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Safe for all eternity

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'Tackling problems from the human perspective'

no. 2 2011

tablet.delftoutlook.tudelft.nl

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Editorial

The world is going up in flames, or so it has seemed these last few months. There are loud calls for democracy in North Africa and the Middle East. TU Delft's alliances in the region are at a low ebb, as you can read in our summary. A natural disaster of unprecedented proportions has hit Japan. This has made nuclear energy into a controversial issue once again. But as well as discussing the issue of safety, the debate must also look at how waste can be safely secured. In France and Belgium, we went to look at the research being conducted into nuclear waste storage in clay strata in the ground. Before we can store nuclear waste in the Netherlands in this way, a ground survey will be required, and of course TU Delft can play a useful role in this. There are fundamental innovations afoot for scientists and technicians, according to Jeroen van der Veer, who is committed to educating enterprising engineers. The good news is that the fires of change are burning on the campus on a daily basis, in the eyes of our students.

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Colophon

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Tomas van Dijk

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Electrolytes

"Adding nano crystals of titanium dioxide can improve an electrolyte's conductivity by a factor of hundred," says PhD student, Lucas Haverkate, from the Applied Sciences faculty. Together with nine other TU researchers, he co-published the research team's findings in last week's edition of Advanced Functional Materials (24 March 2011). The nano crystals are mixed into a solid-state electrolyte with an acid serving as a proton donor. The effect is a large increase in the proton mobility within the material. The research team's finding is of interest for applications in fuel cells and batteries, which depend on electrolytes for the internal charge transport. Adding nano crystals improves the conductivity of solid electrolytes, which enables the production of more compact devices. Professor Fokko Mulder (AS) says that the experimental work (by PhD student Wing Kee Chan) is backed by Haverkate's theoretical explanation. The research team is still searching for the optimal combination of materials.
www.delta.tudelft.nl/22925

World's fastest bike

The Human Power Team Delft presented its design for what is to become the fastest bicycle on Earth and beyond.
The holder of the current world record speed for a human-powered vehicle is a Canadian, Sam Whittingham, who on 18 September 2009 reached the incredible speed of 133 kilometres per hour in his Varna Tempest.
"Our main advantage is the aerodynamics of the hull," says David Wielemaker, an aerospace engineering student and designer for the Human Power Team Delft (HPT). The Varna is shaped by by hand from a block of synthetics. Delft students use computer programmes to calculate the drag and windtunnel models to verify their design. Wielemaker digitally bent and reshaped the hull in 30 iterations to arrive at the present form, which, according to calculations, will experience 20 to 30 percent less drag at top speed. The main visible difference from the Varna is the absence of a canopy: the window is in front of the driver's feet. The rear wheel has been kept small to limit the overall length. Races will be held on 30 and 31 July in Germany (hour record) and on 12 September in Nevada (sprint record).
www.delta.tudelft.nl/22815


Photo: Tomas van Dijk

Crack


Photo: Sam Rentmeester/FMAX

A test of glass as a construction material revealed surprising results. Associate Professor in material sciences, Dr Fred Veer (Architecture) had built a glass bridge that was loaded with 80 kg of bricks for the test. In theory, glass is equal in strength to concrete, but this strength decreases rapidly as a result of irregularities in the material.
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Navigating with the eyes of a fly


Photo: fotobibliotheek Science

Insects have a very blurred view of their surroundings, but their compound eyes detect movement and the polarization of light very accurately, allowing them to fly and navigate with very limited intelligence. They inspired Dr. Mukul Sarkar (EEMCS faculty), who recently defended his PhD research. He developed a CMOS image sensor that functions like the compound eye of an insect.
Robots (and humans) need to compare high resolution images with one another in order to estimate movements, which is complicated and costs lots of energy. Insects on the other hand have their light-sensitive rhodopsin molecules nicely aligned in their faceted eyes, which enables them to detect the polarization of light. They use the angle of polarization as a navigation tool, which costs them little brain processing power.
Sarkar developed a comparable sensor by neatly aligning the metal wires in a CMOS sensor – the wires that are used for routing in the chip. The sensor is built up of grids that only allow light with certain polarisation to penetrate. He believes that these types of sensors could one day be used in endoscopes: "Cancer tissue reflects light with different polarisation than healthy tissue. A small chirurgical robot could use this information to navigate towards the tumor."
Dr. Mukul Sarkar, m.sarkar@tudelft.nl
www.delta.tudelft.nl/22554

Part of TU Delft's cultural heritage was recently digitised. Sixteen hundred old prints and seven hundred Dutch maps are now featured on the TU Delft website. Chris Smeenk, retired librarian in the Architecture faculty and Jan Wegner, former Associate Professor in the history of settlement provided descriptions of all the prints.
multimedia.tudelft.nl Search term: *prentenkabinet*

Leidschendam, lock viewed from the west. Tinted lithograph on paper by Jan Weissenbruch, published by C.W. Mieling between 1850 and 1900.

Photo: Erik Schlangen

Self-healing highways

By heating up asphalt with an induction cooker, Dr Erik Schlangen, and his postdoc researcher, Alvaro Garcia (both of the faculty of Civil Engineering and Geoscience) aim to keep the Netherlands' highways in perfect shape.
Last December road workers resurfaced a section of the highway A58 using a special type of asphalt developed by the Delft researchers: the blacktop contains 1-centimetre long steel fibres, an additive that is meant to make the asphalt self-healing. Due to the fibres, the asphalt is conductive and can thus be heated by holding a coil above it, which generates an alternating magnetic field. When the bitumen in the asphalt heats up to about 60 or 70°C, it softens and tiny cracks in the asphalt close.
www.selfhealingasphalt.blogspot.com
www.delta.tudelft.nl/22444

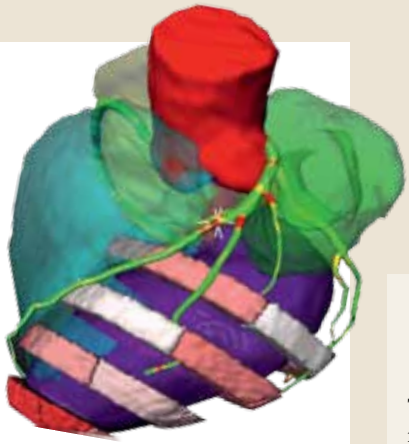

Illustration: Medical Delta

Two better than one

Medical Delta researchers have developed a technology that combines anatomical and functional data from the heart into one image. Hortense Kirisli MSc (Erasmus MC and Leiden University MC), presented images made with a prototype workstation that combines anatomical information from a CT-scan, with functional information from an MRI, in one interactive, three-dimensional image of the heart. Not only does the image show which coronary arteries have been clogged up and to what extent, but it also reveals how the perfusion of the heart muscle fed by those arteries has been affected.
Clever as this imaging may be, it has yet to prove its diagnostic value. Professor Wiro Niessen (Erasmus MC and TU) says the team is still working on the protocol for clinical evaluation. The work is part of the 'Heart in 3D' project.
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Hollow axes

The hollow bronze axes of Geistingen, dating from the late bronze period, present a true mystery to archaeologists. What were these objects, named after the town in Belgium where most of them were found, used for?
Material researcher ir. Janneke Nienhuis studied the bronze and findings only deepen the mystery. Nienhuis found traces of sulphur, lead, iron, titanium, cobalt and zinc in the axes. There is probably no single ore in the world with which you can make an alloy with these characteristics.

One would have had to mix different kinds of ores. Another possibility, which archaeologists believe makes more sense, is that the smiths made the materials by melting scrap or ingots that they had imported.
But Nienhuis doesn't agree: "I found too many traces of sulphur, silver and lead. If the axes were made by (re-)melting scrap, you'd expect most of these traces to have dissipated in the slag. From an archaeological point of view it may seem strange, but I'm a proponent of the theory that the smiths used ores."
ir. Janneke Nienhuis, J.Nienhuis@tudelft.nl

Red dot for incubator

Former IDE student Heleen Willemsen's company Babybloom Healthcare has been awarded the prestigious red dot design award's highest accolade for its child-, parent- and nurse-friendly incubator. The award is the 'best of the best' in the 'product design' category. Willemsen's incubator is the only one in the world that can be placed above a hospital bed, enabling parents or nurses to sit comfortably alongside it. A silent climate control system and light- and sound-resistant cover ensure that the baby is protected against potentially damaging stimuli. Hospitals and distributors have shown a great deal of interest in the new incubator.
www.delta.tudelft.nl/22810

Photo: Babybloom

Pigs may play

Boredom among pigs in overcrowded piggeries quickly leads to tail biting, fights and injuries. A toy for pigs, designed by Beatrijs Voorneman, may offer some distraction.
"I vividly remember the sound of the pig pens - and the smell!" Voorneman exclaims, some six months later. She joined a veterinarian on his monthly visitations to piggeries. At a petting zoo, she watched the animals play. She observed their characteristics as curious and opportunistic, but also that they easily became bored. She identified rooting as the most typical behaviour. Consequently, Voorneman's design - a pile of differently shaped layers of various edible materials - was made for rooting pleasure. Playfully named the Sproot, it also makes sounds when a pile is dropped. And the pigs like that, too. Eventually the layers will be eaten and destroyed, as is everything else in the pig pen, but if it lasts for three months then that's sufficient, because the pigs will have 'moved on' to somewhere else by then.
www.delta.tudelft.nl/22611


Photo: Tomas van Dijk

A cop's smartphone

Can a smartphone application provide police officers with information that helps them operate more efficiently? Jan Willem Streefkerk, a psychologist at TNO and a PhD student at the faculty of Electrical Engineering Mathematics and Computer Science's, developed and tested a prototype.
During his PhD research, Streefkerk developed a system that would use dynamic information from the emergency command centre. Depending on the priority, messages can be sent silently or with an intrusive beep tone. The system also checks what tasks the officers are engaged in and adapts the message's priority level accordingly.
Since there is little budget available for further developing the system for policing purposes, Streefkerk now plans to adapt the system for fire brigades and the military.
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Sustainable mobile

Students of industrial design engineering have succeeded in bucking the trend by devising a mobile telephone that can last for seven years and yet still not become outdated. The 'Nokia Kiva concept phone' lasts so long because the processor is replaced on an annual basis and the battery every two years. According to the students, the camera, screen and other components are of such high quality that they will continue to function for seven years. The mobile will repeatedly be updated with additional memory and capacity ensuring it can continue to be used for the latest applications. However, Nokia is unlikely to start production of the mobile any time soon since the company earns much of its income from new products. The design therefore primarily serves as a statement on unnecessary waste.
www.delta.tudelft.nl/22920


