2007.4

Research and education at
Delft University of Technology

Delft Outlook

Paint

Quest for eternal gloss

For in a row • **Architect Dick van Gameren** •
Building blobs • Scratchfree • **Modelling with air** • **Ethics for engineers**

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Delft Outlook

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It wasn't so very long ago that new cars started showing rusty spots after three or four years. Nowadays, an old banger on the road is an exception. In just a short space of time the world of paint and coatings has seen a revolution occur. The scientific research into improved paint technologies promises more to come. Delft Outlook showcases the developments in a number of Delft research projects, including self-repairing paint, up-to-date monitoring of paint erosion, durable nanopaints and ceramic super coatings.
Sustainability was one of the mottos of last year's jubilee festivities. The theme has gained a permanent place in education and research, as is borne witness by Delft University's successful Nuna 4 solar-powered car and research into the Antarctic ice cap, sustainable building, and sustainable power generation. Scientists can now face the consequences of their actions. Ethics, once an obscure hobby practised by very few, has now secured a place of its own in the daily running of Delft University of Technology, as our last Looking Back at 2007 shows.

Frans Godfroy
Editor-in-Chief

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COLOPHON

coverphoto

Photo: Sam Rentmeester/fmax

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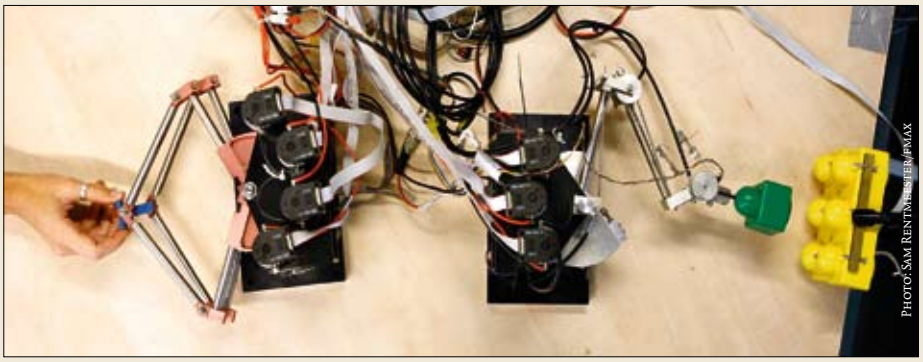

Robots with feeling

Robotically controlled arms offer a helping hand to humans. Researchers at the biomechanical engineering department of the faculty of Mechanical Engineering, Maritime Engineering, and Material Sciences are working on ways to make artificial limbs more sensitive.

According to Dr Ir. Göran Christiansson, who recently completed his doctoral research on robotics, the current generation of robotic arms have two major drawbacks: "The arms providing some measure of feedback to the person operating the joystick are still so rudimentary that it's rather like having to perform microsurgery wearing a pair of boxing gloves." Robotic arms also have problems handling hard objects. The arm's control system cannot respond fast enough when coming into contact with a hard surface, and it breaks down.
According to Christiansson, the trick is to ensure that the robot's claws have a bit of give when they grasp something hard, the way a human hand does. Christiansson had fifty blindfolded test subjects perform tests with a rigid robot arm and with a 'soft' arm on which the claw had been fitted with a system of springs. The latter version made it easier to pick up hard objects and detect the shape of objects. The problem was that the soft arm, which the spring system makes less rigid, made it impossible to lift heavy objects.
The researcher now thinks that it is possible to create an arm that unites the properties of both a hard and a soft arm, by adding artificial muscles. The robot could use these to vary the claw's firmness, just like the human hand does. Co-researchers Dr Ir. Martijn Wisse and Dr Ir. Just Herder, who also work at the biomechanical engineering department, will be investigating the matter over the next few years.

