. "Given current road safety policy, there is little scope for further gains," he remarked at the time. However, he feels that gains could still be made if policy were to focus more on the normal behaviour of ordinary citizens in everyday circumstances, and less on the criminal road traffic behaviour of those who flagrantly flout the rules.

Professor of Aerodynamics, **Hester Bijl**, has been appointed to the supervisory board of the Energy Research Centre of the Netherlands (ECN). In a message posted on the website of the faculty of Aerospace Engineering, she says, "Through the development of new technologies, analyses, and the formulation of smart energy policy, ECN's collaborative ventures with various partners are helping to advance the world a little further. I'd like to play a part in this."

Bart Moors is to become TU Delft's new ombudsman, with effect from 1 September. Mr Moors previously worked for HR services at TU Delft. "He is very charming and inspires confidence," said Executive Board member Paul Rullmann during consultations with the Student Council. "We are very happy with him." Mr Moors, who succeeds Wil Knippenberg, will perform these duties on a part-time basis (0.2 FTE).

Dr Vincent Marchau is the new business director of the TRAIL (Transport, Infrastructure and Logistics) research school. Marchau studied Applied Mathematics at TU Delft, where he has been working since 1994, as a member of TRAIL. The TRAIL research school at Delft is a partnership involving five Dutch universities (Rotterdam, Nijmegen, Delft, Twente and Eindhoven). The Institute employs 200 researchers, including 75 PhD students.

Professor Daan Lenstra does not wish to extend his contract as Dean of Electrical Engineering, Mathematics and Computer Science (EEMCS). His contract expires on 1 November. "The work now requires qualities that I believe I do not possess," he recently told Delta, the university newspaper. "Due to TU Delft's financial problems, the emphasis has shifted to financial management and that is not my thing. I am a scientist. That's what I'm good at and that's where I won my spurs." Before taking up the post of dean four years ago, Lenstra held two positions. He was Professor of Ultrafast Photonics and Opto-Electronic Devices at Eindhoven University of Technology, while at VU University Amsterdam he worked as Professor of Theoretical Physics and headed the quantum electronics theory research group. At that time, he already had more than 300 publications in international scientific journals to his name. It is not yet known who will succeed Lenstra in this post.

Sonja Cox, the only PhD student on the Works Council, is to stand down at the end of the year. She wants to focus on writing her dissertation. Cox, who is with the analysis research group at the department of mathematics (EEMCS), hopes to obtain a PhD in early 2012 on the topic of 'Stochastic partial differential equations (various approaches)'.

Multidimensional rays

Taking accurate measurements, cutting steel, trapping DNA molecules, transforming eyes: the range of applications offered by the laser beam is endless. Fifty years on and it is still one of the most widely used instruments under development and a mainstay of scientific research at TU Delft.

MAAIKE MULLER

He remembers it well. It was the late 1960s, in the woods near Hooghalen, next to the former Westerbork concentration camp in the north-eastern Netherlands. "We had to rig up a line of fourteen antennas over a distance of about 1200 metres," explains Professor Joseph Braat. "We had to measure exactly to the millimetre."
The emeritus professor was a student at the time and was helping with the construction of the Westerbork Synthesis Radio Telescope, a series of parabolic antennas for astronomical observations. "We used a helium-neon laser and Van Heel had developed an elegant method of alignment. Far more accurate than the old method using 'normal' light."
Professor Abraham van Heel was head of the Faculty of Applied Sciences' Optics Research Group at TU Delft when the first laser saw the light on 16 May 1960. The first laser was made by the American physicist Theodore Maiman using a cylindrical rod of synthetic ruby placed inside a spiral flash lamp. When Van Heel died suddenly in 1966, the laser had become such an integral part of Delft optics research it was difficult to imagine the place without it. And this was still the case decades later when Van Heel's former student, Joseph Braat, stepped down as head of the same optics department in 2008.