Photo: IO

Cradle to cradle crashes

Should you happen to lose control of the wheel, chances are that soon environmental-friendly wooden traffic barriers will prevent you from having a head-on crash.A loud cracking sound, a set up with a high speed camera that was almost rampaged, and a total-loss bus - such was the outcome of the first experiment involving a 13-ton bus crashing into a wooden crash barrier at 70 kilometers per hour. "Right before impact the bus got a flat tire," recalls ir. Ingrid de Pauw, of the faculty of Industrial Design Engineering. "The bus changed direction and crashed into the barrier at a much greater angle and with a 60% higher energy-impact than intended." It was about a decade ago that De Pauw designed the barriers and performed the first experiments together with civil engineers from Delft and a few other interested parties, including a company called Wijma, which built the barriers and a company called Ideal & Co. Now, many experiments and bureaucratic hassles later, the first stretch of road in the Netherlands – a 1-kilometer long section of a new provincial road in the town of Heerhugowaard that opened in March – has been equipped with wooden rather than steel crash barriers.
http://bit.ly/fAtsaN
www.delta.tudelft.nl/22818

Photo's: Ingrid de Pauw

Electric

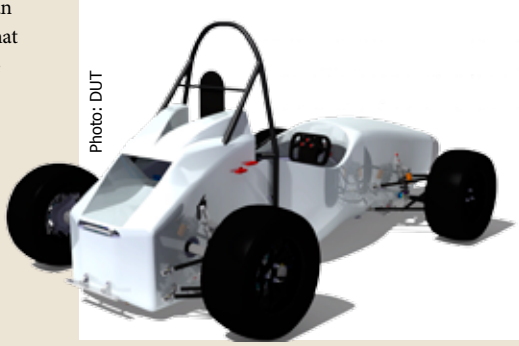


Photo: DUT

The next racing car from the Delft University Racing Team will be an electric one. The previous student racing team, DUT-10, finished first in the competition for combustion engines. Rather than prolonging their successful series of lightweight cars, the students chose a new challenge. The DUT-11, deriving its 55 KW of power from lithium polymer batteries, will more powerful than the combustion predecessor (35 kW). Despite being 40 kg heavier, DUT-11 will accelerate faster.
www.dutracing.nl

The tragedy of the Arab world

There is currently a great deal of unrest in the Middle East and North Africa. The Dutch business community is highly active there but despite the many engineering issues that face the region it has not been of particular interest for TU Delft in the past. The few links that did exist have now been put on the backburner.

Demonstration in Cairo.

When one thinks of the Middle East, the issue of oil is the first thing that springs to mind, followed possibly by water shortages, land created by means of hydraulic filling and dizzyingly high apartment blocks. To some extent all of these are Delft specialities. Many companies that employ TU Delft alumni are keen to do business in the region. But there is, it seems, slightly less to be gained for TU Delft scientists and academics. There are virtually no alliances with local universities in the region.

The question of TU Delft's connections in the Middle East and North Africa arises as a result of the unrest that is spreading to increasing numbers of countries in the region. It started in December 2010 when a Tunisian street vendor set himself on fire because he was unable to find a decent job despite his university degree. In the space of just a few months, there were large and small-scale protests in almost all the countries in the region and sometimes even pitched battles against the authoritarian regimes or what was left of them.

According to Executive Board Chairman, Dirk Jan van den Berg, the limited number of TU Delft alliances in the region is not the result of any deliberate policy. "The way in which relationships develop depends on the alliances sought by academics and scientists," he explains. "They look for areas which have the maximum potential in terms of scientific value." That tends not to be in the Middle East or North Africa, where few universities achieve an acceptable standard.

William Rossen, who, as head of the petroleum exploration research group at the faculty of Civil Engineering and Geosciences (CEG), may be considered a useful source of information on cooperation with oil-rich countries, says that he is not aware of any active alliances in his field. Although he does say that he has regular discussions with people from the region and that there are various memorandums of understanding with universities in the Middle East, which is about as far as it goes.

Development work

TU Delft's current activities in the Middle East and North Africa tend to focus on development work, albeit on a small scale. This is because, as Van den Berg puts it, TU Delft aims to focus primarily on its three core tasks: research, education and valorisation. Indeed, it also does this in an international environment, but still. Cicat, TU Delft's international cooperation agency, currently has development projects underway in Yemen, Tunisia and Egypt. All of these countries are currently facing unrest and the alliances are therefore put on the backburner.

Marcel Crul is project manager in the Industrial Design Engineering faculty's design for sustainability research group. He is coordinating the Tempus project Unchain with universities in Tunisia, Egypt, Syria, Lebanon and Morocco. The European Union (EU) aims to use Tempus to modernise higher education in countries neighbouring the EU. The main objective of Crul's project is to establish professorships focusing on innovation in the countries involved. Smaller subsidiary projects are also linked to this. Four TU Delft students for example are currently supposed to be in Cairo conducting research on mobile communication and social media in healthcare. The negative travel advisory issued at the start of this year meant they were unable to go and were offered an alternative project. Crul: "We apply a fairly simple rule,

The Tahrirsquare in Cairo in February.

which involves always following negative travel advisories. We are in no position to judge the situation ourselves. If people are already in a region troubled by unrest, we also assess whether they are able to continue their work as well as taking account of the travel advisory. Cairo University, in the close vicinity of Tahrir Square, has been closed for weeks, for example. This meant that our partners were forced to stay at home."

Unchain

The project in Egypt has been postponed until September, in the hope that the current unrest will be over by then. But there is no certainty of that happening. "Egypt has to organise elections and you never know what that might lead to. We are keeping a close eye on the situation in consultation with our Egyptian partners and the Ministry of Foreign Affairs," Crul says.

The same applies to the Unchain subsidiary project of Mostafa El-Shinawy, a Master's student in sustainable energy technology (Faculty of Applied Sciences). He intends to travel to Tunisia in September for research into renewable energy supplies for ferries. For the time being, he is not especially preoccupied by the issue of whether or not this research can go ahead.

El-Shinawy comes from Egypt and was entirely caught up in the news from his own country: "From the start, my friends took part in the protests. I really wanted to be there with them, but my family could not afford a ticket. All of their money was invested in shares and the stock exchanges had collapsed. Fortunately, I was able to be there during the February holidays. I was able to join in with the protests, although it was actually more like a festival. It was a really great feeling."

'Scientists look for areas which have the maximum potential in terms of scientific value'

After completing his studies in Delft, El-Shinawy initially plans to work in Europe. He does not intend to return to Egypt until he is ready to settle down. He believes that it should then be possible to find a job, which is much more difficult with an Egyptian degree.

He faces a problem described by Cicat's Bert Geers as "the tragedy of the Arab countries", which has become a source of anger in other countries as well as in Tunisia: "People with a university education cannot find a job because their level is generally extremely low."

Master's student Mostafa El-Shinawy joined in with the protests in Egypt.

Geers is coordinating three development projects in Yemen. Two of these are follow-ups to the master plan for ICT in higher education that TU Delft helped to establish in 2006. Part of this involves setting up a national expertise centre for ICT in higher education and the training of ICT support staff. The third project focuses on providing assistance in the development of Master's degree programmes at a general university that aims to become a technical university. This is all being achieved with the help of people who have retired from TU Delft, the University of Groningen and the Surf Foundation, people from other developing countries in which Cicat has worked on projects, and a handful of TU Delft staff.
According to Geers, the university level in the Arab world is often extremely low: "For example, Saudi Arabia needs a lot of highly trained people, but will not be able to find these in Yemen. Graduates from that country do not even achieve the level of our first-year students. They are also unable to speak English or use a computer."
Geers knows his subject. He has been visiting Yemen five to eight times a year for six years. His most recent meeting could not go ahead because of the negative travel advisory. He believes there is some doubt as to whether it will be possible to complete his projects. He has since had a meeting with his partners at an alternative location in Istanbul. "We needed to discuss what can be achieved this year," Geers says "We hope to be able to make progress on building a library and the IT infrastructure."


Photo: Bert Geers

Citat helps educating ICT-employees in Yemen.

Photo: AFP/Mohamed Huwais

Protest against the regime of president Ali Abdullah Saleh in Sunaa, Yemen, last April.

Desperation

In recent weeks, contacts have been hit or miss when conducted via Skype, email or telephone. Things became particularly tense when a number of countries decided to issue negative travel advisories. How could the four Filipinos working on projects leave the country as quickly as possible? After a lot of complicated arrangements, they were able to return home via Dubai.

'It is an authoritarian regime but it keeps the country together'

Geers believes that education is the only thing that can help Yemen. In his view, the people of Yemen are the only real potential source of revenue for the country. But the problems he describes are enormous: if nothing is done, the country's capital will be the first in the world to be without water and yet the population is growing extremely rapidly. Oil supplies will be exhausted in seven years' time and poverty is already rife in the country. The population is divided into clans, some of which want independence. The security services are everywhere, leading to a feeling of major distrust. It is an authoritarian regime but it keeps the country together. Finally, 70% of the population chew the addictive substance known as qat.
Geers: "Currently, there are no future prospects for all these young people in Yemen. Someone I spoke to said: my family are forced to live like animals. In today's Yemen, we are increasingly hearing the cry of desperation. I know many of these people personally. I would not like to predict what the future holds for them."
In Istanbul, Geers wants to show his contacts that he is willing to continue. "I also worked in Mozambique and Sri Lanka when tensions were high there. People said to me then that they felt abandoned by the rest of the world. Keeping in contact with them during this difficult period really helped to maintain spirits. I aim to use this minimal contact with Yemen to show people that we have not given up on them." *(SB)*

For all eternity

Photo's: Tomas van Dijk

It seems impossible, yet it must be: nuclear waste stored in such a way that safety is guaranteed for hundreds of thousands of years. Under pressure from European legislation, the Netherlands has also launched a research programme.

The descent takes seven minutes. Everyone is packed tightly together in the narrow, steel elevator - all wearing boots, fluorescent jackets and light-mounted helmets, as well as carrying breathing equipment on their backs and alarms on their belts that sound should the wearer collapse. Spokesman Marc-Antoine Martin has wrapped a scarf five times around his neck as protection against the draught in the tunnel.

"Only research is done here," he shouts over the noise of the cables and pulleys. The underground laboratory will never actually be used for storing nuclear waste, although the locals living in this sparsely populated area of north-eastern France find that hard to comprehend. "You've been working on this for fifteen years already. Et alors, you still haven't stored anything yet?" Martin is asked in a neighbourhood café.

