Delft Outlook
MAGAZINE OF DELFT UNIVERSITY OF TECHNOLOGY 2013 • 3

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No need for knives

Museum of Mineralogy and Geology

Future uncertain

Han Vrijling:

'The damage can be tremendous'

Study for free

Online goldmine

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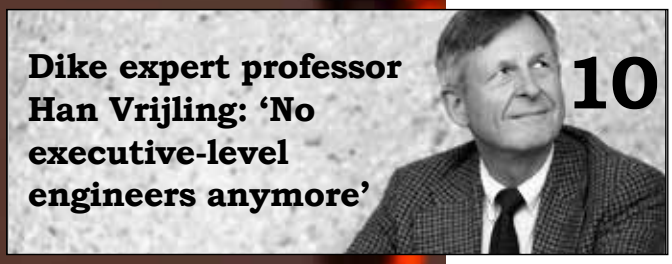

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Risk

Creativity and entrepreneurship are in my opinion the two defining traits of the Delft engineer. Once again, Delft Outlook has several striking examples to share with you. Delft engineers have teamed up with Leiden doctors to apply minimally invasive surgical techniques to repair joint prostheses, which is not only less stressful for patients, but also reduces health care costs. Architect Vollers is determined to market his Pinbed Wizard: "The flexible mould makes the large-scale production of curved panels possible. It's the holy grail of blobland," he says with conviction. Industrial designer Desmet looks at his field from a different perspective. "I would like to see us take a more holistic look at the effect of design on people and communities." It's a shame the government doesn't always acknowledge the added value of the engineer. "There are no executive-level engineers here anymore, says retiring hydraulic engineer Vrijling. "People seem to think the entire Delta Plan can get by without any engineers. This spells stagnation; after all, where does innovation come from? You just sit back and voila, innovation arrives? It doesn't work that way. You must be willing to take risks." The Delft engineer can be trusted to do that.

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Photo: Tomas van Dijk

Water from Mars

Wastewater from the Mars factory in Veghel, the largest chocolate producer in Europe, feeds bacteria in an STW-funded pilot plant, producing bioplastic. The pilot plant, which was built by Paques, has been operational since November 2012 and will probably be in use until the end of 2013. By that time, PhD student Jelmer Tamis hopes to have increased the PHA content of the produced biomass, in order to bring down the production costs of the bioplastic and make sustainability more affordable.

delta.tudelft.nl/26740

Extreme aging

Researchers from Leiden and Delft, who are working together in the Medical Delta program on aging, are unraveling the genetics of longevity.
The European research consortium on aging performed the largest genome-wide linkage scan for longevity thus far. The research-team identified four regions in the human genome that harbour genes responsible for the long life of siblings. For these regions the siblings shared more genetic similarity than you would expect based on Mendel's laws of inheritance only. The fact that the siblings inherited the same beneficial genetic variants in these regions may thus have contributed to their survival.

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Photo: Wikimedia Commons

Bits of quantum

By creating entanglement between quantum bits on distant chips, Prof. Ronald Hanson and his team have laid a basis for quantum information processing. Last April Nature published their achievement of reaching entanglement (coupling of quantum states) between two qubits three meters apart. It's the first time that entanglement between distant chip-based qubits has been produced. Hanson is not worried about the current low success rate. What he sees is the future of quantum computing.

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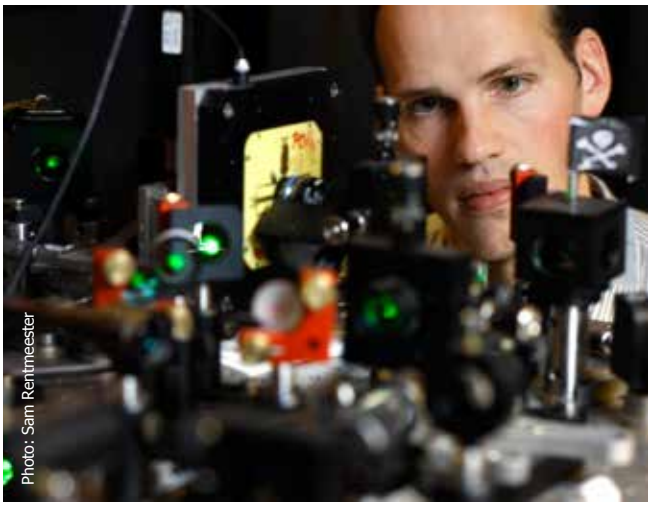
Photo: Sam Rentmeester

Jumping electron

Just days after TU Delft scientists entangled quantum bits on distant chips, another group has successfully allowed electrons to jump between quantum dots. Both groups of the Kavli Institute of Nanoscience lay a basis for quantum information processing. Researchers led by Professor Lieven Vandersypen have showed that they could make an electron jump between the ends of a chain of three small semiconducting islands (so-called quantum dots) without crossing the island in the middle (Nature Nanotechnology, 28 April 2013). Now that it appears that electrons from more distant quantum dots can be brought together, the scaling up to larger chains of quantum dots seems feasible.

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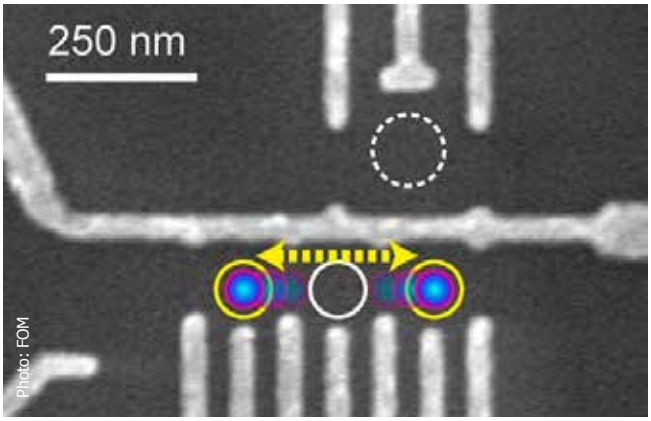

Photo: FOM

Hybrid car

By simply changing the rear part, students from Hogeschool Inholland, TU and Haagse Hogeschool combine the high-mileage vehicle Apollo with the wind-powered vehicle Anemo. Both need a slick, light aerodynamic capsule for the driver, only the back part is different. The vehicle is designed and built by Rootbox, a practical workshop comparable to the TU's Dreamhall. TU researcher Ben Geurts MSc. was involved in the early stages of the TU wind racing team called Team Vortex. He thinks the Rootbox team has made a smart move. "Combining the two vehicles makes better use of knowledge, production facilities, workshops, financial means and sponsorships", says Geurts.

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Nail clippings

Analysis of nail clippings can reveal where you were and what you ate three months ago. Because dirt and nail polish contain over thousand times more trace elements than the nail itself, cleaning is a necessity. But the way of cleaning (scraping or washing with acetone, water or detergent) influences the outcome. Paulo Favaro MSc, who will defend his thesis on 12 July, says science will need a blueprint on sample handling if easily available nail clippings are to be used as biomarkers in a reliable and quantifiable way.

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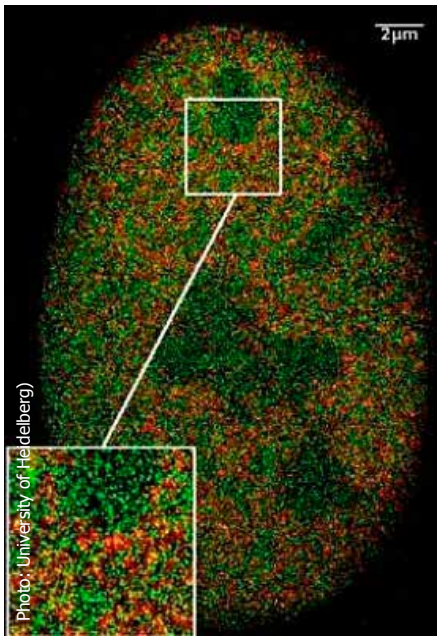

Photo: University of Heidelberg)

Microscopic distances

Delft researchers have made an important advancement in a new microscopic technique that is widely used in medical research. Their findings were published online in Nature Methods (28 April 2013). In microscopy the light of single fluorescence is measured in several places. This is repeated for many proteins in succession. When the data from these individual molecules is combined, the images get about ten times sharper than the standard optical resolution of 250 nanometers. Researchers have now developed a statistical technique to calculate the exact resolution.

delta.tudelft.nl/26662

Monkey face

The primate park Apenheul in Apeldoorn has a very special new photo booth. The gorilla matching mirror, developed by Ir. Erik Groenenberg of industrial design, is an extended version of the currently existing photo booths in the park. Those photo booths tell you which gorilla you resemble the most visually and behaviourally. Visitors mirror the gorillas and their behaviour, by standing in front of a Kinect sensor. Once a picture has been taken the user can enter his/her name, age, length and weight on a touch screen and will then be matched to the most similar gorilla of the group.

Computer homes

Ir. Pieter Stoutjesdijk, who graduated cum laude in Architecture earlier this year, has created a house on the computer. He designed it especially for earthquake-hit Haiti. He used a computer to create a type of lego brick with which a house can be built in just a few days, without any nails or screws. Although his design is only a model, Stoutjesdijk will be helping to build 25,000 of these types of houses in Rwanda this year.

delta.tudelft.nl/26785

Photo: Tomas van Dijk

Annual report

In 2012, TU Delft secured record funding from Dutch and European subsidies and business: 150 million euros. This is according to the financial annual report. Despite the optimistic figures, TU Delft warns that this increase in income from work for third parties cannot continue, because they are outweighed by higher expenditure. Although the University would like to continue to grow, it will not be able to finance this if central government funding falls short. TU Delft ended 2012 with a positive result of 25.1 million euros. The University intends to invest this money in property, teaching and research.

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Digital Delta

Rijkswaterstaat, IBM, the Delfland Water Board, TU Delft, and Deltares have launched a new alliance: Digital Delta. The aim is to share information in order to improve water management and cut costs.
The Netherlands is seen as a world champion in water management, but due to rapidly changing weather conditions it is becoming more expensive year-on-year. It is believed that savings can be achieved by sharing data and through improved cooperation between the various parties involved. The Digital Delta programme therefore intends to amalgamate the data from various water projects and make it accessible. This will include data on rainfall, water levels, water quality, dike sensors, data from locks, pumping stations and dams as well as radar information and forecast models.

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Photo: TV West

Team Sport

For the Computer Games Project, second-year students have developed games that invite people to contact others, work together and move. Games Project coordinator Dr. Rafael Bidarra (EEMCS) asked the students to develop games to entertain people who are waiting in a public space. After fourteen weeks of design and development, the students presented four games in the hall of the Electrical Engineering building. Passers-by spontaneously joined in.

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Photo: Tomas van Dijk


Photo: Vislab

Robot car

Professor Alberto Broggi, who is a professor of Computer Engineering at the University of Parma, gave a lecture about his work on artificial vision for autonomous vehicles and about his 2010 expedition with four autonomous vehicles from Parma to Bejing. He also announced that he and his laboratory, VisLab, are going to collaborate with researchers of the TU Delft Robotics Institute. In November this year this collaboration should result in an autonomous car.

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Less money

TU Delft Library will receive 7.9 million euros less in funding from the Ministry of Education from now on. This is almost half of its total budget of 18.5 million euros. "Truly shocking", said Executive Board member Anka Mulder during consultations with the student council. The cuts will have repercussions for spending on teaching and research at TU Delft, writes President Dirk Jan van den Berg in a response to the Minister. This is because the activities involved in the library's national role cannot simply be suspended.

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Photo: Informs

Award-winning math

A new approach to flood-defense measures won the Franz Edelman Award last April. TU emeritus Professor Kees Roos says it may save us nearly 8 billion euros over the next 40 years.
A team from Deltares, Netherlands Bureau for Economic Policy Analysis (CPB), Tilburg University and TU Delft was awarded the Franz Edelman Award for best achievement in operations research for their rational approach to flood protection in the Netherlands. According to their analysis, three areas in the Netherlands deserve special flood protection: Rotterdam, Almere and the Betuwe.

delta.tudelft.nl/26581

Photos: Sam Rentmeester/LUMC

Rock-solid artificial joints

Engineers from TU Delft and doctors from Leiden are joining forces to make loose-fitting artificial joints a thing of the past. They are at the forefront in terms of minimally invasive interventions, which make cutting open patients unnecessary. "Nobody else is doing this yet."