The laser family

The 'Light Amplification by Stimulated Emission of Radiation' – to give the laser its full name – has a number of special features. The light does not fan out in all directions but rather shines in a straight beam. Moreover, the beam is of such high intensity that it is able to cut through steel like butter.
Perhaps even more important, says Braat, is the sharply-defined colour of the light. "It gives you the precise frequency and wavelength you need, which is very useful for experiments."
The laser family has expanded rapidly since 1960: cores of gas and glass made their entrance; the pulses became increasingly shorter and more intense; the beams became narrower; and the wavelength became shorter. When Professor Hans Frankena was appointed professor of Optics in 1970, he was taken aback by the rapid developments that were already taking place. The "overwhelming stream of publications on lasers" was "only surpassed by the writings about their applications", he noted in his inaugural speech. This trend still continues today. Perhaps one of the most well-known applications is the compact disc or CD.

The laser family has expanded rapidly since 1960

In the 1970s, Braat worked for Philips on the development of the CD. "We used helium-neon lasers – a common application back then – to burn all the information onto video discs the size of an LP." However, it turned out this method was unsuitable for the consumer market. As was initially the case with the laser diode, whose active medium was a semiconductor material, which had to be cooled to below 150 °C to prevent it catching

fire. “Nevertheless, it was nice and small and produced a lot of light,” Braat continues. “By 1975, we had managed to operate the laser diode at room temperature and install it in the CD player.”

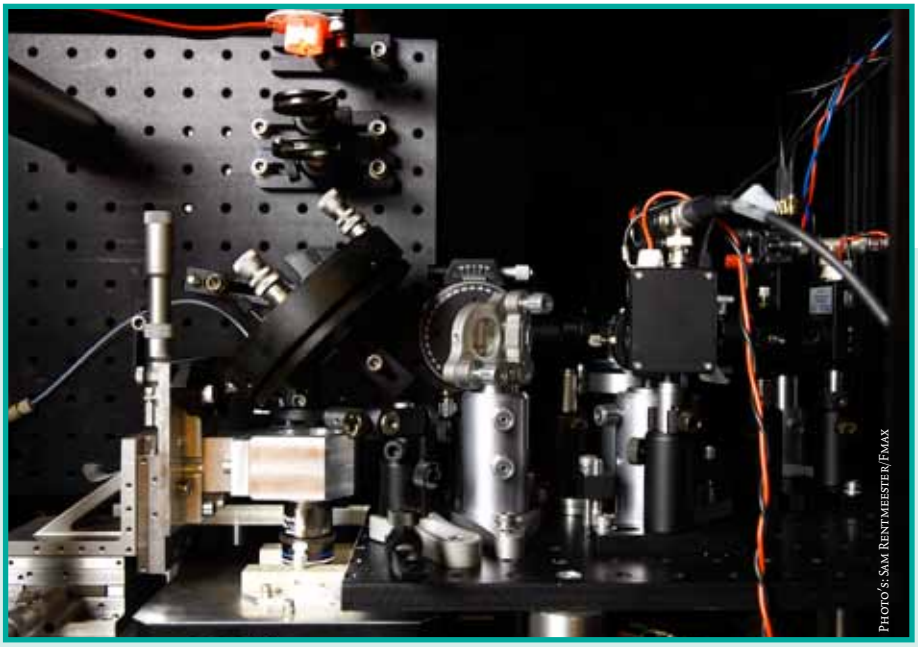
Real-life films

The advent of the laser also gave the impetus for holography. Until 1962, when the first hologram was created using a laser, all previous research had failed. Now, with the promise of three-dimensional graphics and lifelike films in mind, many researchers began to puzzle over the key to holography, Braat included.

“There was huge potential,” he says in hindsight, “and holography is still in use today. But it didn’t meet original expectations.” What perhaps did exceed expectations was the use of the laser to accelerate the development of data flow. In their inaugural speeches, Braat and his predecessors, Frankena and Professor Hendrik de Lang, all addressed the possibility, but in particular the difficulty, of sending information by laser. The problem of the light waves colliding with the wall of the narrow wire was eventually solved and after much effort, professors Meint Smit and Frankena discovered a way to increase the capacity of an optical fibre.