In the Netherlands, too, construction of a final repository for radioactive waste (see box) is now a major issue. The European Commission is pressuring member states to develop solutions for dealing with this waste. Every year another 7000 cubic metres of high-level radioactive waste is produced - enough to fill three swimming pools. Production has been ongoing for fifty years and more nuclear power plants are planned. Consequently, by 2014 the European Commission wants all member states to have plans detailing how and where the waste will be stored, how much it will cost and who will pay for it.

In the Netherlands, Covra in Vlissingen

has been charged with conducting a five-year, €10 million euro research programme known as Opera (a Dutch acronym for 'Radioactive Waste Final Repository Research Programme'). Research institutes and universities are invited to submit proposals. Covra's deputy director, Dr Ewoud Verhoef, expects the research programme to be complete by June.
At TU Delft, geo-technologist Professor Michael Hicks (Civil Engineering and Geosciences) hasn't yet received a call for research proposals, but if it comes he will propose studying the feasibility of constructing a final repository at a depth of 500 m in the Boom clay formation. It all starts with samples, which must first be extensively studied, explains his colleague, Dr Dominique Ngan-Tillard.

Storage in clay

In anticipation of the proposals, a final repository in clay strata seems to be the most likely option. The Netherlands does not have the option of using granite, as in Finland, and ever since the debacle in the German Asse region, storage in salt strata has had a bad reputation. Starting in 1967, radioactive waste was stored in an Asse salt mine, but major leaks and the danger of contaminated groundwater led to the mine's closure. There are 126,000 casks of low- and medium-level radioactive waste there, some of them partly rotted. Storage in clay strata is already being researched in Switzerland, Belgium and France.
Indeed, the French are engaged in a major programme. Close to the village of Bure, near Nancy, a fenced-off complex has been built that includes offices, facilities and an exhibition centre. But the real business takes place in the complex consisting of 1000 metres of tunnels some 500 metres underground. Two huge shafts provide access to the complex. The construction cost €600 million and the annual research budget involves an additional €100 million. The entire complex is equipped with more than 4,000 sensors to record temperature, pressure and movements. So far, the French have invested around €1 billion in the project. The research body, Andra, which manages the lab, owes its existence to a law introduced in 1991 establishing a research programme devoted to finding a solution for the final storage of medium-level and high-level radioactive waste. French energy giants EDF and Areva are funding 95% of the programme.
"We did not know how the clay would react," explains Martin. The oldest parts of the tunnel (dating from 2000) have steel walls supported by trusses. "We didn't know whether the trusses should be positioned at intervals of 40, 60 or 80 cm." There is a lot of experience of mining in coal strata, but the heavy clay in the Callovo-Oxfordian formation is something altogether different. Initially, the main focus was on what is known as convergence. Clay has a tendency to converge during excavation as a result of the pressure from the strata above. Hundreds of measurement points have been built into the walls to chart consolidation and distortions. An automated theodolite tirelessly scans the tunnels.
During construction, the French took extensive advice from their Belgian

In Belgium, researchers have been doing research on storing nuclear waste in the underground laboratory Hades (high activity disposal experimental site) since the eighties.

'Positive ions bind to the negatively-charged surface of the clay'

The underground laboratory in Bure, France.

counterparts at Euridice, an alliance between Niras (national institution for radioactive waste and enriched fissile materials) and the nuclear energy study centre SCK.CEN. Since the early 1980s, they have been operating the underground laboratory Hades (high activity disposal experimental site), which is situated just over the Dutch border at Mol, 250 metres underground in the Boom clay. This is a layer of clay that is around 100 metres thick, becoming thicker and deeper the further north you go. The fact that the clay is moist and plastic can be seen from the traces of water in the tunnel and the clay protruding inwards through holes in the walls.

Radiation level

The key question concerns the spread of radioactivity and the health risks this entails for generations far into the future. This is also the focus of much of the research. Clay contains water, but how quickly is it displaced? For example, the Belgians have measured the water permeability in a drill hole 10 metres deep at the end of the tunnel. Radioactive-labelled water was placed within it. Based on its spread, they were able to determine that water needs 50,000 years to spread through 40 metres of clay.

But this does not apply for all the substances dissolved in the water, says Sarah Dewonck, who is coordinating the Andra experiments. Positive ions bind to the negatively-charged surface of the clay. As a result, uranium and plutonium becomes strongly bonded to the clay. The opposite applies to negative ions, such as chlorine and iodine, which do not bond and can therefore migrate.

Efforts are also being made to ensure that the radioactivity remains encapsulated for as long as possible. This requires detailed knowledge of the chemical interaction between clay, glass, concrete and steel under the influence of high temperatures and radiation levels. Research is also being conducted into this in the laboratories. Another key factor involves changes in the clay layer caused by the construction of the tunnel and by heat. Is there not a risk that this will increase the porosity of the clay and create fissures, accelerating the anticipated transport of water? This is another area both laboratories are studying by heating a tunnel up to 90 °C for a ten-year period and then analysing the results.

Greenpeace refuses to be reassured and points to the dangers of accelerated corrosion, irregularities in the clay strata and the layers containing drinking water above and beneath the Boom clay. Euridice director, Dr Peter de Preter, responds: "We are talking about protection over an extremely long period, up to the point at which the radioactivity has already dissipated to a large extent. According to our knowledge and calculations, radioactivity originating from the repository will contribute at most an additional one percent to the annual natural radiation levels, and only then after many tens of thousands of years. But after hundreds or thousands of years, this level will in any case be equal to zero."

When asked what they would recommend to their Dutch colleagues, both the French and Belgian researchers say: start with a ground survey. Because just as the ground is different everywhere, the same is true for the best imaginable final repository for nuclear waste. The scope of the research is enormous, involving geology, hydrogeology, materials science, simulations and modelling, risk management and social acceptance. It would be extremely strange if TU Delft did not want to be a part of that. *(JW)*

Types of nuclear waste

Based on radioactivity and half-lives, Covra distinguishes between low-level, medium-level and high-level radioactive waste. Low-level radioactive waste originates in hospitals and industry, but also includes rubble resulting from the dismantling of nuclear power plants. Medium-level radioactive waste often originates from the same source but contains higher levels of radioactivity. Finally, high-level radioactive waste includes the non-fissionable remains of fuel rods, unfissioned uranium and plutonium. The underground storage of nuclear waste is intended solely for medium-level and high-level radioactive waste. Waste with a lower radioactivity is stored temporarily in silos until its radioactivity has diminished sufficiently.

The option often used for the storage of medium-level radioactive waste is steel casks in a concrete container to screen off the radiation as effectively as possible. High-level radioactive waste is vitrified in cylinders in the processing plant before being returned to the sender. In Borssele this involves 450 kg or 1.3 cubic metres of non-fissionable residue per year. Plutonium and uranium are recycled. For cooling, Covra stores the cylinders in an orange bunker alongside the Borssele power plant. In 50 years, the heat production drops by 90% and the waste can then be stored underground. Most proposals for storage entail the use of a number of layers of steel, copper, iron or concrete to delay the leakage of the material. It involves geological time-frames. After 5,000 years, high-level radioactive waste reaches the radiation level of uranium ore. For irradiated uranium, the period is hundreds of thousands of years.

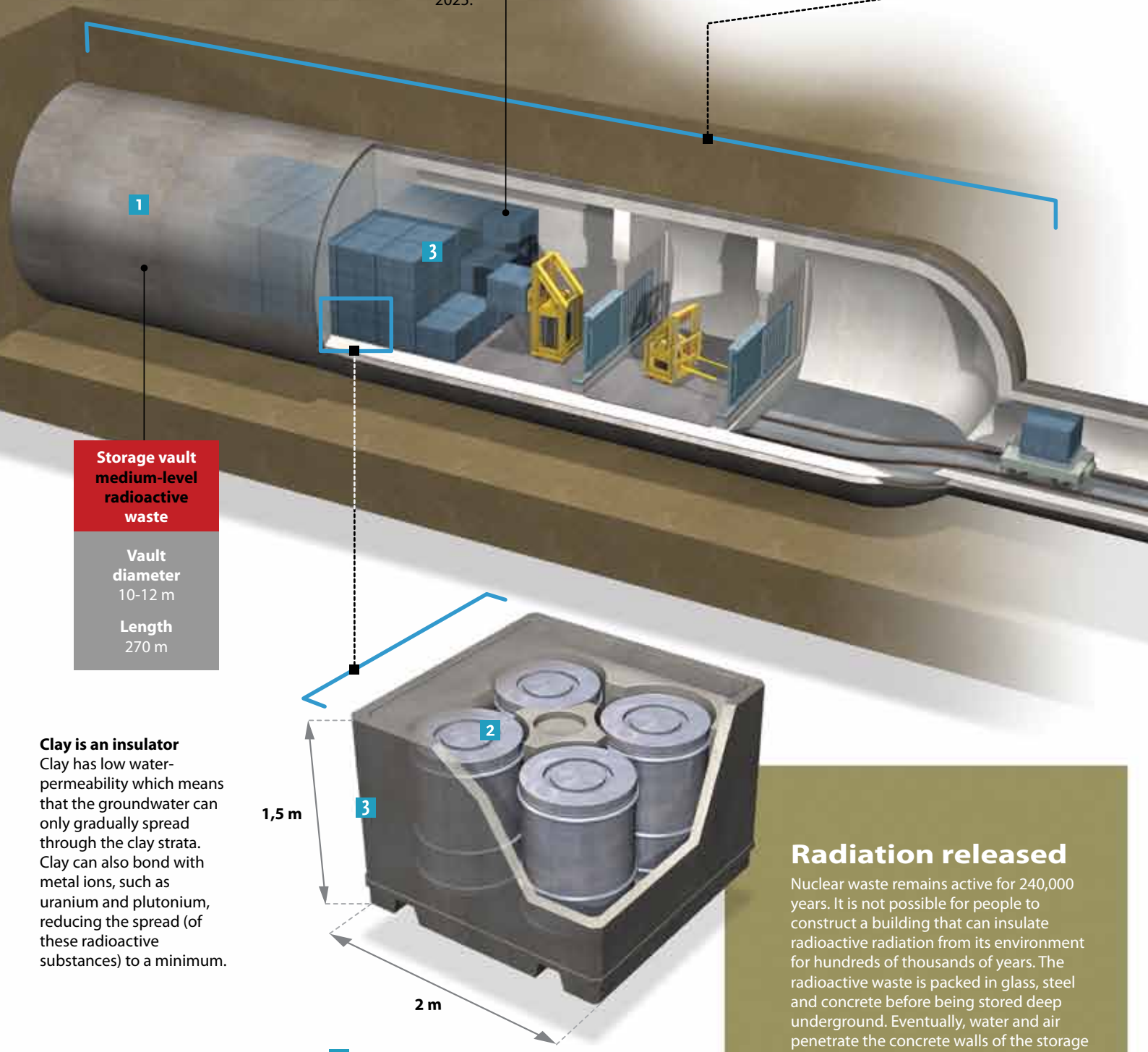
The size of the proposed waste repositories will depend on the number of nuclear reactors. In France, where there are 59 active nuclear power plants, Andra proposes a repository with a surface area of 30 square kilometres with corridors 200 km in length. For its seven nuclear power plants, Belgium envisages an underground repository of three square kilometres. For the Netherlands, 500 hectares should be sufficient.