Saskia Bonger

Mr De Groot is sitting cheerfully on the bed that a nurse has wheeled into the radiology department of the Leiden University Medical Center (LUMC). His left elbow is bandaged up, but otherwise there is no sign he has just had an operation that will save him a lot of pain. But in fact he has just come back from an operating table in the CT scanner – a place usually only used to make x-ray images - of blood vessels, organs, or bones. De Groot, however, had an operation there and then on his six-year old artificial elbow, which became loose following a fall. The pain he had suffered since that time made it impossible for him to use his arm.

Mr De Groot is 81 years old and takes medication for heart problems. Orthopaedists at other hospitals generally tell people in poor health that they simply have to learn to live with the pain, because the likelihood of complications from an operation is too great. Over the past few years, however, the LUMC and TU Delft have together developed a technique that makes such a major operation, in which the artificial joint is replaced by a new one, unnecessary, and which is therefore helpful to people like Mr De Groot.

Just two hollow needles go into the bone of Mr De Groot's elbow, which means it does not have to be completely cut open. As well as reducing the medical risks, it also saves a lot of time and money. The reasons are obvious: no operating theatre is needed, the patient is in and out of the hospital the same day, rather than spending several days there, and only a local anaesthetic is required. Another pleasing benefit is that an artificial joint that is otherwise sound does not have to be wrenched out of the bone (which sometimes has to be broken for the purpose) in order to be replaced by a new one. All in all, if all goes well, an operation of this kind costs 3,500 euros. An operation in which an artificial joint is replaced easily costs 50,000 euros – if there are no complications, that is.

Medical Delta

What is the secret? Injecting polymethylmethacrylate, which is a bit like two-part adhesive, although the doctors refer to it as cement. A small tube is attached to the first needle in the arm, through which the orthopaedist very slowly injects a few millimetres of the 'adhesive' into the bone. Moisture from the bone can escape through the second needle, thereby preventing the pressure from getting too high. The cement hardens after around fifteen minutes, leaving the artificial joint firmly in place.

This method has been developed by orthopaedist Rob Nelissen, in collaboration with mechanical engineer Edward Valstar, who was appointed Antoni van Leeuwenhoek professor at TU Delft in the autumn of 2012. Valstar started his career twenty years ago at Leiden University, when he was part of the start of the biomechanics and imaging group in the orthopaedics department.

Twelve years ago this was followed by his appointment to the TU Delft faculty of Mechanical, Maritime, Materials Engineering (3mE), in the biomechanical engineering department. Since then he has devoted 50% of his working hours to Leiden and 50% to Delft, all in the framework of the Medical Delta. Valstar forms the link between the engineers in Delft and the physicians in Leiden. There are working partnerships with numerous Dutch and foreign research institutes, and funding is also received from the private sector and research financers.

In 2007, Valstar obtained a Vidi grant of up to eight hundred thousand euros for his research into the early treatment of loose artificial joints involving minimally invasive surgery. >>

Product safety

Valstar believes that too many artificial joints are brought onto the market before they have undergone extensive clinical testing. "There are joints which have been proved to work, and which cost seven to eight hundred euros. Newly developed joints easily cost 3,000 to 3,500 euros, even though there is no evidence that they are better. Therefore it is financially attractive for businesses to keep innovating. I think that should stop, because existing artificial joints are fine." Valstar notes that politicians are not taking any steps to prevent joints that have hardly been tested from being sold. "Politicians have to take the bull by the horns and take action on product safety."

'The technique developed by the LUMC and TU Delft eliminates the need for major operations in which artificial joints have to be replaced'

Developing countries

Today, Mr De Groot is reaping the rewards from that research. He has to remain completely immobile during the treatment. He is lying on his left side, his left arm bent in front of him, tied down to the treatment table. Orthopaedist Rob Nelissen and interventional radiologist Arjan van Erkel cover De Groot's upper body as much as possible after taking a CT scan. Based on the images of the inside of De Groot's elbow, they first determine very accurately where the needles need to be inserted into the bone. The space around the artificial joint can be clearly seen on the x-ray photographs: this is where the cement will be inserted later.

Before the operation, Valstar explains that if something goes wrong with artificial joints, it is usually because they work themselves loose in the bone. Every year, 2.5 million artificial knees and hips are fitted all over the world (elbow joints are replaced much less frequently, but they are comparable to the other two). That number will have trebled by 2030 because people are living longer, because of the rise in obesity, which causes joints to wear out more quickly, and because artificial joints are becoming available for people in developing countries.
Something goes wrong with ten per cent of all artificial joints, requiring them to be replaced within ten years. Sometimes this is due to a fracture (seven per cent), as in

Prevention, detection, reparation

A total of thirty people have been treated with a cement injection of the kind given to Mr De Groot, none of whom were considered able to have a major operation. The intention is for every patient to be treated this way in a few years' time.
Before that stage, however, a technique conceived by mechanical engineer Edward Valstar for removing fibrous tissue using water jet cutting needs to be developed fully. A PhD student at 3mE is going to investigate the optimum water pressure required to cut tissue. If the fibrous tissue can be removed first, the cement injections can be carried out more effectively. Valstar is optimistic about the chances of the treatment method. "This is going to be the new standard."
It is Valstar's ambition to ensure that artificial joints last a lifetime. Operations, even the minimally invasive kind that the LUMC has just started, should eventually become unnecessary.
The steps that Valstar and his colleagues are taking in that direction can be divided into three categories: prevention, detection, and restoration.
On his computer, Valstar speeds through a nearly one-hundred page presentation, which he uses in his lessons. It reveals all kinds of secondary projects, such as a clinical study into the effect of a thin layer of hydroxyapatite, a type of calcium, on the artificial joint. "This makes it possible for the joint to be more securely embedded in the bone."
Valstar is also working on improving and developing surgical instruments that can be adjusted in such a way as to make them 'patient-specific'. This would make the process of fitting artificial joints more accurate, which is also the aim of using computer assistance. A bloody photograph of a hip operation instantly makes clear how difficult it is for orthopaedic surgeons to see how accurately hip joints are fitted. "At present, a lot of it is down to intuition", says Valstar. Another factor is that you are dealing with more than just the bone of the joint. Knees also have tendons and muscles, and joints must be able

'This is going to be the new standard'

to move as effectively as possible. Further research should make it possible to take all these factors into consideration at the time a new artificial joint is being fitted.
As well as researching preventive aspects, Valstar is also deeply committed to early detection. "It has been shown that if an artificial joint moves slightly during the first year, it is a good indicator that it will fail in the future owing to detachment. We are currently developing RSA, stereo-x-ray technology, which we can use to identify movement and wear-and-tear very accurately."
It works as follows: the patient lies on the x-ray table while two x-ray machines take photographs of the joint, where small particles of tantalum have been added to the bone. Comparing stereo photographs from just after the point when the joints were fitted makes it possible to see the slightest possible divergence. These slight shifts in position can be stabilised with a cement injection of the kind given to Mr De Groot. The method is very new and not yet fully developed.
But Valstar is already thinking beyond that stage. He also has a great deal of confidence in a biological approach, as he calls it. He explains within the bone there is a balance between osteoclasts, cells that dissolve bone, and osteoblasts, which produce bone. "If I can put osteoblasts in the fibrous tissue and add certain biological substances to that, it will be possible to convert the quicksand into bone. And just suppose I add a thin layer of this mix to the outside of the artificial joint before it is used, and that I can release these substances by heating up the artificial joint by putting the patient in the MRI – you could regard it as a large microwave oven. The fibrous tissue will then be converted into bone without it being necessary even to inject the patient, never mind cut him open. There is a long way to go, but it is something we are actively exploring in the biomaterials research group in Delft."

Orthopaedist Nelissen and interventional radiologist Van Erkel keep a constant and close eye on the images from the CT scan to see whether the needle is entering the bone at the correct angle.

the case of De Groot. Infections are a slightly more common cause (eight per cent), but the main reason to replace artificial joints (72 per cent) is because they work themselves loose after a period of time. Possible reasons for this are that there is too much pressure on them because they have not been positioned right or because the design is not right, or simply because of wear and tear.
Valstar explains what happens when an artificial joint works itself loose. "A fibrous tissue forms around the joint, like a kind of quicksand. The tissue ensures that the joint is no longer securely positioned in the bone, which leads to complaints for the patient. On top of that, the fibrous tissue affects the still-healthy bone, and can even cause holes. Until recently, the only option was to remove both the fibrous tissue and the artificial joint, and to replace it with a new, larger one. You often have to break the bone to get the required access, and then reset the bone so it can heal. In response, the body may start to manufacture new bone in the muscles at the location in question, which can lead to deformities and more pain. In other words, the operation is not without side-effects for the patient – even though the artificial joint itself may well have been perfectly in order."

Prof.dr.ir. Edward Valstar

Orthopaedist Rob Nelissen

Strange aroma

Mr De Groot's artificial joint, too, is still perfectly in order. Six years ago, he was given one in each elbow. The right elbow is still working as it should, while the left one probably would be if Mr De Groot had not had his fall.
Orthopaedist Nelissen first anaesthetises the elbow. He then starts to rotate the first needle, which has a razor sharp point, into the bone. He and interventional radiologist Van Erkel keep a constant and close eye on the images from the CT scan to see whether the needle is entering the bone at the correct angle. After some searching, the needle ends up precisely in the fibrous tissue between the bone and the artificial joint. Once the second needle is also in place, the doctors open the packaging of the 'two-part adhesive', and mix the powder with the liquid for a few minutes in a special machine. A strange aroma fills the air. Nelissen looks at the mixture and is satisfied. "It is nice and thin, so we can start." He uses a tube to connect the reservoir of cement with the first needle in Mr De Groot's elbow, and very slowly inserts some cement. The images on the CT scan show the polymethylmethacrylate entering the bone. Meanwhile, some moisture is escaping from the second needle. De Groot is now very calm as he lies on the treatment table. Only once does the pressure in his bone cause him so much pain that Nelissen has to stop briefly. Less than five millilitres are inserted into his body, and that is enough. After fourteen minutes, when the cement has hardened, the needles can be removed from the elbow. The doctors are satisfied. Mr De Groot is bandaged up, and is able to return home the same day. <<

The name of the patient has been altered for reasons of privacy. His real name is known to the author.

‘The loop is broken’

Professor of Hydraulic Engineering Han Vrijling is sad to see how attention for dikes is fading in the Netherlands. “Everyone talks about innovation like it’s a roast chicken that flies into your mouth of its own accord.”

Tomas van Dijk

The Netherlands is famous for its feats of hydraulic engineering. Do you think that is still justified today?
“It’s true in terms of our history. But if you look at the way water policy is developing at the moment ... (Vrijling sighs). During my valedictory address (23 May, ed.) I talked about the Vice Minister for hydraulic engineering in Vietnam, Prof. Hoc. He wants to build dikes, because he no longer considers evacuations appropriate to the current level of affluence in his country. Before becoming Vice Minister, he was a professor of hydraulic engineering and the rector of a university of technology. When people without a solid background in hydraulic engineering come to visit him, he sees through them immediately. It’s just the opposite with us. Over here we no longer have any engineers at the top. The general thought seems to be that the entire delta programme can operate without engineers. The story in the Netherlands is that we need to work towards multi-layered safety. This implies that dikes are not sufficient. We should also build mounds and organise evacuations in case the dikes fail.”

What’s wrong with a good evacuation plan?
“The plan for multi-layer safety is contrary to the laws of economics. You have to spend your money where you’ll get the greatest bang for your buck. In this regard, prevention - raising and reinforcing the dikes - is the best option. It is relatively inexpensive. A third of our dikes are not in adequate shape. If something were to go wrong, the damage would be immense. A flood would mean an end to the world’s confidence in the Netherlands as an investment country. We saw it happen in 1995. In that year, there was not really a flood. Nevertheless, massive evacuations were conducted (in the provinces of Limburg, Gelderland and Overijssel, ed.) The computer company Compaq Computer, which had located its European distribution system in Tiel, decided to move to Germany as a result. We could also question whether evacuation plans actually work. When you’re in a storm at wind force 13, you’re really in trouble. The forces are enormous.”