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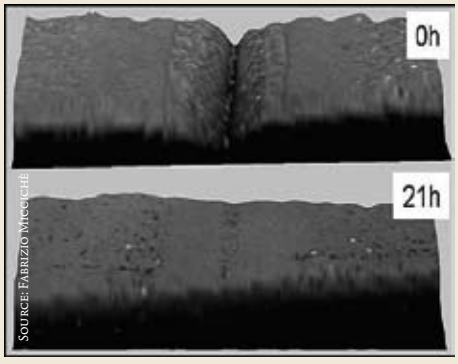
IN·BRIEF

Clay in paint

A coating that repairs itself when it becomes scratched. It's not an entirely new concept, but you usually need a high temperature to melt the paint, as it were. Or you need to mix minute capsules of repair material into the paint. "That is not an ideal solution, since the capsules give a pock-marked surface," says Dr Ir. Fabrizio Micciche. He has been researching an alternative in the form of a thin layer of clay below the paint. As soon as the topcoat becomes damaged, moisture reaches the clay that then expands to fill the gap in the paint. "The great thing is that there is plenty of moisture in the atmosphere." The initial tests show that the concept works. Even so, the find is not ready for use on cars yet. One of the things that still needs to be found is as to whether clay or some other type of expanding material that does not get washed away by driving rain.



The profile of a scratch in a polymer coating with a thin expanding layer of clay below directly after scratching (top) and 21 hours later in a humid atmosphere.

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Smart traffic lights

Many of our daily annoyances at traffic lights are easily remedied, as demonstrated by Ir. Ronald van Katwijk of the faculty of Mechanical Engineering, Maritime Engineering, and Material Sciences. The researcher, who will be defending his doctoral thesis on 29 January, created a computer model in which traffic lights communicate with each other in order to determine the optimum procedure for guiding the traffic through town. The average speed gain for cars is fifteen percent.

The current procedure for traffic lights is to switch to red when they notice a gap after a string of vehicles has crossed an intersection. They get this information from detection loops embedded in the road surface. Once they have switched to red, other traffic lights can turn green. The order in which this takes place is predetermined. "However," Van Katwijk says, "if the number of vehicles suddenly increases, as a result of a diversion for example, this can result in congestion because the green light distribution of the traffic lights no longer follows the optimum pattern."

Van Katwijk's model takes such changes in traffic patterns into account. "My model can incidentally ignore the gap between two successive strings of vehicles if that enables it to reduce the average waiting time for motorists," he explains. The traffic lights know how many vehicles they can expect in the short term. This information comes to them in the form of data from other intersections and from detection loops in the road. They also know whether the cars that they let through will face a green light at the traffic lights further down the street. Van Katwijk: "In the event of cars being forced to stop a bit further on, my traffic lights can decide not to let the cars through until the subsequent lights are also green. My traffic lights can see further than the end of their nose."

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Photo: Sam Rentmeester/FMax

Photo: Hans Peter van Veithoven

Four in a row

Nuna4 has won the World Solar Challenge, which was run in Australia, for the fourth consecutive time. The solar-powered car from Delft completed the three thousand kilometre race through the Australian heartland in 33 hours and 17 minutes to finish first in Adelaide.

With an average speed of slightly over ninety kilometres per hour, the Delft team was slower than last year's Nuna team. However, in the previous edition of the race, the cars were allowed to carry a total of eight square metres of solar panels, as opposed to six this year. After passing the finish line, the competitors went for the traditional dip in the fountain in Victoria Square to celebrate their victory.

More information: www.nuonsolarteam.nl

DIY chip

A microchip that assembles itself. Doctoral student Ir. Vincent Henneken of the faculty of Mechanical Engineering, Maritime Engineering, and Material Sciences recently applied for a patent for just such a thing.

A glass-fibre data connection starts with a microchip carrying a laser source that sends data into the optical fibre encoded as light pulses. The laser source and the end of the fibre must be very accurately aligned on the chip, otherwise the pulse will become indecipherable by the time it reaches the other end of the connection. Aligning and attaching the fibre to the chip is a bit of a challenge, since the whole operation must be accurate to within 0.1 of a micrometre. Just compare that with the thickness of a blonde human hair, which is about 50 micrometres.

Until now it was very difficult to achieve that kind of accuracy. For one thing, the optical fibre will shift position after being fixed in place. "Laser welding adds heat. As the joint cools, it deforms," Henneken explains. "You can always jiggle the fibre about a bit, but it's always rather slap-dash." It also takes someone a couple of minutes to do each chip.