Final repository of the nuclear waste

Many scientists are of the opinion that the storage of radioactive waste underground (in clay, granite or salt strata) is currently the best solution. It is assumed that if layers of earth have already been stable for millions of years, they are likely to remain so for the next hundred thousand years. Alternatives such as firing the waste into the sun or dumping it in the oceans (which did happen until 15 years ago) have been discounted.

French test laboratory
Currently, there is not a single final storage repository for high-level radioactive waste in operation in Europe. However, France is one example of a country that is conducting tests on this kind of storage facility. It is anticipated that the first final repository in Europe will begin operation in 2025.

Current storage of high-level radioactive waste
The Netherlands produces approximately 450 kg of high-level radioactive waste every year (including the non-fissionable residue from the nuclear power plant in Borssele). This waste (1.3 m^3, including packaging) still emits so much heat that it needs to cool for between 50 and 100 years until it reaches a temperature at which it can be stored underground. Until now, this Dutch nuclear waste has been stored in concrete bunkers (with walls 1.7 m thick) at the site of COVRA (Central Organisation for Radioactive Waste) in Vlissingen (the municipality of Borssele). This is a temporary solution because the waste cannot stay there for 240,000 years.



Clay is an insulator
Clay has low water-permeability which means that the groundwater can only gradually spread through the clay strata. Clay can also bond with metal ions, such as uranium and plutonium, reducing the spread (of these radioactive substances) to a minimum.

NON HEAT-EMITTING WASTE

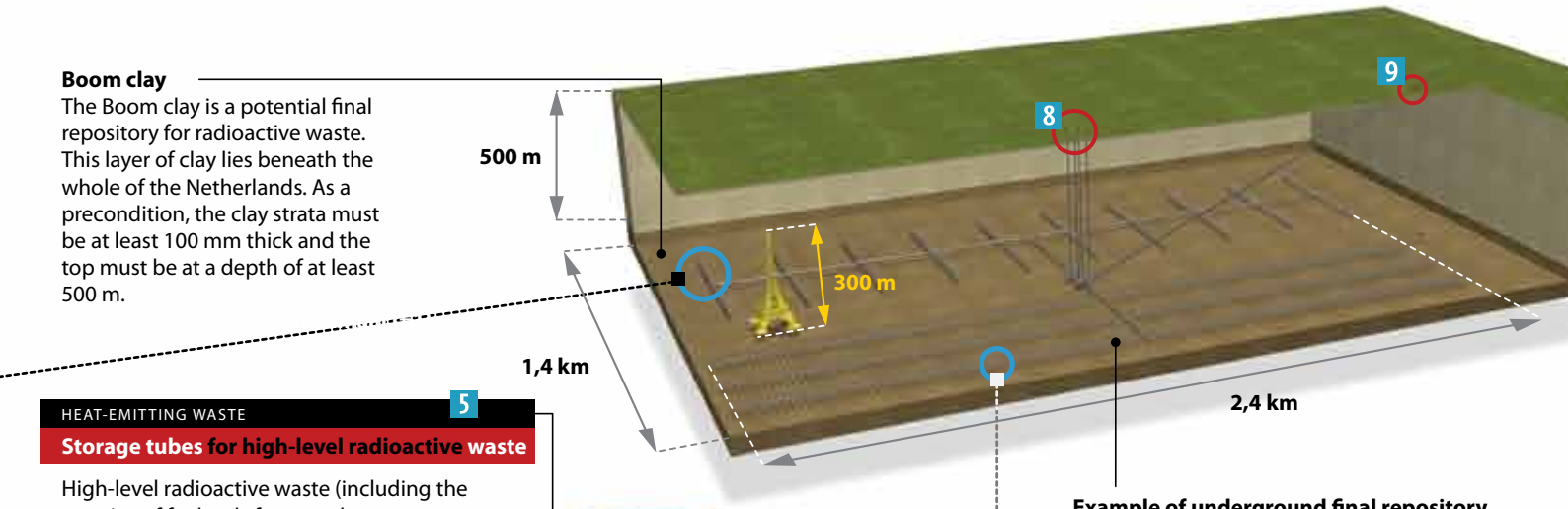
Storage vault for medium-level radioactive waste 1

Steel casks 2 with medium-level radioactive waste (originating from hospitals and industry) are placed in concrete containers 3. These containers are stacked in layers in storage vaults. These circular vaults are 250 m from each other and sensors are positioned in the vaults to monitor the situation. When these storage spaces have been filled, they are sealed with a concrete plug.

Radiation released

Nuclear waste remains active for 240,000 years. It is not possible for people to construct a building that can insulate radioactive radiation from its environment for hundreds of thousands of years. The radioactive waste is packed in glass, steel and concrete before being stored deep underground. Eventually, water and air penetrate the concrete walls of the storage facility, causing metal packaging to rust and enabling radioactive material 4 to leak into the ground. The intention is that the clay strata will as far as possible prevent the radioactive substances spreading via the groundwater. The depth of 500 m is essential to prevent the radiation from reaching people.

Boom clay
The Boom clay is a potential final repository for radioactive waste. This layer of clay lies beneath the whole of the Netherlands. As a precondition, the clay strata must be at least 100 mm thick and the top must be at a depth of at least 500 m.

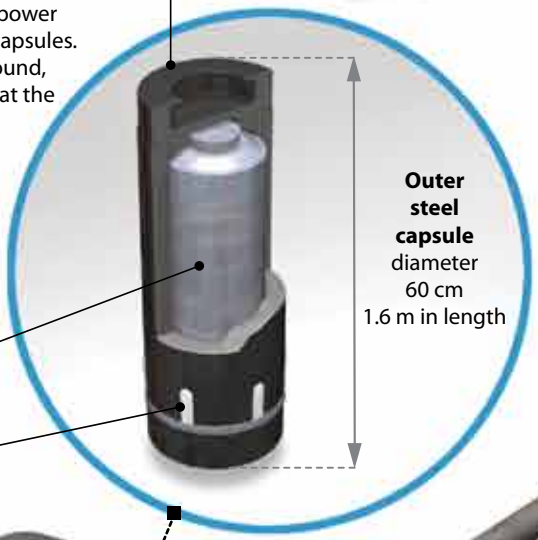


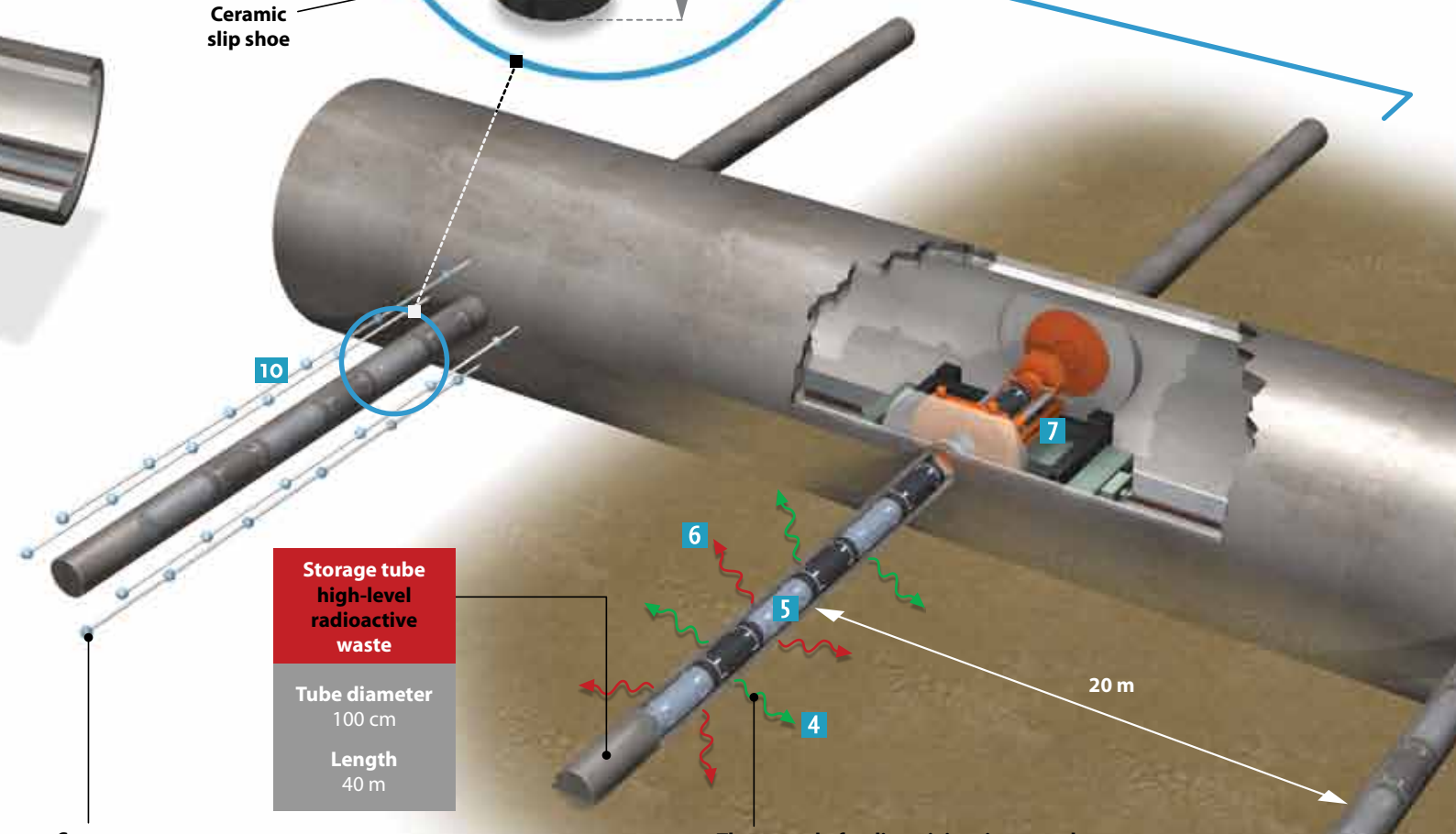
Example of underground final repository
An underground final storage repository will consist of a network of concrete corridors to which storage vaults and storage tubes are connected. A modular storage system is used in order to enable new modules to be added in future. The complex can be accessed by means of lift shafts 8 and a tunnel for freight 9 lorries that opens obliquely. In the Netherlands, a final repository of 50 hectares (= 0.5 km ^{2} ≙ 500 x 1000 m^2) should be sufficient. In France, which has 59 active nuclear power plants, a final repository measuring 30 km^2 is envisaged.