In the early 1970s, you were involved in the design and construction of the storm surge barrier in the Oosterschelde (Eastern Scheldt). You have said that not much of any importance has happened in the Netherlands since then.
“The Maeslantkering came after that. But that was about it. When I was writing my valedictory address, I wanted to read my inaugural address again. In that address I also talked about living in an era in which we asked ourselves where we were going to go from there. That gave me a bit of a jolt. When I was in primary school, we were presented with two plans: the Delta Plan and the National Highway Plan. These plans involved the entire nation. We’ve not had such ambitious plans for a long time now. Some economists are saying that we need another great, compelling plan in order to pick us up out of the doldrums again. The construction of wind farms is one of the proposals. But I’m guessing that would not end well, because the farms would require continuous subsidies after they were built.”

Would reinforcing the dikes pull us out of the doldrums?
“Apart from increasing safety, it would create lot of jobs. In another era they created the Amsterdam Forest. This seems more useful to me.”

You speak out against what you call ‘the new hydraulic engineers’– people who do not attach as much value to dikes.
“Yes, those are the people who haven’t studied hydraulic engineering in Delft, but physical geography, biology or agronomy, and who now call themselves hydraulic engineering experts as well. They are all active in nature-related hydraulic engineering projects. A large part of the budget for flood control is being spent on new nature. And this while we aren’t even sure whether what they say is right. Nature lovers are not exempt from the laws of nature. Just consider the ‘Room for the river’ project. If you do the math, you find that both technically and economically it would be more efficient to raise the dikes than it would be to widen the river. Moreover, if the river is widened, it needs to be maintained as well. Wooded areas should be removed in order to prevent local flooding. Some farmers are still doing this, but they may well be gone in 10 years’ time. What will happen then?”

In the magazine De Ingenieur (The Engineer), you mentioned another possible explanation for why hydraulic engineering in the Netherlands has been at a standstill for so long. “Grandpa is dead”, you wrote.
“Grandpa, that was Rijkswaterstaat. In the past, this faculty received background support from Rijswaterstaat, the directorate responsible for public works. We had access to all the designs created by Rijkswaterstaat. The agency provided financial support for the student society known as the Society for Practical Studies. Someone from Rijkswaterstaat served on almost every graduation committee. The collaboration was very accessible and automatic. No one gave it a second thought. The Grandpa analogy is quite apt. Think about it. What was your grandfather doing way back when you were in secondary school? Nothing?! “No, it just looked that way. Grandpa told your mother, ‘You ought to give that lazy fellow a kick in the pants. And if he earns an eight, he’ll get ten bucks from me.” You had someone in the background whose influence on your life did not become apparent to you until later. Rijkswaterstaat has now pulled back. It no longer wishes to have anything to do with technology. The people there are now only concerned with management.” >>

'The people at Rijkswaterstaat are now only concerned with management'

I thought you were referring to the role that 'Grandpa' had played in your own career. You introduced probabilistic design methodology during the construction of the storm surge barrier in the Oosterschelde. In addition to the probability of flooding, this methodology considers the probability that a wide range of other conditions will combine to overwhelm the dike. You had been conducting research on it for three months, and 'Grandpa' embraced the plan.

"At that time, the organisation still had a management that understood the field; they could immediately recognise a 'smart guy' when they saw one." I didn't realise this until later. At the time, I thought, "Of course we're going to do it this way. After all, I've done all the calculations. After the storm surge barrier in the Oosterschelde, we wanted to apply the same approach to the dikes. But that never happened. It was the end of an era, an era of which I was able to experience the very tail end."

"We recently had a visit from the Delta Commissioner. He told us that he wanted to innovate. He knew the right words. He was looking for new ideas. I told him that he could begin to innovate by shifting to this risk approach for the dikes. That was a bridge too far for him. Everyone talks about innovation like it's a roast chicken that flies into your mouth of its own accord. You sit back and 'Bam!' there comes innovation. But that's not how it works. You have to be willing to take risks, as you may be investing in a washout.

"On another note, the Minister has recently said that she does indeed want to switch to probabilistic design methodology for the dikes. Now, 30 years after the Oosterschelde storm surge barrier. At the time I was a recent graduate, and now I'm a professor."

Your departure also marks the end of an era. You are the last engineering professor to have worked on the Delta Works.

"Yes, the loop is broken. The chair has always been staffed by practitioners. We had people who had worked on the Afsluitdijk and then came to give lectures. Then came Professor Van de Velde from the Haringvliet sluices and Professor Glerum, who constructed sunken tunnels. These were people with considerable experience in construction. I wasn't really in quite the same league with my storm surge barrier" (laughing).

They were classic hydraulic engineers in your eyes?

"Right. We're seeing a trend now in which pure science is valued over practical experience. In the past, you could never became a professor if you had no practical experience. You had to have worked at Rijkswaterstaat, an engineering firm or for a contractor. Now the ideal career path consists in: PhD, assistant professorship, associate professorship, full professorship. It would be good if TU Delft had a better mix of professors with theoretical training and those with practical experience. I hope that TU Delft will never become a ski school in which neither the management nor the instructor has ever skied."

You will be succeeded by two professors: Prof. Matthijs Kok and Prof. Bas Jonkman. Two researchers without practical experience. That's less than ideal, right?

"Cook hasn't had his feet in the water much, and Jonkman doesn't have that much experience either. From that perspective, it's not so good."

But you're happy anyway?

"Yes, of course. It's better than not having any successors at all. I was afraid of that at first. Fluid mechanics, soil mechanics, mathematics and probability are of great importance to the chair. My two successors have all of that."

Can you mention a few interesting research projects in hydraulic engineering that we should keep our eyes on?

"The study on multifunctional flood defences. Matthijs Kok has shown that it's possible to make flood defences with parking garages inside." A brief silence follows...

"In my opinion, we didn't really need research for that. These types of studies are often glorified delaying tactics. Policymakers say that they want a multi-purpose dike, but that TU Delft should study it first. If they really wanted it, I could ask two men I know from Royal Haskoning, and then I'd build them their dike tomorrow."

One of the speakers at your valedictory symposium, your former student Suzanne van Kinderen, called you risk-adverse but also risk-seeking. That characterises you. You do not like to risk getting your feet wet, even though you make a lot of noise about things that you do not like. Is this accurate?

"Yes. I'm not an entrepreneur, like Van Kinderen. I'm a professor. There were 600 people at my farewell event, so I still have a lot of friends. Although I may have created some bad blood among the new hydraulic engineers."

Another speaker, Peter Struik, an engineer AND director at Rijkswaterstaat (and also one of your former students) called you a persistent complainer.

"Yes. I do not know exactly what he meant. But if you have a responsible position at Rijkswaterstaat, you're not going to be happy if someone is always reminding you that a third of the dikes are inadequate."

But you don't see yourself as a complainer?

"No." <<

Who is Han Vrijling?

Han Vrijling (65) graduated from TU Delft in 1974 with a degree in civil engineering (concrete structures). In 1980, he completed a degree in economics at Erasmus University. As a young engineering graduate, fresh from TU Delft, he worked on the construction of the storm surge barrier in the Oosterschelde. He introduced the use of probabilistic design methodology into the project. From 1984 until last month, he was Professor of Hydraulic Engineering and Probabilistic Design at TU Delft. During this period (1983 to 2010), he also worked for Rijkswaterstaat. He still does consultancy work for Horvat & Partners.

Column

The *scientivist*

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

The aim of 'Macademics' is to encourage activism in the scientific world. That's the mission statement that could be read on the site of this brand-new Dutch initiative last month. On 22 May they followed through by organising an evening of debate entitled, 'De wetenschapper als activist' ('the scientist as an activist'). In the Netherlands, as elsewhere, 'scientivists' as they are known, are becoming increasingly prominent. Last year, Professor Pim Martens, professor of sustainable development at Maastricht University, put the cat among the pigeons in nrc.next. He believes that scientists should spend more time manning the barricades. I completely disagree.

Clearly, there are many shades of grey between the researcher who works in isolation and avoids the media completely and the colleague who pens his inflammatory opinions in de Volkskrant and who is more often to be found in radio and television studios than at the university, but, in principle, scientists should give activism a wide berth. Science and activism simply do not go together. The whole business of testing, investigating, confirming, and disproving theories is diametrically opposed to the approach of the average activist, who regards objectivity not as a virtue, but an obstacle; doubt doesn't even come into it. There is only one goal, and that justifies the means. For some, even the democratic principles and our rule of law are nothing more than a set of vague agreements that they embrace as soon as it suits them, but who are happy to brush them aside if they do not help their cause. Hard-core activists are selective with their facts, and their method of communication is populist in nature. Anyone who has followed the climate debate in recent years will know the devastating effect that scientists-on-the-barricades can have, not least on people's trust in science.

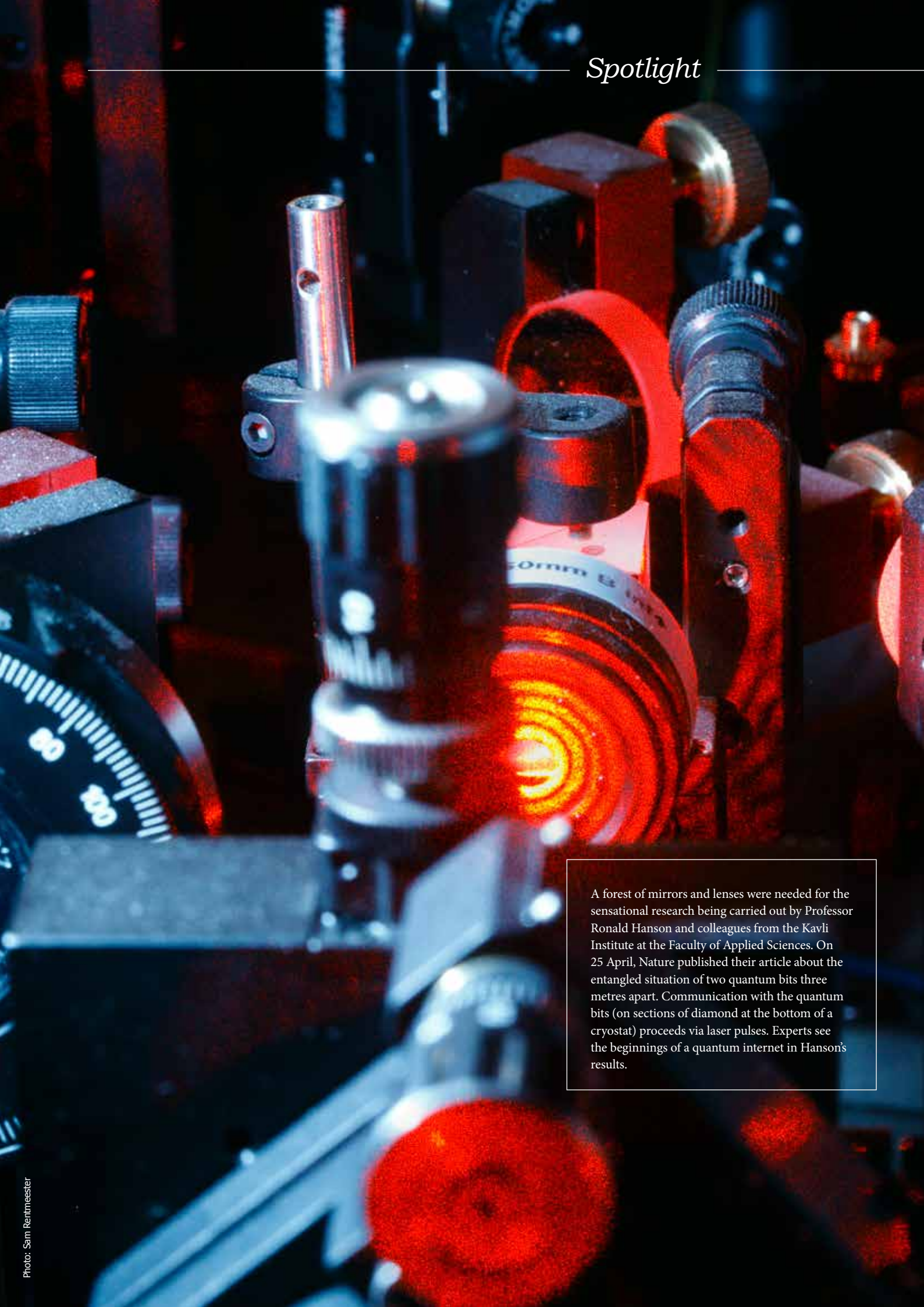
Photo: Sam Rentmeester

Nonetheless, Professor Jan Rotmans, professor of Transitions and Transitions Management at Erasmus University, is more than convinced of the need for activism among scientists. The self-proclaimed 'dissenter who prefers to take a fresh look' preaches revolution in a large number of fields. Like other scientivists, he uses - or misuses if you like – the fact that, as a rule, the general public associate science with objectivity. It is not without good reason that scientists, and especially professors, are eagerly sought out by the media. Ultimately, the scientivist is using his status as a scientist to lend greater weight to his views in the public debate than to that of others; in the long run, he is therefore undermining his own position. Macademics fortunately came to that conclusion after the first debate: the organisation has now removed all references to activism from its banner. Now for the *scientivists*.