Henneken has come up with a self-assembling microchip that incorporates a couple of nifty tricks to move the components about and a minute hook to hold the fibre in place. It is faster and more accurate. "The first chip was hard to make, but now that we know how to do it, the next batch will be much quicker to produce."

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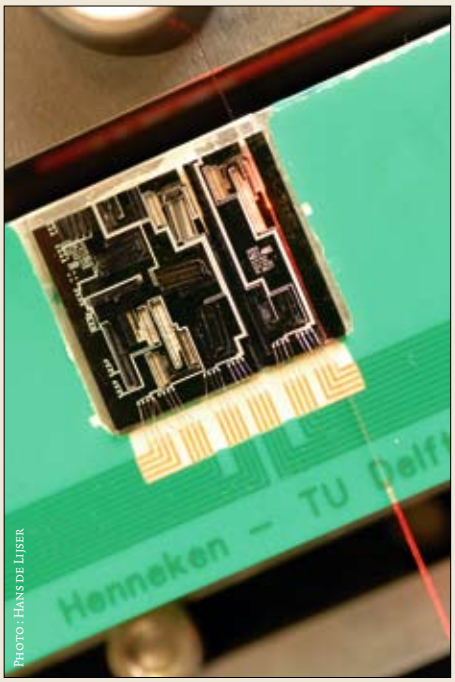

Photo: Hans de Lijser

Playing with a pedometer

How can you get children to go outside and play? By designing residential areas the proper way, according to architecture student Mascha Reek. For her research she equipped thirty children with a GPS unit and a pedometer.

An increasing number of children in the Netherlands are overweight. Architecture student Mascha Reek thinks that city planners can contribute to a solution by designing residential areas with sufficient room for playgrounds in the right places. There is no use just dotting a few playgrounds about the place, Reek says. "I often see empty playgrounds with children playing next to them." For her graduation research, she is investigating where children living in the Voorhof and Wippolder areas of Delft like to play, and how much exercise they get in the process. She asked thirty children from three primary schools to keep a diary. She also provided them with wristwatch GPS receivers and pedometers to increase the volume and accuracy of her information.
The children wore the devices for a period of one week. The GPS wristwatches recorded the location of the children throughout the day. Reek linked the data to the information she has about the areas. "I have a map showing all the streets, pavements, and buildings," Reek says. "Using the recorded data I can see whether the children used formal play areas to play in, such as playgrounds, or informal locations such as a car park or a planted area."
The pedometers record the amount of exercise the children get. Veronica, one of the pupils: "I like it when they can see I spend a lot of time playing outdoors. It's healthy, because you pick up calories or something like that. Anyway, it's just healthy."

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Photo: Sam Rentmeester/fmax

IN·BRIEF

Photo: Sam Rentmeester/fmax

Pick a Piece

Serving birthday cake from a box. A definite no-no, as far as Annet Hennink is concerned. Annet recently graduated as an industrial design engineer. She designed a gaily decorated cake stand made of cardboard, which won the Hema design competition. The cake stand is called 'tast toe', or pick a piece, and sells for 2.50 euro. Hennink: "It's great fun, the stands are selling like hot cakes. Many of the Hema shops have already sold out, and have had to order a new batch."

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Workout

Using a computer will become a method of exercise, if five industrial design students have anything to say in the matter. They designed a system that converts the kinetic energy of shaking legs into electricity to power a laptop computer.

The Delft students developed their system for a competition organised by the Intel computer company. The assignment was to make a laptop computer work for one hour on renewable, green energy. The students opted for the kinetic energy offered by a person's legs. "We needed quite a lot of power. Even after we had tweaked the computer to use as little power as possible, it still pulled about twenty watts." Since a lot of energy gets wasted in the conversion process, about one hundred watts of kinetic energy is required, according to Van Deursen. "That is about equivalent to riding a bicycle at 25 kilometres per hour on a level road."
They had to be able to demonstrate a working prototype to the jury in less than two months. "That gave us very little time," says industrial design student Bas van Deursen. "During the demonstration I pedalled too fast, so smoke started to come out of the system and a component failed. Fortunately the system still worked."
The students used existing components, including two bicycle dynamo hubs. According to Van Deursen the efficiency of the system could be considerably improved by using better components. "I think we will be able to improve the system to the point where fifty percent of the pedalling energy goes to the computer."