HEAT-EMITTING WASTE 5

Storage tubes for high-level radioactive waste

High-level radioactive waste (including the remains of fuel rods from nuclear power plants) are packed into two steel capsules. Even after being cooled above ground, this still emits so much heat 6 that the clay soil will be heated up to around 80 °C. A special transport robot 7 places the capsules in the storage tube. When the tube is full, it is hermetically sealed with a clay stopper and a concrete plug.





Storage tube high-level radioactive waste

Tube diameter
100 cm

Length
40 m

Sensors
Thousands of sensors will monitor the temperature, pressure, oxygen level and chemical composition in the tunnel. Because of the high temperatures and the radioactive radiation, it is difficult to position sensors in the storage tube. For this reason, holes 10 will be drilled parallel to the storage tubes from the transport access route in order to position sensors.

The spread of radioactivity via groundwater
If radioactivity is released, this will be absorbed by clay particles and by the groundwater. The key question is how quickly radioactivity will spread through the clay via the groundwater and how quickly this leaked radioactive waste will reach the Earth's surface. According to Belgian research, water takes 50,000 years to spread through 40 m of clay.

Photo: Sam Rentmeester/FMAX

How does air behave as it flows past wind turbine blades and what influence do the resulting distortions in the blades have on the air flow? This complicated question is the source of many a headache for experts in fluid dynamics. According to PhD student ir. Joost Sterenborg, much more data is required in order to verify the mathematical formulae that scientists use in an attempt to describe these phenomena.
In a smoke-filled hall in front of the large 'Open Jet Facility' wind tunnel at AE, the researcher from the aerodynamics department is conducting experiments with a rotor blade that dangles loosely from a set of springs. There is a movable flap on the back (similar to an aileron on an aircraft wing) that he can use to move the blade up and down, providing that the wind tunnel blows hard enough. The researcher charts the air flow by using lasers to illuminate the smoke particles that flow past the blade.

‘There is so much you can learn from another culture’

Jenny de Boer was recently awarded the Delft University Fund’s ‘Marina van Damme’ grant for talented female TU Delft alumni. She intends to spend the €9,000 prize on a Master’s programme in cultural anthropology.

How does cultural anthropology complement your earlier studies in industrial design engineering?
“Designers conduct research into how they can use a new product or a new service to solve problems people encounter. Social scientists examine how these problems arise in the first place. I often work in the development cooperation sector. Many of those who work in this sector have a background in the social sciences or communication studies. They tend to tackle problems from the cultural and human perspective.”

But that means your technical background is an added benefit?
“On behalf of the Netherlands Organisation for Applied Scientific Research (TNO), I facilitate innovation processes in developing countries and often have meetings with people from different cultures. Studying cultural anthropology can increase my understanding of these cultures. It’s also possible to make progress through experimentation. When you talk to people, they generally respond, but you don’t always understand what they’re saying. I receive a response, but think: surely I asked a different question? So what underlies all of this? A good basis should help me to ask the right questions in the right way. Ultimately that will make the sessions more productive.”

Marina van Damme
Jenny de Boer is the ninth TU Delft alumna to be awarded the ‘Marina van Damme’ grant. Marina van Damme (80) graduated in Delft in 1953 as a chemical technologist. In the mid-1970s, she was the first female PhD candidate at the University of Twente. This was followed by a successful career in the chemical industry, first in research, and then in management.
This kind of education and career were something quite exceptional for a woman in that era. But even today many women still believe that technology is not an area for them, Ten Damme says. “My career development was incredible. My career was wide-ranging and satisfying and enabled me to develop a lot of social contacts. That is not what is generally thought to be the case for engineers.”
Van Damme aims to use her grants to enable ‘young women with a few years’ experience in wider society to take a look at their career and see how they can diversify in a non-standard direction. “The formula is to give people the chance to gain a broader, more in-depth and/or international perspective”. She has established similar grants to the one in Delft at both TU Eindhoven and the University of Twente. Around five years ago the winners of these grants came together to form a network, which meets annually under an apple tree outside Van Damme’s home in Gelderland. “They work together very intensively. They have a wide range of careers, but prove to have a lot in common. They benefit a great deal from each other and that was what I had hoped for.”
Van Damme has noticed that in the last nine years there have been “an incredible number of new prizes awarded, but very few or no grants, especially for women. But they certainly meet a need, if the large number of applications for just one of my grants - 200 at the last count - is anything to go by.” Van Damme does not expect her grants to become surplus to requirements in the foreseeable future. “There is a long way to go before we achieve equality,” she says. “We will definitely need to continue during my lifetime and probably for quite some time after that.”

What do you expect to learn?
“My main aim is to become skilled in the research methods so that I can tackle cultural and anthropological issues. When the World Bank, the United Nations or NGOs are looking to appoint consultants, they often ask for a social background. I’m currently lacking in this area and this makes me feel that I’m at a disadvantage.”

What issues do you encounter in practice?
“I worked in Namibia with a human rights organisation that wanted to use mobile telephones during the elections. The first thing we needed to discover was how people worked together. But when the boss was there, the field staff refused to comment. He did all the talking. It was a real challenge to obtain input from the staff, but vital because they were the ones who would be using the end product. After a while, you realise you need to seize the opportunity when you catch them alone. The boss is higher up the hierarchy and must not be knocked off his pedestal. You cannot simply say to him: ‘I think your staff know more about this’. Personally, I’m fascinated by the issues that underlie such situations and how people deal with them in their everyday lives.”

Does TNO have a department dedicated to development work?
“Four years ago, TNO set up the innovation for development programme. In this framework, TNO tries to work together with Dutch and local organisations on the joint development of new products and services that people on a low income can and want to purchase and that can also be manufactured locally. We’re mainly active in India and Africa, in the fields of energy, ICT, food and health. As part of the

'When you talk to people, they generally respond'

TNO theme 'information society', a number of colleagues are also specifically working on ICT in development cooperation. The focus lies with asking how ICT can contribute to solving social problems. I'm also involved in this."

How do you approach the work?
"TNO has the task of enabling scientific knowledge to be applied in industry. It's not possible simply to say to industry: this is what you need to know. This can sound rather dogmatic. You can also turn things around, though. A company with a problem comes to TNO and asks: what knowledge do you have to solve this problem? This approach is more demand-driven. But the fact that we work with the clients throughout the process means that the chance that the knowledge and solution will be adopted is greatly increased."

Can you give an example?
"An ICT strategy needed to be developed for an HIV/AIDS organisation in Kenya in order to raise people's awareness of how they could use ICT to improve the effectiveness and efficiency of their organisation. We facilitated the process that the organisation was involved in with local ICT consultants and the client Hivos. We asked such questions as: what information and communication problems do you have, what improvements are needed and what tools could you use in the process? Occasionally, the solution is something simple like the use of Skype for internal communications. But because all the parties contributed to the process, they were able to see from the outset what problems can be solved using Skype."

Does the fact that many regions have no computers or electricity present a practical problem?
"The mobile telephone is more important. The penetration of mobile telephony is much greater than that of the internet. Some of the poorest people spend as much as a quarter of their income on a mobile telephone. That's how much they are willing to spend on it. Often people share a telephone with family members and work out the cheapest possible ways of communicating things. For example, by allowing the telephone to ring a number of times, like a sort of Morse code. The challenge we now face is to use mobile services to try to increase living standards, for example in healthcare and education."

How do you do that?
"For example, by using MobiScopy, which involves attaching a mobile telephone to a microscope. Small local hospitals can then use a microscope image to make a photograph that can be sent to a laboratory that has an expert on the staff. The large hospitals in Uganda are located in the capital, for example, so sometimes people have to travel for a week to reach them."

What other mobile services might be possible?
"They can be used to give people greater awareness, for example by informing farmers of the latest prices of their crops. This can help to prevent intermediaries from paying too little in order to pocket the profits themselves."

Who is Jenny de Boer?

Jenny de Boer (1981) has worked at TNO since April 2007. She provides support to innovation processes within organisations. She spends the majority of her time working with organisations in developing countries. She has worked in Mali, Namibia, Uganda and Kenya. This year she will travel to Senegal and Sudan. De Boer studied Industrial Design Engineering at TU Delft from 1999 and 2007. In 2002, she spent six months studying at the University of New South Wales in Sydney, Australia. In 2005, she did a three-month internship with Human Factors International in Mumbai (India).

How did you first become interested in development work, was it something that started at an early age?
"It was during an internship in India. While studying industrial design engineering, I learnt to involve the end user in the innovation process. This involves trying to understand the end users, their behaviour, convictions and emotions. It's an extremely valuable approach. But in India I noticed that I tended to apply many of my own Western ideas in the process of finding a solution to an initial need. In order to filter these out, the solution I devised was sent back and forth several times between me and the people in India. This was something I found particularly interesting. What's more, a good solution can really make a major difference in this sector. There is still so much room for growth in developing countries."

You're not an idealist?
"I do not believe that it's possible to find a sustainable or long-term solution for problems if there is no commercial interest involved. I see it as a market rather than as aid. In the ICT sector, particularly, it's extremely important to tackle things from a commercial perspective. So my answer is no, it does not feel like idealism. It started with a desire to travel, but that phase has now passed. It still fascinates me, however, to look at someone and have absolutely no idea of what is going on in their heads. That makes me determined to find out. There's so much you can learn from another culture and that is something that motivates me personally."

Why did you originally decide to study industrial design engineering?
"As a child, I was very creative and had no difficulties with mathematics or physics. So industrial design engineering seemed a logical choice. Now you could also add to that my fascination with people. I observe people, looking at the way they move and what they do and then try to respond to that. I see that as a strength. Personally, I think it's a great idea to pursue that side of things by studying cultural anthropology rather than the technical aspect. I also really enjoy looking beyond the ICT issues and reporting on my observations. I would find it extremely interesting to include such questions as: 'how does that happen?' or 'what are the differences between...?' This is something I can try to do now, but I don't have the theoretical background."