Under Construction

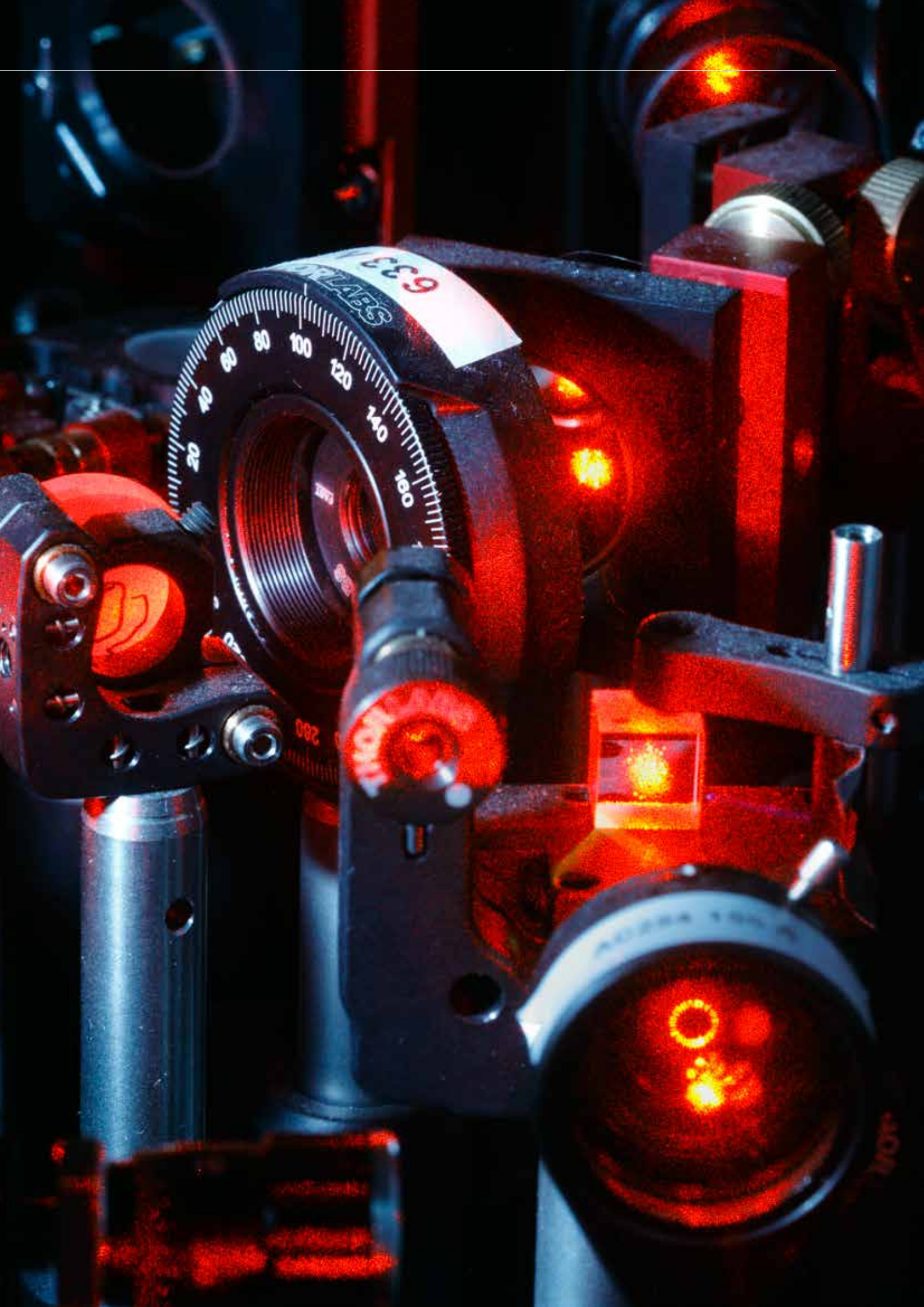
Photo: Sam Rentmeester

In Flood Proof Holland, an experimental site for innovative temporary flood defences, businesses, public-sector organisations and knowledge institutions can test and demonstrate innovative measures to prevent and combat flooding. The new methods are intended to provide an alternative to the good old sandbag. At the site, work is currently underway on three different flood defences: the Green Soil Bag, the Box Barrier and the Water-Gate (pictured), which proved in tests to be more effective in holding back water than the sandbag.



A forest of mirrors and lenses were needed for the sensational research being carried out by Professor Ronald Hanson and colleagues from the Kavli Institute at the Faculty of Applied Sciences. On 25 April, Nature published their article about the entangled situation of two quantum bits three metres apart. Communication with the quantum bits (on sections of diamond at the bottom of a cryostat) proceeds via laser pulses. Experts see the beginnings of a quantum internet in Hanson's results.

Photo: Sam Rentmeester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Dismantle or refurbish

The Museum of Mineralogy and Geology on Mijnbouwstraat celebrated its centenary last year. This spring, the Executive Board made it known that the room would need to be vacated. Everyone agrees that something has to be done.

Jos Wassink

In here, a sense of timeless peace prevails. To the left and right are the rows of display cases flanking long, high-windowed walls. Small cardboard labels indicate which minerals and ores are on display. Silver, gold, mercury, iron and copper metal ores, collected from Bolivia, Siberia, Ontario, Chile and Kongsberg.
The professor of mining engineering, Professor Vogelsang, laid the foundations of the collection in 1864. He was amazed that no such collection already existed. A mining engineering programme without a collection? How would students learn how to identify minerals?
Students, staff and alumni collected minerals, ores and rocks from all over the world. In the collection's heyday, mining engineers would sometimes send entire crates of stones from Africa or Asia to the museum. In a history spanning almost 150 years, the collection of the Museum of Mineralogy and Geology has grown to include 150,000 pieces. "It is a systematic collection," answers Professor Stefan Luthi (Civil Engineering and Geosciences, CEG), when asked about the collection's value. "There are complete classes of minerals: evaporites, halites, sulphites, and so on. Minerals are like species in biology. You have different chemical compounds, and within these, there are further differences in crystalline structure. A systematic collection must therefore have every mineral that exists. This collection is unique in the Netherlands."
To this day, the mineralogical collection has played an important role in the education of students of mining engineering (now Applied Earth Sciences). Prior to examinations, students would visit the collection and stand with their noses pressed to the somewhat dusty display cases, searching for similarities and differences.

Vacating the premises

On 11 March, the rector and professor Karel Luyben announced the end of the museum on Mijnbouwstraat. In a discussion with manager Stefan Luthi and CEG dean Professor Bert Geerken, Luyben explained that the room would need to be vacated, as it would be used for other purposes.
Luyben has little time for the argument that the museum's collection is unique in the Netherlands. He has visited all of the places that currently house the collection: the museum and the basement on Mijnbouwstraat, the CEG basement and the glass main building of Applied Earth Sciences. He was not pleased by what he saw: "With the exception of the museum itself, the collection is in a poor state. It looks untidy, neglected and dusty." The rector was also disappointed by his visit to the museum. Retrieving the log for the electronic lock revealed that hardly anyone had been to the museum last year. In response to this, Luthi points out that for the last six years, there have been no employees to look after the collection properly.
After making his findings, Luyben tasked Luthi and the curator, Maaike van Tooren, with clearing out the collection. The collection's top pieces – estimated at around five per cent of the total, including the Triceratops skull and the dodo skeleton – should be kept for small exhibitions. An educational collection that the students can work with should also remain. The main part of the collection, however, could be transferred to Naturalis, the museum of natural history in Leiden, which functions as a national archive in this area.

'Delft has one of the last large university collections'

Van Tooren undertakes the daily management of the museum.

Dismantling the collection

"Delft has one of the last large university collections," says Dr. Leo Kriegsman, head of geology at Naturalis. He is involved in the discussions between TU Delft and Naturalis about the transfer of the collection. Naturalis has already taken over scientific collections from TU Delft, including fossils from Timor, along with the geological collection from the University of Amsterdam and parts of collections from VU University Amsterdam

Photos: Hans Stakelbeek

The collection of the Museum of Mineralogy and Geology has grown to include 150,000 pieces.

and the former Netherlands Institute of Applied Geoscience. "The end is in sight for the institutional collections," Kriegsman acknowledges. "Aside from Delft, only Utrecht University and TNO in Zeist still have a large geological collection."

A protocol has been drawn up for the dismantling of institutional collections. It determines that Naturalis, on behalf of the state, must be approached first so as to safeguard the conservation of national heritage. "It is important that the systematic collection is transferred in its entirety," says Geerken, who was previously the director of Naturalis. He also wants an agreement on users' rights, so that after a possible transfer of the collection, exhibitions can still be organised in Delft.

Dying a slow death

"It went wrong when mining engineering moved to the new civil engineering building in 2007," according to Maaike van Tooren. In addition to giving her lectures, Van Tooren undertakes the daily management of the museum. Before the move, the whole mining engineering programme had been based in the same building, and students had spent a lot of time visiting and using the collection. The distance from the other building has proved too great, and the collection can only be visited on appointment.

Couldn't the Science Centre open the room to visits and students? The question elicits a sigh from Van Tooren – and also from Professor Jacob Fokkema, in fact. During his time as a rector with a background in geophysics, Fokkema was involved in setting up the Science Centre. Even then, attempts were already being made to link the collection of stones to the Science Centre. Every time, though, the plans foundered on the issue of money.

And that is still the case. The director of the Science Centre, Michael van der Meer, acknowledges that while the CEG faculty might talk up the great value of the collection, it "doesn't have a penny to spare for it". Van der Meer wants to have the room refurbished and kitted out for holding conferences, receptions and presentations. As far as he is concerned, the collection can be moved to the second floor or otherwise transferred to Naturalis.

In Duco Drenth's opinion, "We can't allow money to be a problem." Drenth is an alumnus of TU Delft and chair of the KiviNiria engineering society's mining engineering department. When he read about the impending dismantlement in Geo.brief magazine, he immediately contacted the Executive Board. "What about sponsorship?" Drenth is thinking of oil and gas companies with substantial budgets and a strong connection with what goes on under the ground. In a proposal to the EB, Drenth set out his plans to revive the geological exhibition with computers and projections to bring the exposition more into line with the Science Centre. It should become an educational centre for school pupils and the public, where they could learn more about the ground under our feet, with reference to topical issues. "If you could create an exhibition that was able to quell the unease about shale gas, gas-related earthquakes or CO_2 storage, I think the NEB would be keen to participate. It wouldn't be scared off by one or two million euros."