Photo: Sam Rentmeester/fmax

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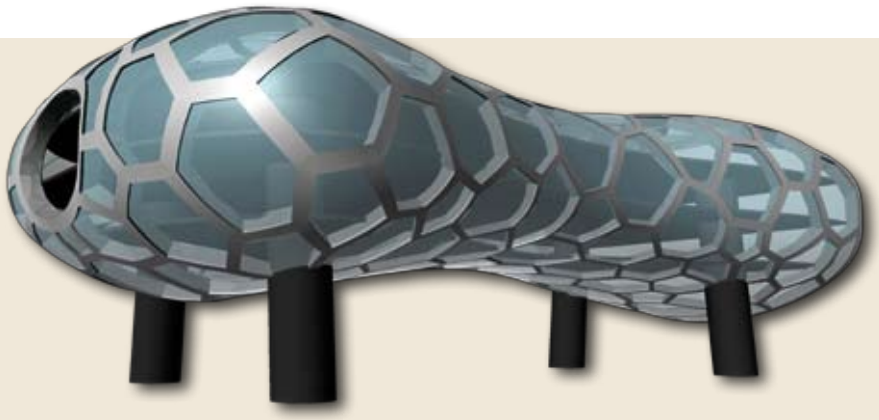
Building blobs



Sitting at his drawing board, an architect can come up with any possible shape for a building. The trick is to find a structure that will hold up a blob, i.e. a building with contoured, irregular outer walls. Traditionally, buildings are constructed using straight beams. Of course, these can perfectly well be used to construct a rounded facade, as the Bilbao Guggenheim Museum demonstrates. "The problem is that this leaves all sorts of voids to be filled up. It looks a mess," says Dr Ir. Martijn Veltkamp, who received his doctorate with honours for his research into the development of new structural systems, including 'Delta Ribs', which can be bent to any shape.

The steel ribs together form a network which Veltkamp compares to the nets supermarkets use to pack oranges in. "You can rearrange the oranges into any shape you like, and the net will still fit around them. In the same way you can create a steel structure that follows the shape of your building."

The system is ready for use, but builders will have to be prepared to pay more than they would for a building using standard construction methods. "You opt for the system because it is better, not because it is cheap," Veltkamp says. He is convinced the price will soon drop once production has become routine. "The steel sheets used to produce the ribs have to be cut, curved, and assembled into a network. The shape changes, but the operation remains the same."

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IN•BRIEF

Five thousand

On Tuesday 6 November, Dr Ir. Jana Tatur became the five thousandth person to receive a doctorate from Delft University of Technology. Ukrainian-born Tatur and her supervisors were unaware of the special nature of the occasion, so it came as a complete surprise when the rector, Jacob Fokkema, presented Tatur with a floral tribute to mark the event. The first doctorate was awarded in 1906 at what was then the Delft Polytechnic Academy. The number of doctorates has increased sharply over the last decades. Four thousand of the current total of five thousand were awarded after 1973.

PHOTO: SHANS STAKELBEEK/FMAX

Myopic

The optical data storage capacity of Blu-ray Disks (BD) can be increased tenfold using new optical techniques. During his research at Philips Research Dr Ing. Ferry Zijp developed a special type of optics that hovers extremely close to the surface of the BD. At 25 nanometres, the air gap separating the disc from the lens is only a fraction of the wavelength of blue light (400 nm), as a result of which the light can cross between the two virtually unhindered. Thanks to the special lens (a Solid Immersion Lens, or SIL) the dimples in the disc can be reduced even further in size so they can be packed closer together than on the Blu-ray Disk. Zijp built a demonstration rig which he successfully used to write and read optical data at extreme densities, using a Sony invention for maintaining a constant distance between the SIL unit and the disc surface. In his doctoral thesis, 'Near-Field Optical Data Storage' he states that a single-layer Blu-ray Disk has a capacity of 125 gigabytes, with a double-layer disc holding 250 GB. According to his supervisor Professor Dr Ir. Joseph Braat the research is the first step towards a fourth generation of optical data storage devices, after CD, DVD, and BD. Zijp received his doctorate from the optics section of the faculty of Applied Physics (department of Imaging Science and Technology).