You intend to combine your studies with a job. How are you going to manage that?
"That's something I still need to figure out, but I don't want to take a sabbatical. What really matters to me is being able to apply the theory immediately in my projects." *(SB)*

Modular glove boxes

Irritation can often prove to be a source of inspiration. It was what led to the development of the Glovecube – a modular glove box for use in experiments with hazardous and sensitive substances.

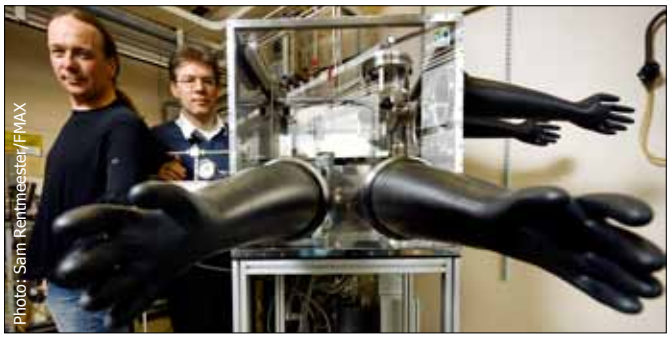


Photo: Sam Rentmeester/FMAX

Last spring saw Glovecube deliver its very first glove box to the Delft reactor institute, to be used for research on nanoparticles for hydrogen storage. This modular glove box was invented and developed by the physics engineer Walter Legerstee and materials engineer Frans Ooms. These two first became acquainted around 1998 in the Applied Sciences chemistry department. When Legerstee joined the department, he was told: "This is a glove box – you will find yourself using it a lot." That certainly turned out to be the case. Ooms also worked there and soon found it to be a source of increasing irritation. "Lots of different people share the same box, so if one of them makes a mess of things, it causes problems for everyone", he recalls. Ooms eventually decided to have a small box made for himself. This, combined with irritation about the lack of flexibility of the boxes, led to discussions on how improvements could be made. The idea emerged of starting with a frame and then placing airtight panels around it. You can then make all kinds of inlets in the panels and you can also link the frames to form a greater whole.

In the evenings, Legerstee developed some ideas on the design programme Auto-CAD and discussed them via Google Chat. This gradually evolved into a design for a modular system, which has now been awarded a Dutch patent. Two earlier prototypes were followed by the first production model in early spring this year.

Both men are currently spending two to three days on further developing and marketing their invention. There has been no external funding – the production has been financed using savings. All profits are also reinvested in the company.

Depending on the specific requirements and model, a full Glovecube with air treatment equipment costs around € 30,000. The good news is that a second additional box costs only € 6000 extra.

Legerstee and Ooms expect to sell between three and five models this year: not quite enough yet to justify giving up their day jobs. Legerstee works as a research technician at the reactor institute and Ooms runs another business in the field of batteries. But the aim is definitely to achieve further growth, which is why they are attending trade fairs such as 'The Precision Fair' and, next year, 'Het Instrument'. There they hope to offer potential customers the solutions they need. "The system should sell itself", thinks Ooms. Competitors are keeping a close eye on developments. Almost all boxes currently in use are manufactured by the American firm Mbraun, which has made very few changes to the design of its large boxes since the 1970s. Linking their equipment is extremely difficult and extending it is impossible. Now that the tiny Glovecube operation has appeared in their market as if from nowhere, the Americans are carefully studying the Glovecube website. This was revealed by Google Analytics. *(JW)*

www.gloveqb.com

Return of the portraits

At the University of Groningen, Emeritus Professor Geert Boering has revived the tradition of professors sitting for painted portraits when they retire.

The Dutch newspaper *NRC Handelsblad* (19 January 2011) writes that the centuries-old tradition of professors donating their portraits had come to a sudden end in the revolutionary 1970s when equality became the new paradigm and portraits were regarded as elitist. Forty years later Professor Geert Boering tested the waters by donating his portrait to Groningen University. His example was swiftly followed by five colleagues.

"I have always admired the portraits at Leiden University," says Emeritus Professor Ted Young (Applied Sciences). He missed such a professorial portrait gallery in Delft. "It's important that we honor the university as an institution, and it is the professors who are emblematic of the institution. An official gallery of portraits paid for by a retiring professor is a way to build a sense of history, a sense of continuity."

"This is no university for historic Senate Rooms with club fauteuils and ashtrays for cigars," says Professor Hans Beunderman, Vice Rector at TU Delft. Together with Marga Schrijvershof-Vink, he set up a gallery in the Aula of 20 black and white photographs featuring all the university's Rectors since 1945. Beunderman prefers the university to have a say in who is remembered: "We honor people with merit. That is different from professors offering their own commemorates."

Professor Miro Zeman (Electrical Engineering, Mathematics and Computer Sciences) already has his own portrait: a photograph of him wearing his professorial gown that is printed on canvas and framed. It was a gift from colleagues at the occasion of his professorship. Prof. Zeman regrets the lack of historic awareness at the university: "I've been working here for twenty years, but to have an idea of who my predecessors were or what they did you'd have to go to the library and make a deep search." Prof. Zeman, who is also the founder of Slovakia's first private art gallery, 'Galeria Nova', would like to have a series of portraits displayed in the department's immensely long corridor. Each he portrait would include a short description of the accomplishments of the person portrayed. But it needn't be painted portraits: a more modern portraying technique involving lasers and 3D would perhaps be more appropriate for TU Delft. Prof. Zeman argues that portraits do in fact complement a forward-looking university: "You cannot orientate towards the future if you have no knowledge of your past. If we expect students to be proud of the TU, it's not because of the buildings or the Mekelpark, it's because of the people." *(JW)*

Life after Delft

‘Hello factory’

After graduating from the faculty of Industrial Design Engineering, Anne-Meike van Kinderen drifted between different jobs in Shanghai. At one point she even thought she might be deported.

Photo: Tomas van Dijk

Role-play sessions, salary, bonuses and holiday leave: Anne-Meike van Kinderen had either attended or discussed all of the above. She had already received her KPN contract in the post. The plan was to become a product manager in mobile telephony. “That kind of company gives you coaching and career guidance. It’s a steady job with prospects,” she says But then a different company altogether offered the Industrial Design Engineering alumnus the opportunity to go to China. “It happened to be China, but I didn’t really mind where it was,” she recalls. “If they’d asked me to set up an office in Buenos Aires, it wouldn’t have been a problem for me either. I don’t relish the idea of waking up in the suburbs at the age of 40 and wondering what it would have been like to experience an adventure abroad.”

In 2007, Van Kinderen set off for Shanghai to work for the Chinese branch of the Xindao company, which works in the promotional industry. She was tasked with working with designers to develop a new product line.

The adventure was to last just three months. After her office at yet another studio was closed down in the wake of the credit crisis, she became a travel guide for a company specialising in extreme sports, but her work permit was not in order and she was almost deported.

She explains all this in the offices of her latest employer, Tuono Lighting International, a company that specialises in LED lights – “products that you can hold in your hand and that fit into a small box – just my kind of thing,” she says.

“My job here involves sourcing. If you want to market a specific product in the Netherlands, we contact factories in China and explain how we would like the products. ‘Hello, factory, I have an idea and some funding and would like to discuss this project with your engineers.’ I’m really positive about the work that’s going on in China. We work a lot with local engineers, because the ideas we develop on the drawing board in the Netherlands are definitely not always the smartest or cheapest solutions. The factory understands its own production processes best and can come up with highly ingenious solutions. However, I sometimes find the short-term thinking that Chinese people can be prone to very frustrating. They don’t seem to consider the fact that if they rip us off now and make us pay an extra 20% per component, we will never want to do business with them again.” *(TvD)*

The View

Space research 2030

Planetary science expert, Professor Imke de Pater, combines her professorship at the University of California, Berkeley with a part-time position in Delft. She envisages enticing opportunities for Delft researchers and students to contribute to planetary missions.

“Every mission reveals so many new and unexpected things that it is difficult to speculate about them. However, I’m especially looking forward to a mission to Titan, which will involve a balloon slowly descending into the atmosphere of this moon of Saturn, releasing some Delfly micro-vehicles as it goes. It’s a place that continues to intrigue us. We know that its seas consist of methane but we do not yet know what changes with the seasons. Each season last eight years and the entire orbit takes 30 years. It will be necessary to take measurements for decades. Using a balloon, it is possible to map a larger portion of the surface than with a single probe. Meanwhile, you can also study the atmosphere and hopefully find out more about the aerosols, a type of smog particles that are concentrated above the poles and which cause a kind of nebula. At SRON [Netherlands Institute for Space Research, ed.] they are already working on an instrument called Spex. This could be attached beneath the balloon to provide information about the size, structure and composition of the particles. This is essential information if you want to find out how the particles emerge and disappear again.

“These aerosols appear to counteract the greenhouse effect. Titan is warmer than expected as a result of a greenhouse effect caused by the methane in Titan’s atmosphere, but the smog caused by the aerosols actually increases the outward infrared radiation, which counteracts the greenhouse effect locally. This could be relevant to the Earth’s situation as well, because aerosols also have a cooling effect after a major volcanic eruption.

“In the longer term we hope to return to Uranus and Neptune, as we know so much less about them than about Jupiter and Saturn. Voyager 2 is the only probe to have flown past them and they are so far away that the signals were extremely weak. The images reveal so much less detail. The moon Miranda looks interesting, but the images remain very vague. Triton is also extremely interesting. It too has seasons, but each one lasts for 40 years. It’s possible to make out the south pole and the equator, but I would like to see these in much greater detail. Both ESA and NASA currently have long-term plans to return to Uranus and Saturn, but these are not yet definite. I envisage significant opportunities for TU Delft, SRON and Dutch industries to contribute towards the development and implementation of these long-term missions, as well as for the smaller missions that may occur in the shorter term.” *(JW)*

Photo: Sam Rentmeester/FMAX

Column

A broader perspective

Jeroen van der Veer (1947) studied mechanical engineering and is chairman of the Supervisory Board of ING Groep and Philips. From 2004 to 2009 he was CEO at Shell.

As chair of Platform Bèta Techniek, I occasionally have the opportunity to take a look around schools. For example, I recently visited the Cartesius Lyceum in Amsterdam. The school has introduced the concept of 'Science Coaches' ('Bètacoaches'): students in the third grade assist first-grade students with science subjects in order to help prepare them as effectively as possible for their future careers at school and beyond.