“On paper, the solution was simple: pass different light colours into the fibre,” Braat says. “The hard bit was getting it up and running and unravelling ▸▸

Prof.dr.ir. Joseph Braat.



Photo's: Sam Rentmeester/Fmax

wanted to demonstrate how it worked.”

Dekker also uses lasers for other purposes. At the beginning of the year, she was awarded a VICI grant of half a million euros, which she invested in equipment and researchers to study the interaction between molecules within a cell. Her team of researchers assign the molecules ‘light labels’, which light up as soon as you shine a laser on the cell. “Here you can see a few proteins,” Dekker says, pointing to a few small green lights on her computer screen. Give the DNA molecules a different colour and the interaction between the DNA and the DNA-protein sharing becomes visible. This is very promising research, Dekker enthuses. “We have studied a lot about what happens outside the cell. Now we are able to examine the same proteins both inside and outside the cell to discover more about the workings of the cell.”

'Discover more about the workings of the cell'

nynkedekkerlab.tudelft.nl

Folding error

She pulls on DNA molecules and follows light-emitting proteins in a cell. Professor Nynke Dekker of Applied Sciences is using different lasers to discover how cells work.

“If you focus a laser beam using a lens, a narrow image point emerges in which you can capture a small plastic ball.” Dekker goes on to explain the principle of laser tweezers. The ball moves a little but under the influence of optical forces continues to search for the focal point in the laser beam. Researchers at the Nynke Dekker Lab use laser tweezers to pull and rotate fixed DNA and protein molecules on the little balls. “This is how we research the mechanical properties of a molecule,” Dekker explains. “How does this type of molecular chain fold itself? And how hard do you have to pull to straighten the molecule?” She gives Alzheimer's disease as an example. The cells of Alzheimer’s patients contain misfolded proteins.

“We don’t know whether this is a cause or a result of the disease but it’s interesting to learn how exactly the folding system works.”

Earlier research carried out by Dekker and her colleagues' provided a greater understanding of the workings of a cancer drug. Using tweezers, they monitored the length of a DNA molecule and observed how the cancer drug prevented the protein topoisomerase from carrying out its work properly. Normally this protein unravels the DNA, facilitating its duplication in the cell, but the presence of the drug dramatically slowed down this process. Dekker: “We already knew that the drug interacted with topoisomerases. Now we

the signals at the end of the wire." What's more, a number of researchers had moved to Eindhoven, where telecommunications research was concentrated, yet they managed it nevertheless and Wavelength Division Multiplexing now made it possible to pass up to 100 lasers through one single optical fibre. Braat: "The advances made in laser technology over the past fifty years are astonishing." Indeed, it's impossible to imagine our daily lives without it. The laser transmits information for us, improves our vision, and allows us to listen to music and watch films. And the experimental research conducted in many of TU Delft's laboratories would be in a very primitive state were it not for the laser, Braat adds. Measurements would be less accurate and would take an awful lot longer. "It's all become so much easier," he says. "It makes you appreciate even more the excellent trials carried out on light bulbs in the past."

Further information:
http://www.optica.tn.tudelft.nl/history/history.asp
www.laserfest.org

Removing the mask

Thirteen thousand channels sending approximately one thousand DVDs worth of information per second. Without cables. This is the challenge that two TU Delft alumni have set themselves in developing a new lithography machine for the chip industry. The answer is laser.