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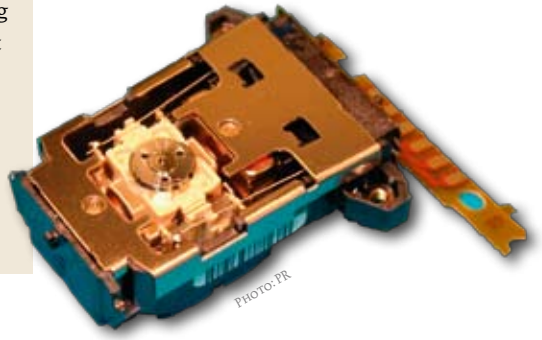

PHOTO-PR

Melting Antarctica

Most experts agree that the layer of ice covering Antarctica is getting thinner. However, the speed at which the ice is disappearing and the parts of the continent affected by the problem still remain the object of speculation. Dr Riccardo Riva of the Delft Department of Earth Observation and Space Systems intends to clarify the matter by analysing elevation data gathered by NASA's ICESat satellite.

According to researchers at Colorado University estimates of the annual ice loss vary between 232 and 72 cubic kilometres (Science, 24 March 2006). This information is based on satellite measurements of the gravity fields over Antarctica. According to Rive the wide margin is caused by the large degree of uncertainty about the effect of tectonics under Antarctica. "Between twelve thousand and four thousand years ago the ice was melting much faster than it is now. As the pressure on the underlying land eased, the continent rose," the researcher explains. He is hoping to discover the parts played in the gravitation changes by the melting ice on the one hand, and by the rising continent and its back-fill of magma flows on the other. For this purpose he will be combining the gravitation data with elevation measurements.

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Smart as paint

Early Warning System for coatings

In the basement of the Chemistry Building, a new method has been developed to measure the ageing process of coats of paint. "The method is extremely sensitive," says Professor Stephen Picken of the department of NanoStructured Materials. The doctoral research conducted by Massimiliano Giacomelli Penon ('Max') appears to offer a fresh approach to an old problem.

Jos Wassink

The first sign of ageing in paint is often a loss of gloss. Paint becomes dull because the medium – the main ingredient of paint – at the surface erodes. The paint can then start to release dust as pigment particles get released. The coat becomes gradually thinner as long molecules in the medium are broken down into smaller, volatile molecules that evaporate. The coat then becomes brittle because the molecules of the medium start to coagulate. The brittle paint coat starts to form cracks, and once the cracks reach the bottem, flakes of paint will start to come away. Where the paint has peeled, the underlying material remains unprotected.

When this happens to a window frame, it is annoying, and the time has come to either take up a paintbrush or move house. Out in the big world however, the ageing of coatings is a problem involving lots of money. Think offshore rigs, container ships, bridges and sports stadiums. Coats of paint are essential for the protection of these structures, but it costs a fortune to apply a new coat. It is therefore of the utmost importance to know the current condition of a coat of paint, and to know how long a certain coating can provide adequate protection given the conditions. Unfortunately no one can tell you with any certainty.

Research methods

As matters stand, research into the ageing of paint has made very little progress over the last fifty years. In spite of a plethora of research techniques, there is still no way of making a reliable prognosis of the remaining service life of a coat of paint.

The main causes of paint erosion are well known by now. They are sunlight, temperature, water, oxygen, and chemical components in water (sea salt or acid rain) or in air (ozone, sulphuric and nitric oxides).

A whole range of research methods has been devised to gain some insight into the quality of a coat of paint or its remaining service life. Leo van der Ven, group leader of the automotive enamel expertise group at Akzo Nobel, lists the three most common methods. There is dynamic mechanical thermal analysis (also known as DMTA), a commonly used test to measure the brittleness of paint coats, then there is infrared spectroscopy of the paint surface, and finally there is gloss measurement. "Ultimately," Van der Ven says, "nothing beats simple exposure to the elements. There are racks full of painted panels in Florida, and parking lots full of cars, just to see how the paint holds up in conditions with lots of light and humidity."