Luthi has also submitted a plan; he suggested to the EB that the museum be organised in such a way that parties could be held in the proximity of the display cases. "They also do that at the Natural History Museum in London, for example. What could be nicer than having dinner with a Triceratops behind you?"

Salomon's verdict

"Closing it down is hardly a creative solution," says Professor Salomon Kroonenberg, who was responsible for the collection from 1996 until his retirement in 2009. "We were really proud of this collection, and we still are. And you can't just get rid of that room; it's Delft's Teylers Museum. The room can be given a combination of functions."

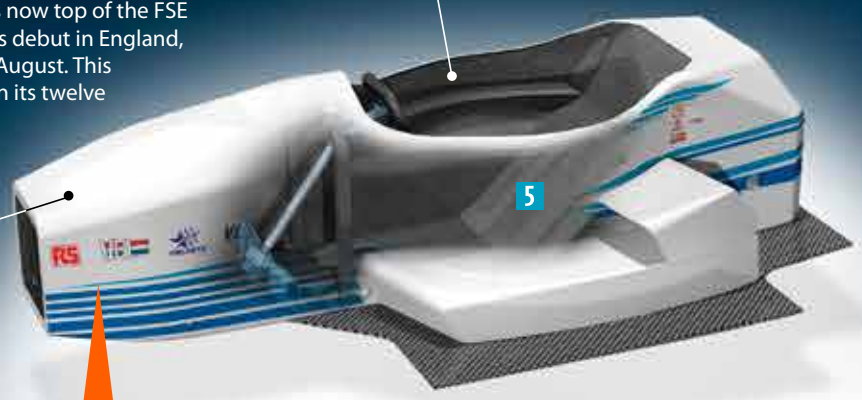
Kroonenberg backs the plans put forward by his successor, Luthi: "You leave the top pieces where they are and you also use it as a reception space, without undermining its function as a museum. The EB is responsible for more than financial and organisational management – it must also be a proud champion of Delft's cultural heritage." And the money? "Yesterday I was at the KNGMG (the Dutch Earth Sciences Society, ed.). There, all of the Delft alumni were in favour of seeking sponsorship. Call it the Shell, NAM or BP room, for all I care; but if you get rid of it, you'll never get it back."

<<

Build you own racing car

This year, the DUT Racing Team is building a racing car for the thirteenth time that will take part in the Formula Student Electric (FSE). There is a great deal at stake. In 2012, the team from Delft won the official World Championships in Germany, and finished in second place on the Silverstone F1 circuit in the UK. As a result, TU Delft is now top of the FSE world rankings. The Delft racing car will be making its debut in England, followed by appearances in Germany and Austria in August. This infographic shows why the DUT13 is even better than its twelve predecessors.

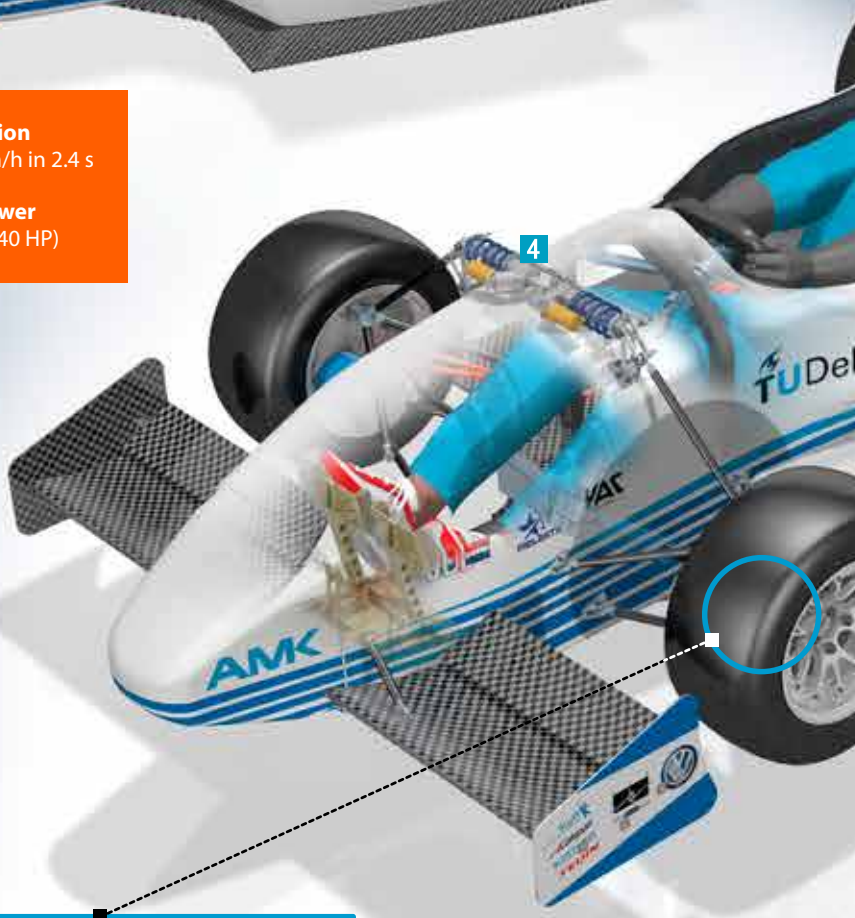
Monocoque
14.5 kg



Chassis
The car's chassis is a self-supporting construction (monocoque), made up of a 2.5-cm thick foam core covered with carbon fibres. The mono¬coque is attached to the base plate and laminated. The wings and the base plate are made from special TeXtreme fibres, into which the resin has already been impregnated. This means that it is better distributed in the fibres, as a result of which less resin is needed.

Acceleration
0 - 100 km/h in 2.4 s

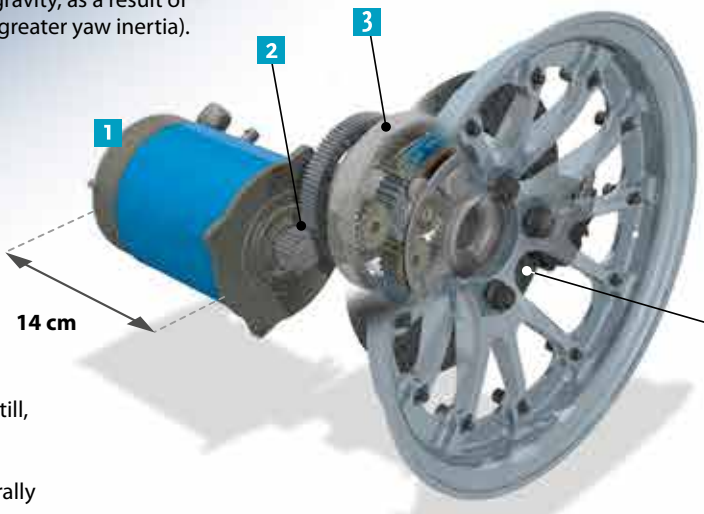
Motor power
102 kW (140 HP)



Four-wheel drive and skid regulator

The friction (and therefore the propulsive power) between the tyre and the road is at its maximum at 15% skid (at 100% skid, a wheel rotates twice as quickly as it does when rolling perfectly). A computer – the skid-ratio controller – regulates the number of revolutions of the wheels so that each tyre generates the maximum propulsive power by making optimal use of skid. The yaw rate controller (yaw rate is the velocity at which the car rotates around its vertical axis) ensures that the forces are distributed over the four wheels in such a way that the car is able to take bends as tightly as possible at the highest possible speed (by enabling the outer wheels to rotate more quickly).
Four-wheel drive is needed to be able to control the forces on the wheels accurately. Last year, the DUT12 was the first Delft racing car to have four-wheel drive.

Motors 4 x 26 kW 1
Each wheel is propelled by its own electric motor. The advantage of this is that no axes or gears are needed between a central motor and the rear wheels, but the disadvantage is that the heavy motors are located a long way from the car's centre of gravity, as a result of which the car is less agile (it has a greater yaw inertia).



Transmission
The gear box has to fit into the small wheel rim. Two-gear transmission provides the correct transmission (the engine turns fourteen times faster than the wheel) with the help of a standard cog set (1:4) 2 and a planetary system (1:3.5). The large ring wheel 3 remains still, and the four planet wheels are connected to the rim.
The engine is not positioned centrally on the wheel, which allows more space for the steering rod.

4
Spring damper system
The spring damper system should preferably be low, in order for there to be a low centre of gravity. As there was not enough room near the front wheel suspension, the system has been placed on the monocoque.

Composite brake discs
The aluminium composite brake discs combine high heat capacity with a high level of strength. They are twice as light as the old steel brake discs.

Driver
Every driver gets his own carbon seat 5, made according to his personal dimensions: he sits in a foam sack, while a two-component resin hardens.

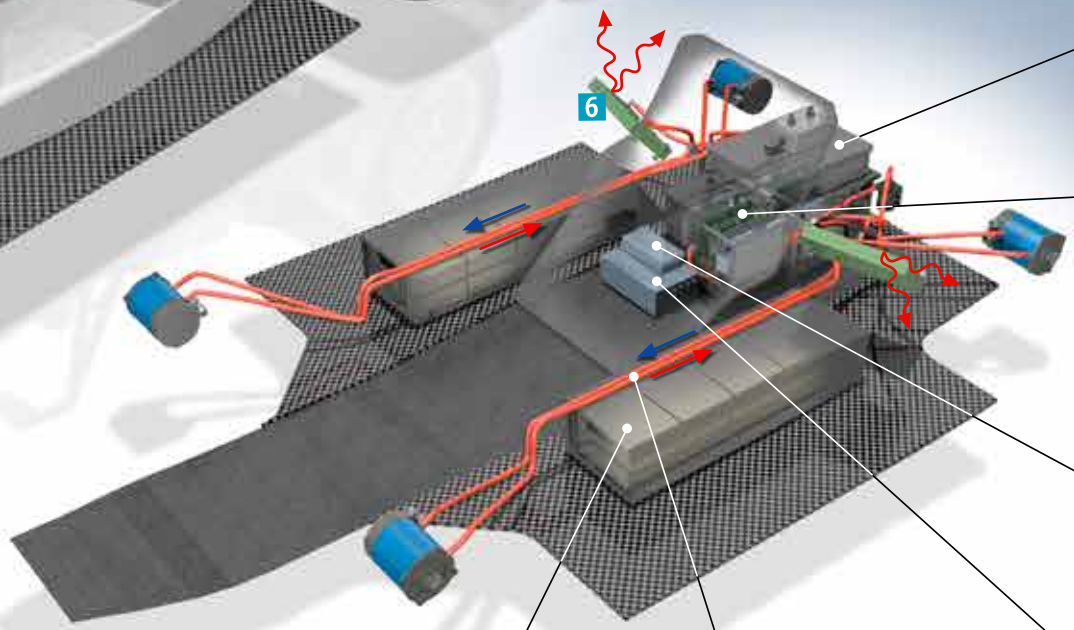
Wings
This year, the car has two front wings and a rear wing that are supposed to generate a negative lift of 500 N at a speed of 60 km/h. This downforce pushes onto the car, allowing it greater acceleration on bends. A drawback here is that other parts (chassis, rims) have to be made stronger, so the car is 25 kg heavier than without wings. Practical tests should show whether the downforce really is generated. The wings will undoubtedly result in greater air resistance.

Design philosophy
The FSE is not about racing at top speed. In order to win, the car has to be able to handle bends well, and more especially accelerate on the short stretches between the bends. Acceleration is determined by the non-constant friction coefficient, which decreases the more the tyre pushes down onto the road. For maximum acceleration, the mass of the car should therefore be as low as possible. The weight distribution across the tyres should also be equal. Finally, the car's centre of gravity should be as low as possible. If it is high, the car will tilt, so that the outer tyres will bear a heavier load. This will reduce their maximum grip, and the car will fly off the bend.

Wheelbase
(axis-axis)
153 cm

Mass
173 kg

Regenerative breaking
When the driver brakes, the motors work like alternator so that some of the braking energy is stored in the batteries. Four-wheel drive is more suitable for this than is two-wheel drive, because it is the front wheels that bear the heaviest load during braking – and these wheels do not have motors if two-wheel drive is used. As a result, the batteries can be smaller than those used last year. The batteries are designed to store at least 25% of the braking energy used.