"These are the lasers." Technical director and founding member of Mapper Lithography, engineer Marco Wieland, points to a bundle of orange cables connected to the prototype of a lithography machine. Each cable has a plug containing 12 laser sources. According to Wieland, we can now considerably reduce the cost of one of the stages in the manufacturing process of chips, lithography. Normally, a mask is used for lithography. A slice of silicon called a 'wafer' (from which chips are cut) is coated in a layer of photosensitive varnish. Light is shone through the mask, illuminating some parts and not others. The varnish reacts in the areas where the light falls, forming a pattern on the chip, enabling researchers, for example, to mount small copper pipes. Wieland hopes to compete with chip giants such as ASML and Nikon by creating smaller lithography machines without the need for a mask. "Our goal is to produce one square metre of ten 'wafers' per hour," says Wieland. Depending on the type, this could be as many as a 100 to 1,000 chips. "Our machines are slower than ASML's, which write 150 wafers per hour, but proportionally cheaper due to their smaller size." And as Wieland points out, if we can dispense with the need for expensive masks, large chip manufacturers will be able to save hundreds of millions of dollars every year. Wieland compares the standard machines to the printing press: "We make a kind of laser printer." Electron beams moving back and forth write the information directly from the computer onto the chip. The prototypes – in Mapper's cleanroom, with one in France and one in Taiwan – currently have 110 beams. The final machine will have 13,000. "And they all have to know what to do." Each of the 13,000 beams must receive 3.5 gigabits of information per second – the total equivalent of around 1,000 full DVDs. Given that data cables on a piece of silicon measuring 26mm by 26mm are not an option, these numbers came as quite a shock to Wieland and his colleagues. "But laser remains the only effective solution for data flow."

'Large chip manufacturers will be able to save hundreds of millions of dollars'

www.mapperlithography.com

The search for free charges

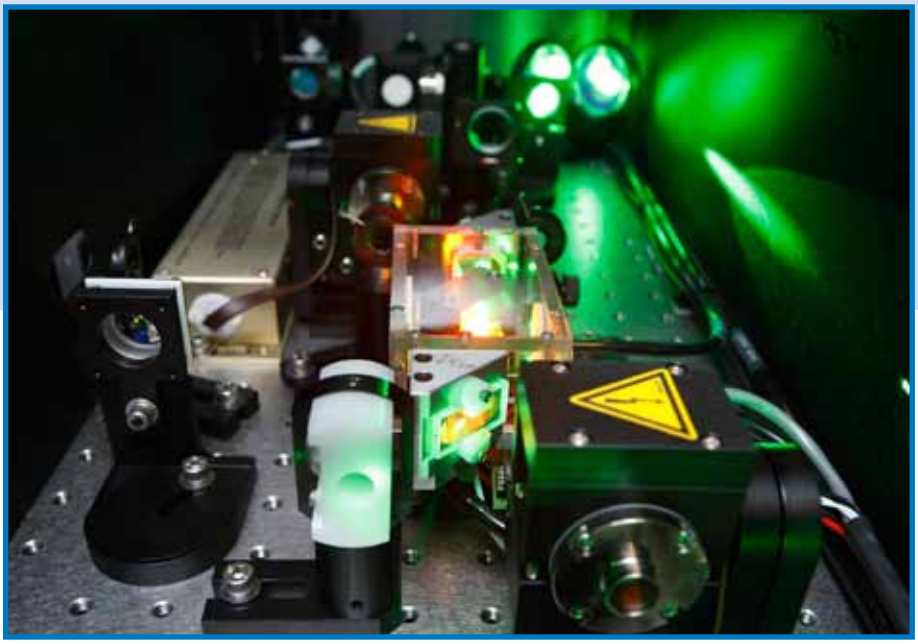
After putting the finishing touches to the roof paint we can mount the electrodes and turn on the appliances indoors. As Professor Laurens Siebbeles explains, a great deal of fundamental research still needs to be conducted into the materials used in solar cell paint before this stage is reached.

Siebbeles walks past a large table covered in mirrors, lenses and filters. This is one of the test set-ups for his Optoelectronic materials research group in the faculty of Applied Sciences. Everything has been assembled with painstaking precision. "Here we can create light at the correct wavelength and by moving the mirrors, create laser pulses to the exact length we need them." These precise instruments are key to Siebbeles' and his colleagues' search for the ideal material for solar cells. This ideal material has to enable sunlight to release electrons from positively charged nuclei. The loose electrons, called free charges, must then be able to move easily through the material towards the electrodes. Polymers and quantum dots make good ingredients for solar cells. As Siebbeles points out, "they're cheap and easy to process – for example, in a kind of paint." Quantum dots are particles of semiconductor material measuring 2 to 10 nanometres. By varying the size, you can determine which colour of light prompts the dot to release a free charge. With their elongated molecules working as an electric wire, the polymers act as an excellent conductor for the electrons.