There are various ways of looking at the Netherlands' position when it comes to innovation. In terms of the availability of scientists and engineers, there is a great deal of room for improvement, since the Netherlands currently ranks 22nd in the world. Some progress has been made: two out of ten students now opt for a science or technology course. I believe this figure will increase to three out of ten in the coming years. After all, an effective balance in human capital in terms of education and background is an important precondition for the Dutch economy and its development. Fundamental innovations rarely come from managers but are actually initiated by scientists and technologists.

Photo: Sam Rentmeester/FMAX

In recent years TU Delft has seen major increases in its intake of first-year students. But, we do not only need scientifically trained engineers. Across the whole of education the way in which demand on the regional employment market is coordinated needs to be both improved and strengthened.

At secondary (MBO) and higher (HBO) professional level, the HBO Centres of Expertise and MBO Centres for Innovative Expertise have recently been launched. Thanks to these centres, knowledge generated within the key national areas and within the social innovation agenda now has a position within the educational and knowledge infrastructure. Centres of Expertise will need to cooperate with universities and scientific knowledge institutes in order to market knowledge developed at the top level within professional education. This wide-ranging approach is so promising that I hope to see other top-level areas adopt the same approach, as high quality and sufficient human capital is an important precondition for future economic success.

As indicated earlier, the Dutch Cabinet has placed a number of key economic areas at the heart of its policy. In the near future, higher education will also be presented with the recommendations of the Veerman report, in which profiling features prominently. I am hoping that, as in recent times, this will also include positive and stimulating policy in the field of science and technology. In any case, it is a positive development that the plans are already in place within primary and secondary education.

In therapy with avatars

Combating phobias and psychotic disorders using virtual technology: that is what the work of Dr Willem-Paul Brinkman of the Faculty of Electrical Engineering, Mathematics and Computer Science involves. Of course one does not have any of these disorders oneself – or at least that's what our reporter also thought.

As a white European, I glance from under my mask at the monitor on which my heartbeat and sweat production are creating fluctuating patterns. I have just entered a virtual pub, packed full of people of North African appearance.

And it gets worse: Dr Willem-Paul Brinkman has just pressed a button causing the few remaining white people to suddenly get up and leave. The empty chairs gradually fill with North African avatars who wander into the pub.

Luckily, the sensors on my fingers do not send out any strange signals, even when I use a joystick to approach the new arrivals in the pub up close and make eye contact. Being with people of different skin colour does not make me feel any less comfortable. This is something I already knew about myself, but now I have proof. The pattern on the monitor remains the same.

"Ah, that's what you think," laughs Brinkman, who is supervising the experiment in a completely darkened room in the Electrical Engineering, Mathematics and Computer Science (EEMCS) building. "The patterns of your heartbeat and sweat production have shown some real changes. They have become more irregular. You cannot see it with the naked eye, but we have computer programs that analyse it."

Brinkman can tick boxes on the screen with words such as 'crying', 'angry', 'tense', which are used to mark the behaviour of the test subject on a timeline. This can prove helpful in reconstructing the most awkward situations retrospectively. I am spared this ordeal, as there is nothing to tick on this occasion.

Willem-Paul Brinkman

The TU Delft researcher is developing what are known as VRET (Virtual Reality Exposure Therapy) systems, which can be used to help people deal with their anxieties, such as fear of flying, fear of heights or claustrophobia, or psychotic disorders such as paranoia. He took over the research project, which has been running for almost ten years, from Dr Charles van der Mast in 2007.

One of the first products to emerge from the laboratory of fear was a vibrating aircraft seat. Two economy class seats in the corner of the laboratory serve as a reminder of the time when Brinkman and his colleagues were experimenting with them.

In collaboration with the University of Amsterdam, Leiden University and KLM's Valk Foundation (established to help combat fear of flying), the Delft researchers developed a system to enable people with a fear of flying to don a virtual reality helmet, hear characteristic aircraft sounds and experience the vibrating seat as if they were really in the air. This helps people become accustomed to the sensations and overcome their fear.

The system is used intensively by the Valk Foundation, explains Brinkman.

Even scarier

Dr Brinkman's recent work has focused on programmes like the virtual pub, which are designed to help people with social problems. He is working in alliance with researchers from Parnassia, a Dutch psychiatric institute.

"They have many patients of North African origin with psychosis," explains Brinkman. "These patients suffer from delusions that other people want to harm them and they are especially suspicious of people from outside their own ethnic group."

The idea is that reconstructing the social environment in a virtual world and exposing people to it will enable psychiatrists to improve the research they conduct on the psychotic symptoms and ultimately provide better help to patients.

The virtual pub is still in the pilot phase, however, and needs to be made even scarier. Patients find it extremely frightening when people look at them for long period of time, and hence this feature needs to be added. It

should also be possible to conduct a simple conversation.
"Developing a real treatment method will take quite a few years," says psychiatrist Dr Wim Veling. "We have now conducted research on what happens when we expose people to a crowded environment and to people of a different ethnicity - two factors which are known to cause psychosis. The results are highly encouraging: people with paranoia show a similar response to situations in the virtual world as to those in the real world."
The researchers conducted the experiment with 15 patients and 24 white, European students and staff from TU Delft. They were all asked to walk through the pub and - as a kind of distraction - search for numbers that had been put on the chests of five random people in the pub.
"In the test with healthy test subjects, I reversed the roles," Brinkman explains. "This makes the stress factor the number of North Africans - rather than white - people present, given the fact that the test subjects available to me were mainly white. But the principle remains the same."
The small increase in fluctuations of heartbeat and sweat production observed by Brinkman after collecting and analysing all the data from all the Delft test subjects serves as a baseline, which subsequently can be compared to the outliers among the patients.
"It's like an echo," says Dr Veling, describing the measurements. His colleague, Professor Mark van der Gaag, explains: "For millions of years we lived in clans with only a few hundred people. This means that our brain is probably constructed in such a way that we are quickly able to determine who belongs to the group and who doesn't."
The ultimate aim of the research is to develop a method for use in cognitive behavioural therapy that "brings the world into the consulting room", in the words of the psychiatrists. "Now patients tell us afterwards that they were afraid when they were sitting in the tram, for example, because they felt that they were being stared at," explains Prof. Van der Gaag. "Or that they heard fragments of conversations and thought people were talking about them. In cases like these, their response is to flee.


Photo's: Sam Rentmeester/FMAX

Patients are exposed to a social environment in a virtual world.

'People with paranoia show a similar response to situations in the virtual world as to those in the real world'

"In the virtual world, we encourage them to respond differently. The threshold for staying in the tram for one more stop – we intend to also create a virtual world set in a tram - is lower because you know that there is no actual danger. The patient then realises that people eventually look away and there is actually nothing going on."
The virtual worlds still look quite artificial. Is that an area that still needs further work?
"Photo-realism is not important at all," says Prof. Van der Gaag. "All you need are the right fear cues. Take the system to combat fear of flying for example: it uses a helmet in which you see images of old-style VGA quality. If you look past the airport towers, all you can see is pixels. It bears no resemblance to anything. And yet, people still throw up in a bucket."
Another interesting feature of the experiment is that the avatars look particularly attractive. Have the Delft researchers simply programmed their dream women and men, like a bunch of nerds? And could that not also be the reason why my heartbeat became slightly more irregular, I ask optimistically? That slight paranoia, however natural it appears to be, was still a bit embarrassing.
"No, it's not down to that," laughs Brinkman. "Of course, in order to make the virtual world appear more natural we would have preferred to use avatars that are more average in appearance, but we had no choice. We bought these avatars from an American company and these were the only figures they had. It would cost us a great deal of time and money to create them ourselves." *(TvD)*

In-depth ideas

The Delft University Fund/EBN Geo Energy Master Award will be presented for the first time this year. The award recognises students who have developed innovative ideas for deep underground exploration and exploitation in the Netherlands in their graduation projects. Examples include ideas relating to conventional oil and gas, non-conventional gas, geothermal energy or gas and CO_2 storage.

Lodewijk Alblas.

Marc Pagen.

This year's short-listed candidates are Marc Pagen and Lodewijk Alblas. Alblas describes a new method for optimising liquid flows in reservoirs, such as oil or gas fields.
Its aim is to maximise the economic value of a reservoir and could even result in a doubling of the value compared to conventional methods.
Marc Pagen describes a communications strategy to promote the social acceptance of geothermal energy in the Netherlands. The exploitation of this kind of energy is a fast-developing technology. As with the use of other new energy sources, prior social acceptance is essential for its success.
Both students will present their work at the prize-giving ceremony on 20 April in café Psor at the Faculty of Civil Engineering and Geosciences. A jury will then select the winner. The first prize will be €6,500 and the second prize €4000.

Eight hundred friends for TU Delft

As many as 800 alumni have already signed up as 'friends' of the Delft University Fund. They are donating a total sum of €42,000 to the university via the University Fund. By donating money, they are helping to support talented students and academics and strengthening their professional and personal links with the university. 'Friends of Delft University Fund' is a continuation of the work of the now defunct TU Delft Alumni Association. Recently, approaches have been made to alumni who were members of that Alumni Association. Any alumni who have not yet been approached are also welcome to become 'Friends of the Delft University Fund'. Details of exactly how it works can be found on the website www.universiteitsfonds.tudelft.nl under the heading 'Vrienden' (Friends). In the coming months, alumni will be sent a personal invitation to become a 'friend'.

'Delft Geothermal Heat' project wins prizes

Three pioneering and outstanding ideas in the field of energy efficiency and sustainability have been awarded the Delft University Fund/Cofely Energy Efficiency Award by Cofely and the Delft University Fund.
Up-and-coming academic talent at TU Delft rose to the challenge of devising innovative solutions to achieve a substantial reduction in energy consumption. The three most innovative ideas were awarded prizes on 24 February. Douglas Gilding, Master's student in earth sciences, was awarded the first prize of € 7500 for his 'Delft Geothermal Heat' project. He designed a model to investigate how the exploitation of geothermal heat under Delft would affect the soil conditions. An understanding of soil composition is important for the exploitation of geothermal heat. Differences in the soil composition can affect the yield by as much as a factor of 10. Douglas's study shows that several geothermal energy facilities could be constructed around the Delft area and could be used for the exploitation of sustainable heat for at least thirty years. His results mean that the economic application of geothermal energy in the Netherlands is now a step closer to becoming a reality.
The projects developed by Michael Prodromou (civil engineering) and Víctor Vélez (civil engineering) were both awarded a prize worth € 2500. Prodromou devised a plan for future-proofing outdated and monumental buildings. He developed three strategies for the sustainable redevelopment of BK City. Vélez developed energy supplies at community level, using heat/power engines, a high-performance boiler and a windmill.