Split box
The split box splits up the power from the battery to the motor controllers.

Motor controllers
The high voltage from the battery cannot be fed directly to the motors. Four motor controllers convert the high-voltage direct current from the batteries to low-voltage alternating current for the motors.

Low voltage battery
This battery provides power to the computer, the motor controllers, and the water pump, among other things.

ECU
The electronic control unit processes all the sensor data, and determines the power that goes to each wheel.

Battery packs
High voltage means low current, and therefore little heat loss. Batteries for electric cars, for example, supply 600 V, but are large and heavy because they have to store a lot of energy. The longest FSE race lasts just thirty minutes. A battery in radio-controlled cars, for example, has the capacity to store large amounts of energy and has a low weight, but supplies just 3.7 volts. For the racing car, 288 separate lithium polymer battery cells are bundled in series (so that the voltages, together, add up) in two battery packs (each of eight modules with eighteen cells). The heavy battery packs, weighing 23 kg each, are positioned as low as possible on the base plate on either side of the driver, as close as possible to the centre of gravity.

Cooling
The air-cooled electric motors are normally used in factories to supply power of 3 kW. As a great deal of heat is generated during the race application (of 26 kW), each motor is fitted with an aluminium cover with cooling channels. The cooling water flows through the motors via tubes to two radiators 6 on the sides of the car. The water cooling ensures that the internal temperatures remain below 150°C.

Studying online

The internet abounds with academic courses – free of charge, and available to all. Universities are re-examining their role.

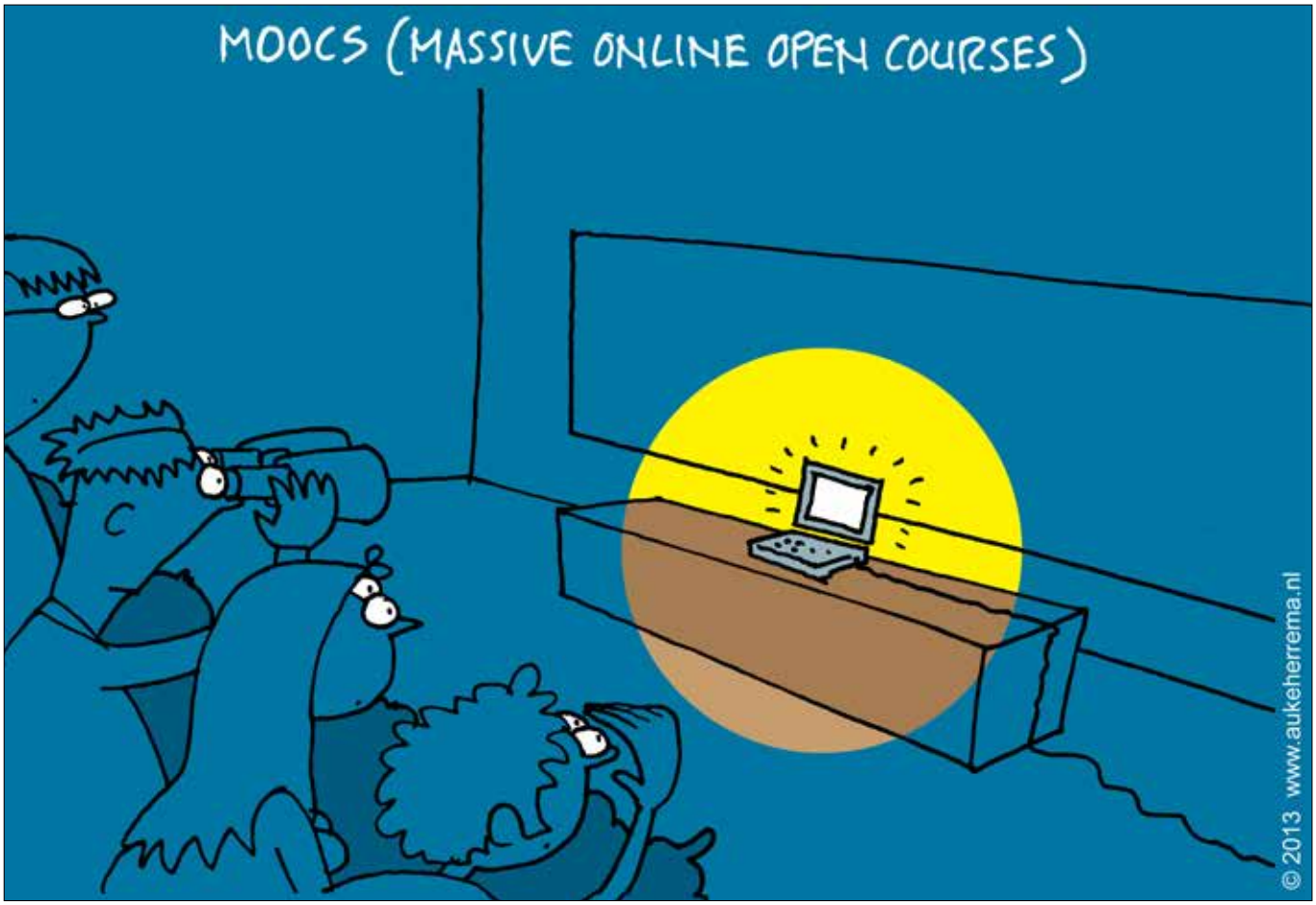
Desiree Hoving

In 2002, the Massachusetts Institute of Technology (MIT) started to share course materials with the rest of the world via the internet (ocw.mit.edu). Since then, universities all over the world have been making course content available online free of charge, on iTunes U and Wikiwijs, for example. TU Delft started the process in 2007 and has now made more than one hundred courses available (ocw.tudelft.nl). In principle, every English-speaker anywhere in the world can take the courses in their own time.

There is now a new trend - MOOCs (massive online open courses). The main difference with the other type of free course content is that people have to register and that the courses start on a particular day. Every week, people watch a series of short video lectures of no more than ten minutes' duration, and answer a few multiple-choice questions. They then hold discussions with fellow students using a forum, before taking their final exams after around eight weeks.

One such course in artificial intelligence started at Stanford University in September 2011, and attracted no fewer than 160,000 enrolments from 190 countries. A total of 23,000 reached the finishing line. This represented the definitive breakthrough for MOOCs.

In September, TU Delft will be offering two MOOCs, with another two being launched in the spring of 2014. After the summer, it will also be possible to take Civil Engineering's entire Master's track in water management online (though not as a MOOC), while TPM and AE students can complete part of their Master's online. However, students will still need to pay the regular tuition fees for these Master's programmes.



Replacing conventional teaching

What influence is this flood of internet teaching having on universities? "The most important question to me is the extent to which online education is going to replace conventional education", says Willem van Valkenburg. He is the open courseware project manager and is in charge of almost everything to do with internet teaching at TU Delft. He carefully formulates an answer to his own question: "Due to the rise in online teaching, it is plausible that universities will attract fewer students. This puts the universities' business model under pressure – after all, it is based on the number of students who are enrolled with them. Nonetheless, students will not be able to manage without universities for the time being, because they are the only bodies entitled to award diplomas. I can imagine that someone who has taken different MOOCs will want to receive their diploma from the university with the best reputation."

Paradoxically, Van Valkenburg thinks that a university's reputation can actually be enhanced by offering more online teaching. Global competition also applies to the best academics and PhDs. This is why TU Delft has decided to set up its MOOCs only for subjects that it excels in, such as water management and aerospace engineering. It is all part of the battle to get the best students and researchers.

Standing out

However, the MOOCs business model does appear to be flawed. Why do universities spend money on creating online lessons which they then put onto the internet, while at the same time running the risk of attracting fewer students? If every university were to offer a MOOC, then no-one would stand out any more. Van Valkenburg does not think it will happen that way: he does not believe there is a market for so many MOOCs, because people will prefer to follow one given by a leading university. Research consultants Gallup have also confirmed that not every university is going to offer MOOCs. In May, they used the Inside Higher Ed news site to publish the fact that most American chairmen of executive boards did not see any added value in MOOCs. Just three per cent thought it would help students to learn more effectively, while two per cent were of the opinion that they would resolve universities' financial problems.

Internet teaching also begs the question of what the role of the university actually is. Lecture rooms would appear to be superfluous if students are able to follow complete modules using their own laptops, tablets, or Smartphones. Teachers would seem to be out-competing each other if students prefer to follow lectures by top-level professors on the other side of the world. What's more, everything is online anyway, so why should teachers bother teaching classes in person the following year?

At the Faculty of Civil Engineering and Geosciences, the mood is unequivocally positive. "Online is not a substitute but a complement", declares Anke Grefte, who coordinates the water management online Master's, and who is also taking a MOOC. "To be honest, I think things are actually going to get a lot busier for teachers, because the online and offline Master's run in parallel. Both the greater student numbers and the more individual approach are upping the pressure."

Associate professor Mark Bakker also sees only benefits. "This year my subject, geohydrology 1, has been included for the first time. It is one of the 25 subjects for the online Master's. To be honest, it surprised me that students were pleased about the fact. They use it when they've missed a class due to illness, for example, or when preparing for their exams". Nor is Bakker afraid that he will become surplus to requirements now that his subject is available online. "I have colleagues in America who refuse to repeat what they have to say all over again. To their students, they say: first watch my lecture from last year, then we will have something to discuss in class". The teacher is actually convinced that more and more often students are specifically choosing those subjects that are provided both offline and online. "It is only the lessons of the old stick-in-the-muds who refuse to record their lectures which are emptying out".

'It is only the lessons of the old stick-in-the-muds who refuse to record their lectures which are emptying out'

Attractive presentation

But does online teaching really help to prevent those dry-as-dust lectures? After all, an uninteresting lesson does not become more interesting just because you can follow it online. Teaching advisor Linda Mebus helps teachers to make their lessons interesting. This requires a skilled and experienced teacher – someone who is at home with all the digital tools for communicating with students. They then have to present a subject in a visually engaging manner. This applies both to the online Master's, for which every lecture has been recorded or replaced by specially recorded short web lectures, and to the MOOCs, for which special films have been made lasting ten minutes.

"I look at how we can incorporate interaction, and how we can prompt students to ask questions online. After all, you cannot simply copy knowledge from the teacher to the student", says Mebus. The business of asking the teacher questions will be easier in the case of the online Master's, with their smaller numbers of students, than is the case with the MOOCs. "I do not want to receive questions from 50,000 people", says Bakker. In other words, in the case of MOOCs nobody receives personal supervision from the lecturer. Instead, the students help each other on discussion forums specially set up for the MOOC.

Recognised diploma

To return briefly to the question of to what extent online teaching is going to replace conventional teaching: this also depends on the value that is going to be attached to free online courses. If commercial American providers of MOOCs are serious about competing with universities, students will have to be able to obtain recognised diplomas for them in order to get a job. They are already working on this. In September 2012, for example, edX, the open source platform on which TU Delft is going to offer its MOOCs, announced that it was forming a working partnership with Pearson, a world leader in the administration of computer exams. As a result, edX students now have the possibility of taking an exam at one of 450 test centres in more than 110 countries. Our students would like to be able to show their future employers an independently validated certificate, argues Anant Agarwal, the chairman of edX, in a press release . An exam of this kind costs less than one hundred dollars, much less than the year's tuition fees that you have to pay a university, even if you only want to take one subject. This means universities definitely need to continue to reflect on their role in the coming period. <<

Propositions

The most important purpose of evaluation is not to prove, but to improve.
Davide Masutti, aerospace engineer

When in China someone is seen to obey a red traffic light, the person is likely to have studied abroad.
Shangyang Li, hydrologist

Plurilingualism is imperative for a peaceful multicultural society.
Mireia Alos Palop, physics engineer

Kids change our priorities, not our aspirations.
Dominika Malgorzata Krzeminska, hydrologist

If one wants to learn what 'Calvinism' means, (s)he should have a regular lunch in Holland.
Olgu Çalişkan, urban planning engineer

Contrary to what users expect, software updates usually result in devolution, not evolution.
Mahmut Nezih Yiğitbaşi, computer science engineer

Aesthetics and a designer's ego stand in the way of a sustainable society.
Bas Hasselaar, architect

Proposition

In a world without bad luck, researchers would be as dead as a dodo.
Jojanneke Dirksen, civil engineer in information technology

Defence

The liability culture has well and truly taken hold, representing a real threat to science. We have all seen the warning on cups 'caution: contents can be hot' and labels informing you not to put your cat in the microwave. For scientists and academics, this may seem to be something that doesn't really affect them. But in fact it does. There seems to be an increasing refusal to accept that such a thing as simple bad luck exists. After the earthquake in L'Aquila in Italy in 2009, scientists were condemned for failing to predict it. If even natural phenomena can no longer be categorised as bad luck, any information that you collect is by definition dangerous because it could be used against you. You'd be better off pretending to be stupid.