In order to find the correct composition and structure of the solar cell material, Siebbeles and his colleagues needed to use two lasers. First, they used a 'pump pulse' to release the electrons. To see how many electrons are released and what happens in the material afterwards, they use a series of very short 'probe laser pulses'. Electrons absorb light; the researchers are, therefore, able to deduce how many free electrons are produced by examining the amount of light that penetrates the material.

'Polymers and quantum dots make good ingredients for solar cells'

"When I joined TU Delft back in 1994, we had a laser that emitted pulses of 5 nanoseconds," Siebbeles recounts. "We were unable to see electrons being released on a smaller time scale. Now, the research group has a femtosecond laser (a femtosecond is one quadrillionth of a second), which was small enough to reveal the suspected 'avalanche effect' in certain semiconducting nanocrystals in 2008. The rapid, short laser pulses allowed us to observe how a photon released not only one, but two or three electrons." Siebbeles, however, expects it to be some time before the quantum dot solar cells are available commercially. "Although we've been able to produce energy in labs using materials with quantum dots, the efficiency was only a few percent." We need to improve on that, says Siebbeles. "And we can. It will take a long time but I'm convinced this principle will go beyond the confines of fundamental research."



Propositions

The typical Dutch 'broodje kroket' is one of the least understood elements of Dutch cuisine both in terms of nutrious and culinary value.
Richard Lakerveld,
CHEMISTRY ENGINEER

The fact that television still survives in the current information age is solely because people are not critical enough of its contents.
Jorik Blaas,
COMPUTER SCIENCE ENGINEER

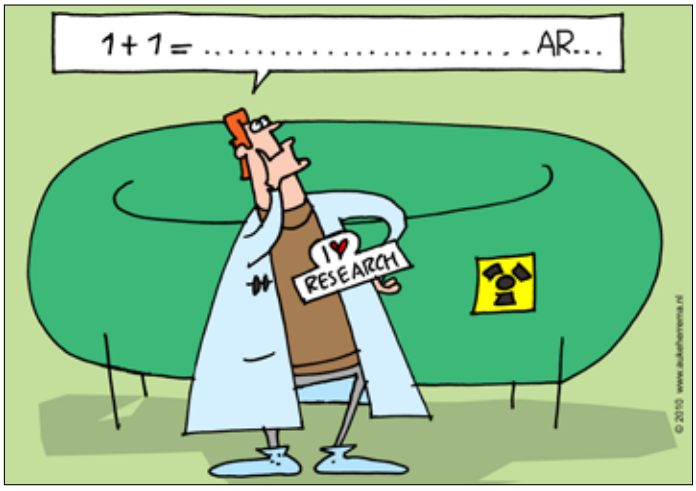
The complexity involved in an Indian arranged marriage is no less than that of a doctoral research.
Suresh Neelakantan,
MATERIALS ENGINEER

In theory there is no difference between theory and practice. However, in practice there is.
Lars Sonneveldt,
AEROSPACE ENGINEER

A mature society, like a mature individual, is one where development is no longer tied to growth.
Rafael González,
COMPUTER SCIENCE ENGINEER

In view of the usefulness of many scientific results obtained by serendipity, more funding should be made available for seemingly useless research.
Bas Wols,
CIVIL ENGINEER

An alternative source of energy is only truly an alternative if it can provide enough energy to maintain itself.
Tristan van Leeuwen,
MATHEMATICAL ENGINEER



Some mathematical disciplines would have developed much more if computers had not been invented.
Vladimir Milovanovic,
ELECTRICAL ENGINEER

[Sound]BITES

"Shale gas is not exactly going to take the world by storm. Despite various improvements, techniques for extracting the gas are still relatively expensive. Nor, indeed, did the discovery of "heavy oil" in Canadian and Venezuelan tar sands spark a revolution. The same is true of shale gas."
Stefan Luthi, Professor of Applied Geology, commenting on shale gas extraction, in Trouw.