In his doctoral thesis, Max Giacomelli includes a list of some thirty research methods used to evaluate coats of paint, including microscopy, ultraviolet analyses, nuclear magnetic resonance, x-rays, and fluorescence. In addition, a number of techniques have been developed to speed up the ageing process, such as exposure to high temperatures (approximately 150 degrees Celsius) or to pure oxygen, radiation from UV lamps, chemical treatment with caustic soda or sulphuric acid, or a combination of several of these abuses.

When all's said and done, paint researchers can hardly be accused of lacking resourcefulness. However, the problem remains that the results of the artificial ageing tests are difficult to correlate with service life in the real world. In other words, laboratory tests bear little relationship to the service life of a paint coat exposed to the elements. And that is the whole point of the exercise.

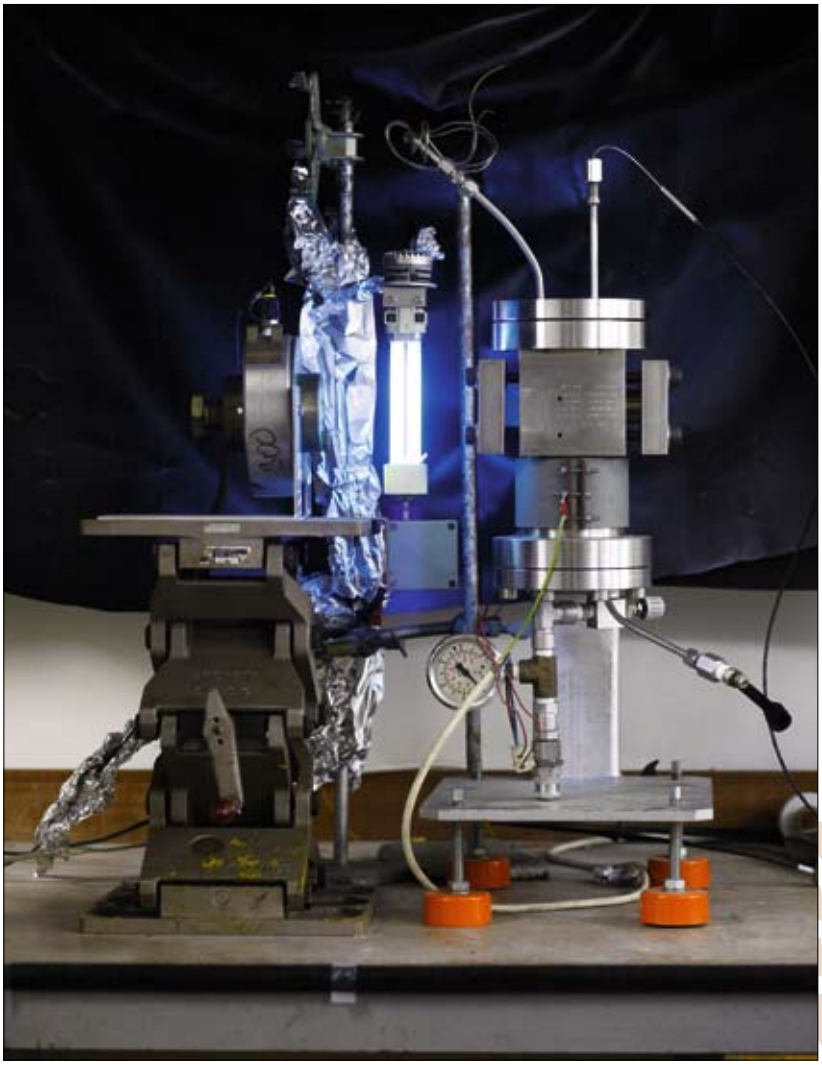
Cylinder

When Max Giacomelli started his doctoral research in 2002, his assignment was to predict the service life of coats of paint. The idea came from Professor Jan van Turnhout of the department of nanostructured materials. The assignment was far from rigid, and Giacomelli was encouraged to seek collaboration with industrial parties (Akzo Nobel and SigmaKalon) and research institutes (TNO). "I started by looking at the available research methods, and took it from