Soundbites

"I have my heart set on a medal for fifty years' membership. I believe in 'the voice' : in being heard. I am threatening to announce that I will stay."
Emeritus Professor in Public Housing and Dutch Labour Party member Hugo Priemus in the Financieele Dagblad newspaper on the departure of Jan Pronk.

"The pitch will be lowered by four meters, as a result of which the flat seating areas will become steeper. We need to go deeper into the ground. The stadium will be more impressive and higher and logistically more practical, because people will go up and down to find a seat."
Hennes de Ridder, Emeritus Professor in Civil Business Studies in AD newspaper on an alternative for a new Feyenoord stadium.

"There is an analogy with 2D printing. When the colour printer emerged in the 1990s, it gave a boost to desktop publishing software. Suddenly, everyone could publish anything themselves. But how often do you use your colour printer now?"
Assistant Professor in Industrial Design Engineering ir. Jouke Verlinden on 3D printers in De Volkskrant newspaper.

"Hydrogen is really starting to take off. Although the infrastructure is still limited, there are plans to expand it. Hydrogen production is also still expensive, but when that is dealt with, hydrogen will be massive."
Frank Rijks, team leader of the hydrogen car Eco-Runner, in De Telegraaf newspaper.

The chances of a female car driver to die in a crash with another car driven by a man is twice the chance of a male driver to die, as women drive lighter cars than men on average.

Henk Stipdonk, traffic engineer

The View

Positive design

Experience-based design is the future, believes Professor Pieter Desmet (IDE): "how you make something that has a positive effect on the user."

"Design is a problem-solving field – you identify a problem and conceive a solution to it. That solution solves one problem, but then creates new ones. That is how it works with technology. You then solve the next set of problems, and so on. I would like to see us look more holistically at the effect of design on people and communities, so that we think less in terms of isolated problems, but more in terms of the overall effects on users, their surroundings, and their well-being.
"It is clear from the field of experience-based design that design is already becoming more holistic. Fifteen years ago, little was known about the subjective perceptions of product users, but nowadays design-for-experience designers are providing concrete ways to take that subjective perception into account. An example is that of

'Is a design good for you, as a person?'

a wheelchair for children. Such a chair is designed to solve a child's mobility problem, but it also affects the perception and self-image of that child. The wheelchair designed by ir. Eva Dijkhuis not only makes the child mobile in a way that is safe and useful, but also in a way that reaffirms the child's identity. For me, this is a good example of experience-based design.
"A next step is to enable users to get the best out of themselves. That is more abstract. Everyone has potential and we live in a designed world. That determines who you could be, to yourself and to others. Regardless of whether it feels good or not, this touches on the question of whether a design is good for you as a person. I would like designers to be able think about what they are doing on that level and to use that as a basis from which to shape the totality of ingredients into something that contributes to someone's well-being. That will require a transformation on the part of design, but also on the part of the private sector, which has so far not seen a feasible business model in this.
"In the relationship between design and user, experience-based design is the successor to ergonomics and usability. Ergonomics is a field of knowledge that arose from requirements to ensure that a product was safe to use in a mental and physical sense. The design must not harm the user. This was followed by usability, for devices with many knobs and switches. Designers had to ensure that they did not confuse people. Together, these two knowledge fields ensure that products have no negative effects on users.
Design for experience has taken the next step: how do you make something that has a positive effect on the user? For me, and the Delft Institute of Positive Design, that is what experience-based design is all about. (JW)

The inaugural address of Positive Design can be seen at
bit.ly/113BA6C
www.io.tudelft.nl/positivedesignday

Photo: Sam Rentmeester

Since you asked

Autism

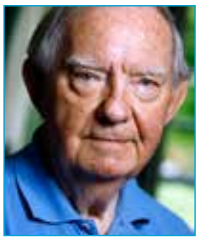
New Scientist wonders if we are on the cusp of an autistic revolution. It reports that German software company SAP is seeking people with an autism spectrum disorder to test software. TU psychologist Paula Meesters is pleased to hear it.

We are seeing the rise of autism, says Ari Ne'eman, president of the Autistic Self-Advocacy Network in Washington, in the article. According to Ne'eman, the reservations companies typically had regarding people with an autism spectrum disorder are making way for recognition of their special talents.
Paula Meesters, student psychologist at TU Delft, calls it a "fantastic initiative" by SAP. "Close supervision is required," she went on to say. "But acclimated, they make terrific employees: reliable, honest and not easily distracted."
Today, autism is considered a "spectrum disorder" that can vary in terms of severity. Most of the people Meesters sees are very gifted and have a relatively mild disability.
"They digest information differently than others," says Meesters. Some may be hypersensitive to light or sound, for example, accompanied by insensitivity to cold.
Social information, too, is processed differently. They may take figures of speech literally ("pass the buck") or have difficulty discerning and expressing emotions in others and themselves. Conversely, they have highly developed systematic and analytical thinking skills and an eye for detail, which is exactly what software testing requires.
Autistic students also perform exceptionally well on math-heavy projects related to electronic engineering, physics and civil engineering.
On average, one percent of the population registers on the autism spectrum. Given the nature of TU programmes, this figure could well be higher amongst the TU student population, although this has never been researched.
Stress-related problems are often what bring them to the psychologist, often caused by misunderstandings with others or trouble with finishing a project. This stress can lead to depression or anxiety, which prompts the students to seek help.

'Autism is no longer a taboo subject'

Companies that hire such individuals must make special provisions, which are not one size fits all (a dark room versus a silent room, for example). They also need to appoint someone with a straightforward and direct style of communication to serve as a contact person.
Monique Draijer at the TU Career Centre is pleased that autism is no longer a taboo subject, thanks in part to a successful Shell employee speaking up about his autistic spectrum disorder and how he copes.
The Career Centre offers special job interview courses for students with autism. This is a combined effort with Onbegrensd Talent, an organisation that strives to match Dutch companies and talented people with autism. (JW)

Ultimately, it will be up to the public to decide who wins the Technology Foundation STW's Simon Steven prize. Ir. **Joost van der Neut** (TU Delft) will be competing against Nienke Bosschaart (AMC) and Bram Verhaagen (UTwente)in Nieuwegein on 3 October. Van der Neut has improved a method for tracing hidden oil reservoirs using virtual sound sources.



Buildings can be air-conditioned using entirely natural means, without mechanical ventilation systems. This is according to **Benjamin Bronsema** (78), who was awarded his PhD on this subject on 7 June. He wants to create an energy-positive office environment using the sun, the wind and cascading water. Bronsema is now looking for a building in which to carry out a large-scale trial of his Earth, Wind & Fire concept.

The two dike experts Prof. **Matthijs Kok** (left) and Prof. **Bas Jonkman** will succeed Professor in Probabilistic Design and Hydraulic Structures Han Vrijling, who retired in May (see interview page 10).

The Executive Board has appointed Dr **Paul Breedveld** as Antoni van Leeuwenhoek Professor in the Faculty of Mechanical, Maritime and Materials Engineering (3mE). Breedveld develops flexible instruments for keyhole surgery. In 2004, he patented a spring system using cables, developed after observing octopuses.

The University now has a set of complaint regulations on academic integrity. The confidential counsellor responsible for it will be Professor of Industrial Microbiology, Prof. **Jack Pronk** (Applied Sciences). Staff and students should contact him if they suspect breaches of academic integrity at TU Delft.

An old acquaintance is set to return to TU Delft: ir. **Jeroen van der Veer** has been appointed by minister Jet Bussemaker as Chairman of the Supervisory Board with effect from 1 July and he succeeds Gert Jan Kramer. Van der Veer studied Mechanical Engineering at TU Delft and Economics at Erasmus University Rotterdam. Until 2009, he was the boss at Shell.

Still in the early stages of his career is ir. **Marcel Klomp** from Rotterdam engineering consultancy IMd: he graduated at TU Delft on 24 May, with work on a mobile stadium for major sports events. Permanent stadia almost always make heavy losses. If the mobile stadium is used eight times during its lifespan of 30 years, the cost to the hirer will be only 22% of that of a permanent stadium, calculated Klomp.

The multi award-winning professor in environmental biotechnology Prof. **Mark van Loosdrecht** has won yet another prize: he is the Simon Stevin Master 2013. Van Loosdrecht was awarded the prize – 500,000 euro to spend on research - at the annual congress of Technology Foundation STW on 3 October.

The Netherlands Organisation for Scientific Research (NWO) has awarded Vidi grants to eight TU Delft scientists. The NWO grant offers them the possibility of developing their own line of research and building their own research group. Each scientist receives a grant for a maximum of 800,000 euros.

Dr. **Rienk Eelkema** (Department of Chemical Engineering) is going to make smart, structured and reactive materials, by using (switchable) catalysts to direct the dynamics of their molecular building blocks.

Jorge Gascon (Catalysis Engineering) will develop a new generation of synthetic catalysts able to directly transform methane gas into liquid methanol. **Jeroen Kalkman** (Delft Center for Systems and Control) is building a new type of optical microscope that can produce high-resolution three-dimensional images of the structure and function of the zebrafish. **Lucia Nicola** (Virtual Materials and Mechanics) researches friction. Friction costs millions of euros in wasted energy. For example, no less than one-third of a car's fuel consumption is used in overcoming friction.

Alessandra Palmigiano (Technology, Policy and Management) researches multi-agent phenomena, a crucial challenge in all fields of science. **Riccardo Riva** (Geoscience and Remote Sensing/ Climate Institute) researches sea-level rises. **Brian Tighe** (Process & Energy Department) uses computer simulations to understand jamming and unjamming in flows. **Andy Zaidman** (Software Engineering) develops techniques for making optimum use of implicit knowledge about software errors.

After Delft

Name: Sieger Burger
Residence: Utrecht (temporary)
Civil status: unmarried
Job: none (sabbatical)
Salary: none

Thirty-three year old Sieger Burgers spent the past two years in a remote corner of Afghanistan, working for the international aid organisation Medair. There the civil engineer using low-tech solutions to battle the drought.

"Here in the Netherlands, I can go outside just like that." Since his return from Afghanistan in April, the most normal things seem strange to Sieger Burger. Even though he could be taken for a local with his beard and Afghan clothing, during the months he spent in the capital he was only able to leave the secure gates of his compound after the necessary preparations. It was generally during the harsh winters that Burger was in Kabul – during the rest of the year, he was in the isolated and safer Bamiyan province. This far-flung corner of the country, forgotten even by the Taliban, is afflicted by drought, which is exacerbated by overgrazing and deforestation. "Flooding, drought and vegetation are closely related", explains Burger. "Vegetation cover is receding. When it rains, this soon leads to floods, which is then followed by drought, because the water isn't retained by the soil."
One of the things Burger did was build contour trenches and small dams

'They have to be able to manage it themselves once we have left'

that were designed to retain and slow down the movement of the water. "I tried to teach the local population about these low-tech solutions. It was not easy, because they lack basic knowledge, but they have to be able to work with it themselves once we have left."
Burger graduated in integrated water management in 2005. The main thing his time in Delft gave him was his analytic capacity, he says. After his studies, Burger started work at construction company Heijmans, where he was involved with urban water management. Eventually, he was given final responsibility for the water design of the major road-widening projects at different locations on the A2, A7, and A50 motorways. "Very enjoyable, because each situation was different. Water affects the soil, the crash barriers, lamp-posts, the asphalt."
After spending five years at Heijmans, Burger wanted to try something new. The idea of working abroad had always appealed to him, and then he saw the vacancy at Medair. He had already spent time away during his internship and for his graduation project, in Kenya and Iran respectively. In Kenya, he worked on solutions to the drought conditions in the Sahel, while in Iran he was involved in work on a model designed to forecast flooding patterns of the Helmand River.
Burger very much enjoys the variety of switching between working in the private sector and the aid sector. "I am pleased to have worked at Heijmans for five years, but after that it was good to be able to use my knowledge for some less fortunate people." His next job will probably be in the Netherlands, but since his return from Afghanistan, Burger has planned a four-month sabbatical for himself, just to give himself a chance to recover from what were two very demanding years. (SB)


Photo: Sieger Burger

The Firm

Flexible mould


Photo: Sam Rentmeester

He calls it the holy grail of blobland. Architectural engineer Dr Karel Vollers is working on an adjustable mould that you can use to make double-folded panels of glass, concrete, and plastic.