"When trains are delayed, Dutch Railways (NS) should announce the extent of the delay involved. This information is statistically of far greater value. That's really the only way to tell if things are going well."
Ingo Hansen, Professor of Design of Transport & Traffic Facilities, in NRC Handelsblad.

"Internet is depicted as a rabbit warren of one and a half billion users, tens of thousands of providers, and hundreds of countries. According to our study, however, 50 percent of all infected PCs are hosted by just 50 providers."
Michel Eeten, Professor of Public Administration, on a study of his showing that in 2009 there were well over 300,000 infected PCs in the Netherlands, in NRC Handelsblad.

"If you're honest, you have to assess the value of some offices in unpromising locations at zero euros."
Norwegian researcher Hilde Remoy, in Trouw. Earlier this year, she obtained a PhD at TU Delft on the topic of office vacancy rates.


PHOTO: SAM RENTMEESTER/FMAX

PROPOSITION
Publishing scientific failures and mistakes would significantly enhance scientific progress.

DEFENCE
"Different scientists often make the same series of mistakes before they find out how to get something up and running. In my department we make qubits from small, superconducting aluminium rings. The circuits consist of a huge number of parts. Some components must not be placed side by side, or they would influence one another too much. Errors are caused by numerous subtleties of this kind. You can always discuss these issues with colleagues. However, there is little contact with researchers from other universities. Nobody likes to publish their mistakes, let alone those that - with hindsight - appear to have been obvious. So we are all doomed to make the same mistakes. This issue is sometimes discussed at conferences though. (with a smile) That's actually the most important reason for going."
Pieter de Groot, PHYSICS ENGINEER

A TU Delft alumnus first writes a personal column, then passes the baton to another alumnus of their own choosing.

Very early on it was clear that I would go to TU Delft. As a small boy I was always 'inventing' things. I initially preferred Industrial Design Engineering (IDE) - getting involved in product development seemed a logical step. However, I eventually opted for the more general field of Applied Physics.
It turned out not to have been such a great choice. I wasn't at all interested in the prospect of doing two years' research in the Master's programme. So, after obtaining my BSc, I went to IDE after all, to the newly established Strategic Product Design programme. While completing my studies, I wrote about an approach to the branding of innovative products.
I am not well suited to a career in large multinationals. I dislike bureaucracy, have little patience for office politics and have no desire to put in 20 years of work before I can reach a level where the work starts to get interesting. This too quickly became clear. What I really wanted was to work in fast-growing, innovative companies: brainstorming about strategy right from the start, and helping to build for the future.
After graduating I got a job at a leading design agency, where I was thrust into the post of innovation consultant. My job involved solving the strategic side of customer's questions, and laying out the agency's own strategic approach. I devised a plan to enable the agency - in the course of its work - to invest in start-ups that needed our knowledge.
While the academic aspect of a consultant's role appealed to me, I was extremely unhappy about always having to hand over well-crafted plans to others. I wanted to implement them myself. Fortunately, just then I was approached by a high-tech start-up that had just received a large investment. The managing director was keen for me to run the company's marketing activities. My first task was to rebrand the company and to set up an entirely new strategy for the coming few years. I was to present details of my approach to a shareholders' meeting, but had just two weeks to prepare!
We launched our new brand soon afterwards, in Barcelona, at the largest telecom industry event in the world. Products built around our technology are now sold in 20 different countries, including India, Kenya, Germany and Colombia.
I'm currently stationed in Nairobi, Kenya, for six months. This will serve as my base while I'm setting up our sales network in Africa. My work takes me all over the world. I work with customers in China, coach sales staff in Latin America, Africa and India, and learn about the various markets.
The work is very varied. It involves convincing telecom CEOs of the power of our product, teaching our customers' sales staff how best to place these products in the market, and then working with the team behind the scenes to chart out the company's future course. This is a fantastic experience, and excellent training for when I start my own business.