Delft University Funds/Imtech Bachelor Grants

In alliance with the Delft University Fund (UfD), Imtech established the UfD-Imtech Fund. It awards a total of €10,000 in grants every year for the promotion of innovative technology at TU Delft. Students who have written an outstanding final Bachelor's report, either individually or as part of a team, are eligible for the award. Five Imtech grants are awarded annually.
The judging panel consists of three professors from different faculties, a member of the board of Delft University Fund and an Imtech business director. They assess all entries, paying particular attention to the following five criteria:

Inflatable wind turbine.

- Nerve & innovation;
- Cooperation between different subject areas/disciplines;
- Practical applicability;
- Communicative impact;
- Corporate Social Responsibility (CSR)

This year's UfD-Imtech Bachelor Grants were won by the following projects:

- Crystallisation During Lorazepam Infusion (AS Faculty) - Lorazepam is a sedative used widely in the Netherlands. It can be prone to crystallisation, preventing the flow to the patient during infusion. This project involved researching the initial steps towards solving this problem.
- Faster medical diagnoses thanks to oscillating micro-bubbles in Labs-on-Chips (AS Faculty) - Research into an active mixing method for Labs-on-Chips, a micro-laboratory measuring just a few dozen square centimetres. Primarily of use for speeding up medical analyses in Third World countries.
- CNVMiner (EEMCS Faculty) - Data visualisation and analysis tool that enables biologists to study Copy Number Variations, an important type of genetic abnormality.
- The Continuous Red-Eye Effect (3mE Faculty) - Strabismus, also known as a squint, lazy eye or cross-eye can be detected using the red-eye effect on images. The research focused on the relationship between the direction of the squint and the intensity of the red-eye reflection.
- Portable Power Pack (AE Faculty) – Design for an inflatable wind turbine that can be carried in a rucksack.

Discover the Normal Amsterdam Level at a discount

In October 2012, Prince Willem Alexander opened the educational visitors' centre at the monument to the Normal Amsterdam Level (NAP, also known as Amsterdam Ordnance Datum). The monument has existed since 1988 and shows the baseline for the water level in the Netherlands. A visitors' centre has now been added, featuring an experience-based exhibition that highlights a range of interesting facts about the NAP. There is also a wealth of information on the history of the fight against water. For this exhibition, TU Delft has provided a number of different historic artefacts.
Within Europe, the NAP is the leading measurement for water levels. As a reference, the NAP is necessary in order to gain and maintain control over all types of water: salt and fresh surface water as well as rainwater and groundwater. It is also essential for all types of construction activities involving roads, bridges, tunnels and buildings and monitoring earth movements during gas exploration, for example. At a European level, it is used as the unit for monitoring variations in sea level and plate tectonics and is the only national reference for converting one to the other. The exhibition features some leading figures from Dutch history, including Christiaan Huygens and the engineer Lely. There are also numerous historic artefacts. The Treasury of the 'TU Delft Library Special Collections' has made a range of instruments and images available for the NAP Visitors' Centre. Examples include a spirit level used in the 17th and 18th centuries for water level measurements and a levelling instrument created by J.H.Onderdewijngaart Cansius. This originates from the late 18th/early 19th century and was used by General Krayenhoff.

Discount for readers of Delft Outlook

If you hand in this discount coupon (or a copy of it) you will be entitled to 25% discount on a visit to the NAP visitors' centre. Standard price: 4 euros per person, children up to the age of 12 free of charge.

NAP Bezoekerscentrum, Amstel 1, Amsterdam (in de passage van het stadhuis), 06-83085155, www.normaalamsterdamspeil.nl of www.canal.nl/bus/nl/NAP

This discount voucher is valid until 31 December 2011. Maximum of four people per discount coupon. Not valid in combination with other promotions and/or discounts.

PLU 8133 adult

Propositions

Dyslexia is a much too complicated word for people who have this learning disability.
Sigrid Marika Scherrenberg
civil engineer

Devaluation of diplomas is caused by pushing back the premature loss of students.
Herbert van der Ham
civil engineer

Those who whish to cross an elephant with a rhinoceros must remember that the product is always | elephant | | rhinoceros | sin 0
Ayon Kumar Dey
imaging science engineer

The number of unsolved problems one faces during one's PhD research does not converge to zero.
Birgit Witte
engineer mathematical statistics

Machines are legally endorsed drugs. The more we utilize them, the more we get addicted to them.
Kamana Sigdel
engineer software technology

Through weight lifting, scholars can maintain the balance between their muscles and their brains.
N. Bharosa
engineer information technology

Proposition

Because of the cultural differences between the Netherlands and Flanders, the two will never form one entity.
Tom Van Helleputte, space technology engineer

Defense

The cultural differences between Flanders and the Netherlands are too great for them to come together quickly, referring to culture in its broadest sense: from gastronomic culture (chips with a choice of 10 different kinds of sauce in a Belgian '*frietkot*' – a *kroket* from a 'snack wall' in the Netherlands), cinema (successful films are remade, as in the case of 'Alles is liefde' and 'Loft'), art (I couldn't tell you the name of a contemporary Dutch painter) to political culture (endlessly seeking compromise – tolerating and approving). The reasons for this lie in commercial navel-gazing on the part of both parties, which the media engage in too: the usual methods and faces are preferred over a wider and more open perspective. The strong tie of a shared language only serves to accentuate these differences instead of serving as a bridge.

Sound Bites

'If the cooling in the nuclear power plant fails, everyone knows what needs to happen: it must be reactivated. You train people for these scenarios. In the case of a disaster, an earthquake followed by a tsunami followed by fire, improvisation is the only option. In that case, you need to have stress-resistant people on standby.'
Professor in Safety Science and Disaster Abatement, Ben Ale, on Intermediair.nl

'The law is seriously lagging behind technology. Recently, a judge ruled that it is not illegal to secretly use someone else's secured router [a piece of equipment for wireless internet, *ed.*]. The reason given was that it was not a computer but only a communication channel. I really do not think that the judge fully understands what the consequences of illegitimate use could be.'
Professor in Philosophy, Jeroen van den Hoven, on the privacy debate in De Twentsche Courant Tubantia

'What will be the benefit of having 26 paid-for apps on my mobile? The market is already totally lacking transparency with all the different tariffs for transactions and it remains unclear who will be using whose infrastructure.'
Professor in Technical Public Administration, Michel van Eeten, in NRC Handelsblad

'Because a mould powder needs to be forgiving, it serves as a scapegoat for the shortcomings in the casting process.'

Jan Kromhout,
materials engineer

In Person

Dr **Merle de Kreuk** was awarded the Jaap van der Graaf prize for her article *Behavior of polymeric substrates in an aerobic granular sludge system*. The prize, a sum of €5,000, is awarded annually by the engineering company Witteveen + Bos to the best English-language article on wastewater. De Kreuk received her PhD from the TU Delft based on research on the development water purification plant.

Dr **Edward Valstar** was presented with the Anna Prize during the annual conference of the Dutch Orthopaedic Association. He works in the biomechanical engineering department of 3mE, which works closely with the Biomechanics and Imaging Group (BIG) of Leiden University. BIG researches the detachment of prostheses and provides support for the implantation of prostheses using computer navigation techniques.

TU Delft's Executive Board has appointed Professor **Peter Wieringa** to the post of vice-rector. Wieringa is currently a full professor of Man-Machine Systems and Director of Education and Deputy Dean of the Faculty of 3mE. On 1 April he took the place of Professor Hans Beunderman, who has retired and become an emeritus professor.

Dr **Ad van Wijk**, entrepreneur in sustainable energy systems, has been appointed as endowed professor in Future Energy Systems, for two days per week. His chair at the faculty of Applied Sciences is sponsored by energy producer Eneco.

On 26 March 2011, Emeritus Professor **Leo Ligthart** and Professor **Lou van der Sluis**, were awarded honorary memberships of the Electrical Engineering Student Association (ETV - *Elektrotechnische Vereeniging*) for their exceptional efforts. Ligthart regularly accompanied excursions and provided ETV with contacts abroad. Van der Sluis gave lectures to parents at ETV's parent's day for five years in a row.

An asteroid - 12160Wakker – has been named after Professor **Karel Wakker** (Aerospace Engineering). As a leading expert in orbital mechanics, Prof. Wakker has combined teaching at TU Delft for over 30 years with consultancies for numerous ESA and NASA space missions. He also served as TU Delft's rector and director of SRON (Dutch Institute for Space Research).

As of 1 January 2011, Dr **Jan Peter van der Hoek** and Professor **Walter van der Meer** have been appointed part-time professors at the faculty of Civil Engineering and Geosciences. Together with Professor Luuk Rietveld, they now hold the chair of sanitary engineering. Dr van der Hoek specialises in choices of purification processes and water quality, while Prof. van der Meer develops innovative processes.

Professor **Marco Waas** was awarded the 'Achieve More Award' in Brussels. The dean of 3mE is well-known for his enthusiasm for entrepreneurship, valorisation and innovation. 'Achieve More' is a European initiative that aims to provide small and medium-sized businesses in the IT sector with financing and access to academic sources.

TU Delft alumnus and Nobel laureate **Simon van der Meer** (1925 – 2011) died on 4 March in Geneva, where he had been residing since 1956. He was awarded the Nobel Prize in 1984 for his cunning design of particle accelerators at Cern.
Simon van der Meer came to study at TU Delft immediately after the end of the Second World War, having waited two years after completing his gymnasium exams in The Hague. In Delft he studied Technical Physics and chose the then new discipline of 'measurement and regulation technology' as his specialisation.
In a recent obituary in de *Volkskrant* newspaper, Professor Jos Engelen, the former scientific director of Cern, said: "Simon was no scientist but rather an engineer in the best positive meaning of the word, someone who used his expertise and intuition to build exactly the accelerators that we physicists dreamt of."
Van der Meer was awarded the Nobel Prize for physics together with former Cern director, Carlo Rubbia, for the detection of W- and Z-particles, which convey the weak nuclear force, one of nature's four fundamental forces, together with the strong nuclear force, electromagnetism and gravity.
Van der Meer married Catharia Koopman in 1967, with whom he had a daughter and a son.

Photo's: Sam Rentmeester/FMAX

who & where

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

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Biotechnological Sciences Delft Leiden (bsdl)
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Centre for Transportation Engineering
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Dutch Institute of Systems & Control (DISC)
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Koiter Institute Delft (Institute for Engineering Mechanics)
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Reactor Institute Delft
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Central Library

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

For further information:
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Prometheusplein 1
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Information on research fellowships:
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General information on university education in the Netherlands:
Min. of Education, Science & Culture
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