The Kunsthaus in Graz in Austria is perhaps the best-known example of blobitecture. With its dark bulging walls, the building most closely resembles a kind of prickly caterpillar.
Many types of different plastic moulds were cut for the purpose of bending the acrylate wall panels of the building. This is an enormously labour-intensive process that also seriously environmentally unfriendly, as much of the material is wasted.
There has to be a better way, thought Vollers some fifteen years ago. Together with PhD student Daan Rietbergen he came up with the first adjustable mould. Using 36 pins that are adjustable in height, a flexible supporting surface was pressed into the desired shape. And at the STW Annual Congress in 2012, Vollers presented the 'Pinbed Wizard', a mould with two hundred simultaneously moving pins, which he had been able to develop thanks in part to funding from STW and the help of the Electronic and Mechanical Support Division of TU Delft.
A layer of rubber is applied on top of the Pinbed Wizard pins, and on top of that, the material to be moulded. This makes it possible to make concrete panels by reshaping the mould at just that point during the hardening process that the concrete has the right level of viscosity.
"Each pin can support a weight of six hundred kilos", explains Vollers, "whether lifting or pulling. In its entirety, the device can support a panel weighing 120 tons."
The TU Delft researcher and entrepreneur would like to link the adjustable mould to a glass-bending kiln for the production of double-folded glass panels. The idea is that when the glass turns soft, at 570°C, its shape will adapt itself to the flexible supporting surface underneath.
It is also intended that the device, which is currently operated manually, will eventually be completely computer operated. "Technologically, it is very challenging to move so many pins", says Vollers. "The actuators all have to cover different distances and yet all have to arrive at their final position at the same time."
For the glass company that Vollers worked with for many years, it was all too ambitious, and it withdrew from the project several years ago. "When the Pinbed Wizard finally worked, I was able to lick my wounds", recalls Vollers. "For a long time, I was not earning anything."
Vollers has since set up the Free-D Geometries company. He has also found new partners, including a company that makes actuators for rotatable solar panels, and a metalworker who makes shrimp peeling machines, among other things.
"I am going to pursue this", says Vollers firmly. "There is a huge market for this product. The flexible mould allows the production of bent panels on a large scale. It is the holy grail of blobland." (TvD)

‘Many doors will open to you’

The Honours Programme Delft (HPD) is for excellent Bachelor and Master students with an above-average track record. The specifics of the supplemental programme are largely up to them. Participating in the programme opens many doors to you, as Valerie Goemans, Jasper Muller and Keveri Lychcettira have experienced.

Goemans enrolled in a forerunner of the HPD in 2007 whilst studying mechanical engineering. “Excellent students were given the chance to think about ways to develop in addition to the existing curriculum,” she explains. Together with 12 students, she organised a major project for the NURC research institute in Italy. She also attended summer courses in leadership in France and sat on the board of an HPD-related international student association. “All these extra activities gave me the confidence that I could handle a lot on my plate. I also acquired a useful network and doors literally opened to me.”

Entrepreneurship

Nowadays, HPD is no longer restricted to 3mE; all excellent TU Delft students are welcome to join. A coordinating board was established two years ago. Architecture student Jasper Muller was on the board for a year and also actively participated in the programme. “HPD students earn 15 extra credits in their faculty and five extra interfaculty credits in addition to the existing curriculum. Each faculty determines the extracurricular options.” Muller went to Rome and worked with civil engineering and electrical engineering students on a wind energy study. “They were good at calculation and I was good at visualising, so we were able to learn from each other.” He also took part in workshops and courses. “Lectures on enterprise and networking are what got me into entrepreneurship. I met someone who had a project I could work on and decided to set up a business with two friends. For me, HPD was the stepping stone to my own engineering design and consulting firm: Studio Flex.”

Challenge

Lychcettira was in the EPA Programme (EPA) and will soon be pursuing her PhD. “The Honours Programme helped me find a topic for my doctoral research.” In addition to the existing curriculum, she conducted an individual study on Energy Economics. “I was able to establish an extensive network with students from different degree programmes thanks to the HPD. It’s interesting to share ideas with them. I also made useful contacts during networking events with companies that otherwise would have been hard for me to access. The HPD is increasing my chances on the job market.” (PW)

The Alumni pin

If you are you a TU Delft alumnus, we have an alumni pin for you. To receive yours, visit one of the (TU) general alumni meetings.

Design for our future

The Faculty of Industrial Design Engineering is hosting an open house on 13 September. Visit one of the Delft Design Labs and learn more about the faculty’s research activities, or get acquainted with the basics of industrial design via the Delft Design Guide. Be sure not to miss dean Ena Voûte’s inaugural address at 15:00. More information: **www.io.tudelft.nl**.

Alumnus of the Year 2013

TU Delft is proud of its alumni and likes to show it. Alumni who inspire others or make unique contributions to technology, innovation, science or enterprise have a chance of becoming “Alumnus of the Year.” The winner will be announced at the alumni symposium on 11 October. In addition to a special memento, the recipient will receive €2,500 in cash and €7,500 to donate to a TU Delft research project of his or her choice. TU Delft alumni can put themselves forward or be nominated by someone else. To fill in the entry form, go to: **universiteitsfonds.tudelft.nl**. Nominations must be received by **31 August 2013**.

Alumni Event

The Alumni Event will be held in the TU Delft Aula on Friday, 11 October from 16.00 – 22.00. The event kicks off with a main programme featuring lectures by leading researchers, contributions from outstanding students and an up-to-the-minute report on the TU Delft Nuon Solar team’s status. The evening will include lectures, workshops and discussions organised by the various faculties, Delft Research Centres and other parties. We will provide a buffet dinner and plenty of opportunities for you to socialise with your fellow alumni.

More information: **www.tudelft.nl/alumni-event2013**

‘My network has significantly grown and strengthened’

Expand your view, gain a tremendous amount of knowledge about energy market developments and get acquainted with a vast network of experts: according to module manager Hans Hellendoorn, these are key reasons to pursue a Master of Business in Energy (MBE).

Hans Hellendoorn (left) and Nico Büskens.

The MBE is offered by DelftTopTech, which provides training to professionals and managers who have several years’ of work experience and are interested in enhancing their knowledge. “The MBE mainly attracts people who completed their technical or financial studies at either a university of applied sciences or a research university a long time ago,” says Hellendoorn. “Everyone stands to gain from being up to date on the latest developments in the energy industry.”

Latest developments

Nico Büskens graduated as a hydrogeologist in 1988 and later pursued a business administration degree as a manager. “I work in business development for the energy distribution network Alliander, which involves dealing with a large number of other parties. Broad insight into the energy world and in particular the latest developments in this field is essential. I felt that I needed to grow in this area, which led me to this programme. For me, it was the most efficient way to quickly get my knowledge to the required level. Many of the lecturers are involved in relevant research or play a crucial role in the sustainable energy sector outside of the lecture hall. The experts from Philips and the CIEP (Clingendael) are superb examples. I learned so much from them. I also found it very helpful to work together with my fellow students. Together we represented a decent cross-section of the energy industry. This programme helped significantly expand and strengthen my sustainable energy network.”

Guest speakers

The two-year MBE programme was created years ago, but it was fundamentally revised last year. Hellendoorn: “All of the lecturers and module managers are new. In the past the main focus of the programme was technology but now the emphasis has been moved to the complexity of the energy world. Topics covered include new types of energy, energy-saving methods and energy systems.” He is struck by the participants’ collective thirst for knowledge. “They are incredibly keen and always want to know more, which is highly motivating for guest speakers, too.” Efforts are being made to get the course accredited. Hellendoorn feels some kind of examination is needed and that the current structure is somewhat too casual. “It works fine for 80% of the people, but the remaining 20% needs the threat of the big stick.” Büskens belonged to the vast majority who took the programme very seriously. “It was quite a strain on top of my demanding job. Now that it’s over, however, I realise what it gave me. It was terrifically interesting and I would do it again in a heartbeat.” (PW)

MOOC registration

Registration for the first free MOOCs has begun. The courses “Solar Energy” and “Introduction to Water Treatment” start on 16 September. Anyone can now access TU Delft’s expertise for free, anywhere in the world. Everyone is eligible to take the course; there are no entrance exams or prerequisites. The complete course will be provided on platform edX, including videos, course material and practice exams. MOOCs are given during a fixed period of eight to ten weeks and offer opportunities to interact with fellow students. Courses are in English. Participants are given homework and receive a certificate of completion. For more details, see the article on page 20.

Agenda

9 July	**Alumni meeting Singapore**
11 July	**Alumni meeting Shanghai**
13 July	**Alumni meeting Beijing**
30 August	**DAF company visit**
31 August	**Alumnus of the Year nomination deadline**
2 September	**UfD Best Professor award presentation**
16 September	**MOOC Solar Energy starts**
16 September	**MOOC Introduction to Water Treatment starts**
11 October	**Alumni Event 2013 – TU Delft**

Colophon

Alumni portal
www.alumniportal.tudelft.nl
Changes of address
Subscribe or unsubscribe
- e-mail newsletter
- alumni events

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Become a ‘Friend of TU Delft’ and support Talent, Technology and TU Delft with your contribution.
Account number: 22 68 50 471
Stichting UfD, mentioning “Friends”
universiteitsfonds.tudelft.nl

Questions or suggestions?
Alumnibureau@tudelft.nl
Telephone (015) 2789111

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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Multidisciplinary Centres

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Biotechnological Sciences Delft Leiden (bsdl)
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Telephone +31 15 278 5140/2342

Centre for International Co-operation and Appropriate Technology (cicat)
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Centre for Transportation Engineering
Stevinweg 1
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Telephone +31 15 278 6634

Dutch Institute of Systems & Control (DISC)
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Telephone +31 15 278 7884

Koiter Institute Delft (Institute for Engineering Mechanics)
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Netherlands Institute for Metals Research (NIMR)
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Wind Energy Research Group
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Reactor Institute Delft
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Telephone +31 15 278 5052

OTB Research Institute for Housing, Urban and Mobility Studies
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Telephone +31 15 278 3005

Open Building Working group (obom)
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Telephone +31 15 278 5400

Delft Institute for Microelectronics and Submicron-technology (dimes)
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Telephone +31 15 278 3868

Interduct Delft University Clean Technology Institute
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Telephone +31 15 278 7233

J.M. Burgerscentrum Centre for Fluid Mechanics
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Netherlands Schools for Advanced Studies in Construction
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Advanced School for Computing & Imaging
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Trail Research School
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Telephone +31 15 278 6046

Central Library

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

For further information:
Delft University Central Library
Prometheusplein 1
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nl-2600 MG Delft
Telephone +31 15 278 5678

Delft University Press
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E-mail order@iospress.nl

Information

General information:
Information office
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Telephone +31 15 278 5404

Information on facilities for foreign students:
Student Advisory Office
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Liaison between business and research:
Liaison Office
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Telephone +31 15 278 1500

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

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

(Post Graduate) Courses

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

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

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