Rik Wuts, Marketing Director of Intivation in Nairobi, studied Applied Physics and Industrial Design Engineering at TU Delft. He passes the pen to Martijn van Hassel, founder of Fromanteel Watches.

Folding chair

Photo: Sam Rentmeester/fmax

Robert Visscher

It's like watching a magic trick, as designer engineer Douwe Jacobs from Flux Furniture places a simple, paper-thin suitcase on the ground and transforms it into a full-size designer chair with just a couple of folds. Known as the Flux Chair, it has beautiful contours and a broad seat to ensure optimal comfort.
For many people, the idea of a folding chair conjures up images of the uncomfortable camping chairs that barely survive the holidays intact. Jacobs' new chair however offers an inspiring alternative. "The idea for a designer folding chair came to me during my final year as an industrial design engineering student. I studied the history of folding chairs and found that Egyptian pharaohs, Roman emperors and Napoleon alike were all mad about beautiful, folding chairs. Quite a world away from today's purely functional designs."
Jacobs studied possible folding techniques in great depth and then began experimenting with paper. He pulls open one of his desk drawers containing numerous models. "I folded a piece of A4 along curved lines and was immediately struck by its sturdiness. I then made a larger version using cardboard and had my neighbour, a girl, test it."
This then led to further test chairs. "Some of which were dreadfully uncomfortable," Jacobs recalls. "The seat was far too narrow and pinched the buttocks. I also adapted the material. My idea was to create a chair made of plastic with the fold lines milled into the material. This resulted in the current design, which was aided by the fact that I was able to design using computer models. Previous versions still had a large open back, which didn't work since it meant you sank too deep into the chair."
Jacobs is not afraid of consumers viewing his work as throw-away furniture in the same way they do camping chairs. "Research carried out on prototypes shows that people actually consider it a design chair," Jacobs says, adding that he also sees potential in the business market. "The chairs fold up in the form of a small suitcase just 15-millimetres thick, making them easy to stack and transport. Hotels and caterers have already shown interest and the chair is currently on sale online and in design shops."
Jacobs' chairs will be available in eight different colours starting in October, and he hopes to sell 10,000 chairs in the first year: "We've just invested a lot of money in an injection mould, which you don't do with just 1,000 chairs in mind. We're also launching the product in several countries outside the Netherlands. If the chair sells well, I have a range of other ideas in store for foldable furniture."

www.fluxchairs.com
info@fluxchairs.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.

TU Delft
P.O. Box 139
2600 AC Delft
The Netherlands
telephone +31-15 278 9111
telefax +31-15 278 6522

Disciplines

Aerospace Engineering
Kluyverweg 1
NL-2629 HS Delft
Telephone +31 15 278 2058

Applied Earth Sciences
Mijnbouwst raat 120
NL-2628 RX Delft
Telephone +31 15 278 1423

Applied Physics
Lorentzweg 1
NL-2628 CJ Delft
Telephone +31 15 278 7774

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

Chemical Technology & Bioprocess Technology
Julianalaan 136
NL-2628 BL Delft
Telephone +31 15 278 2667

Civil Engineering
Stevinweg 1
NL-2628 CN Delft
Telephone +31 15 278 5440

electrical engineering
Mekelweg 4
NL- 2628 CD Delft
Telephone +31 15 278 4568

Geodetic Engineering
Kluyverweg 1
NL-2629 HS Delft
Telephone +31 15 278 3289

Industrial Design Engineering
Landbergstraat 15
NL-2628 CE Delft
Telephone +31 15 278 4750

Life Science & Technology
Julianalaan 67
2628 BC Delft
Telephone +31 15 278 8271

Marine Technology
Mekelweg 2
NL-2628 CD Delft
Telephone +31 15 278 6666

Materials Science
Mekelweg 2
NL-2628 CD Delft
Telephone +31 15 278 6666

Mechanical Engineering
Mekelweg 2
NL-2628 CD Delft
Telephone +31 15 278 6666

Computer Science
Mekelweg 4
NL- 2628 CD Delft
Telephone +31 15 278 4568

Applied Mathematics
Mekelweg 4
NL- 2628 CD Delft
Telephone +31 15 278 4568

Technology, Policy & Management
Jaffalaan 5
NL-2628 BX Delft
Telephone +31 15 278 7100

Multidisciplinary Centres

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

Biotechnological Sciences Delft Leiden (BSDL)
Julianalaan 67
NL-2628 BC Delft
Telephone +31 15 278 5140/2342

Centre for International Co-operation and Appropriate Technology (CICAT)
Mekelweg 2
NL-2628 CD Delft
Telephone +31 15 278 3612

Centre for Transportation Engineering
Stevinweg 1
NL-2628 CN Delft
Telephone +31 15 278 6634

Dutch Institute of Systems & Control (DISC)
Mekelweg 2
NL-2628 CD Delft
Telephone +31 15 278 7884

Koiter Institute Delft (Institute for Engineering Mechanics)
Kluyverweg 1
NL-2629 HS Delft
Telephone +31 15 278 5460

Netherlands Institute for Metals Research (NIMR)
Mekelweg 2
NL-2628 CD Delft
Telephone +31 15 278 2535
Fax +31 15 278 2591

Wind Energy Research Group
Kluyverweg 1
NL-2629 HS Delft
Telephone +31 15 278 5170

Reactor Institute Delft
Mekelweg 15
NL-2629 JB Delft
Telephone +31 15 278 5052

OTB Research Institute for Housing, Urban and Mobility Studies
Jaffalaan 9
NL-2628 BX Delft
Telephone +31 15 278 3005

Open Building Working group (OBOM)
Berlageweg 1
NL-2628 CR Delft
Telephone +31 15 278 5400

Delft Institute for Microelectronics and Submicrontechnology (DIMES)
Feldmannweg 17
NL-2628 CT Delft
Telephone +31 15 278 3868

Interduct Delft University Clean Technology Institute
Rotterdamseweg 145
NL-2628 AL Delft
Telephone +31 15 278 7233

J.M. Burgerscentrum Centre for Fluid Mechanics
Mekelweg 2
NL-2628 CD Delft
Telephone +31 15 278 3216

Netherlands Schools for Advanced Studies in Construction
Stevinweg 1
NL-2628 CN Delft
Telephone +31 15 278 3332

Advanced School for Computing & Imaging
Mekelweg 4
NL-2628 CD Delft
Telephone +31 15 278 8032

Trail Research School
Kluyverweg 4
p.o. box 5017
NL- 2629 HT Delft
Telephone +31 15 278 6046

Central Library

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

For further information:
Delft University Central Library
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p.o. box 98
NL-2600 MG Delft
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Nieuwe Hemweg 6B
NL-1013 BG Amsterdam
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E-mail order@iospress.nl

Information

General information:
Information office
p.o. box 5
NL-2600 AA Delft
Telephone +31 15 278 5404

Information on facilities for foreign students:
Student Advisory Office
Jaffalaan 9a
NL-2628 BX Delft
Telephone +31 15 278 4670

Liaison between business and research:
Liaison Office
Mekelweg 2
NL-2628 BX Delft
Telephone +31 15 278 1500

Information on research fellowships:
Mrs. M.Y.M. Spiekerman-Middelplaats
Stevinweg 1
NL-2628 CN Delft
Telephone +31 15 278 3773

General information on university education in the Netherlands:
Min. of Education, Science & Culture
Central Information Dpt.
p.o. box 16375
NL-2500 BJ Den Haag
Telephone +31 70 412 3456

(Post Graduate) Courses

Delft TopTech
(vocational courses)
Mekelweg 2
p.o. box 612
NL-2600 AP Delft
Telephone +31 15 278 8019
Fax +31 15 278 1009
www.delft-toptech.nl

Institute for Biotechnology Studies Delft Leiden (BSDL)
Julianalaan 67
NL-2628 BC Delft
Telephone +31 15 278 2355

For information on courses in the Dutch language:
Language Laboratory
Jaffalaan 5
NL-2628 BZ Delft
Telephone +31 15 278 4124