Photo: Nout Steenkamp/fmax

Applications

Coatings differ widely in the use of medium. In other words, they are based on many different polymers. Alkyd (based on white spirit) and polyester coatings are used for timber, enamels, blinds, floors, pools, boats, cars, and planes. Formaldehyde polymers are used in varnish, metal paints, and printing inks. Epoxy coatings are for industrial use, for containers, and on ships. In addition to these there are chlorinated rubber, polyurethane coatings, (for use on polyester), and acrylic paints. Fluoric polymers are used as anti-fouling compounds on ships, as flame retardants, and as non-stick coatings in cooking utensils.



'We had quite a bit of trouble getting this far'

there to search for a new method in any direction," Giacomelli says, "but I got stuck."

The current test set-up is located, together with someone else's set-up, in the basement of the Chemistry building. The first thing you notice in the room are a couple of desks with laptop computers on them, everything covered under documents. Between the desks is a rack containing electronics and a PC connected to three displays. To the left, shrouded in black plastic curtains, is the test set-up Giacomelli used to conduct his experiments, and next to that is an old desk covered in pliers, plugs, and leads. "It's a bit of mess," Giacomelli apologises. "Must be because we're both Italian." From a desk drawer he retrieves a white plastic cylinder the size of an ice hockey puck on a metal base. He carefully removes the upper half of the white cylinder, revealing a golden electrode. From the electrode a wire runs to a connector, and from another connector a wire runs to the lower half of the plastic block. The block of white plastic forms the heart of the measuring device. Giacomelli has spent the past few years clamping a great number of films and coating between the two halves of the block to measure them.

Dielectrics

One of the measurable properties of a coating is the electric capacity, or to put it in more general terms, the dielectric value. This is measured by pushing a pair of electrodes against both faces of a layer of paint, applying an AC voltage, and measuring the layer's permeability for the alternating current.

"Van Turnhout had been quick to suggest dielectric measurements," Giacomelli recalls, "but I wasn't very keen on the idea, because dielectric tests are tricky and complex, and highly sensitive to this, that, and the other. They are affected by humidity and temperature, even by the number of people passing in the corridor. I wasn't expecting much to come out of it." Ultimately, Giacomelli resigned himself to conducting dielectric tests, simply because all other avenues had come to a dead end. The initial results gave little reason for joy. It turned out that the measurements weren't very sensitive to ageing effects in coats of paint. "I had to wait a month to see only a few percent change in the readings." Another approach was to measure the amount of water absorbed by coatings. This is done by exposing a coating to water and then measuring its increase in mass as a function of time. Unfortunately, the water absorption didn't change measurably either for coats less than a month old.

Breakthrough

The breakthrough in the research came as a result of a talk Giacomelli had with his supervisor, Professor Stephen Picken. Picken proposed measuring the water absorption using dielectrics, but this time using humid air. This turned out to be a winner, as dielectric measurements are highly sensitive to water.

Water molecules are dipoles, molecules with a positive charge at one end (hydrogen) and a negative at the other (oxygen). In the changing electric field of a dielectric measuring set-up the dipoles will resonate freely with the field, an effect that can be easily measured from the outside. Together with technician Gerard de Vos, Giacomelli then built a test set-up.

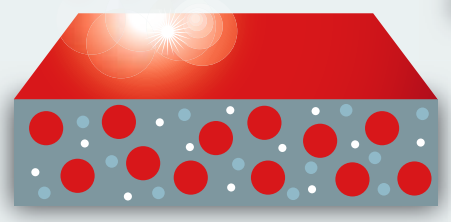
"The application of the humid air flow suddenly made the test eighty times more as sensitive," Giacomelli discovered. Penetration by water turns out to be a sensitive indicator of the degree of weathering of a coat of paint. As molecules ▸▸

Photos: Sam Rentmeester/fmax

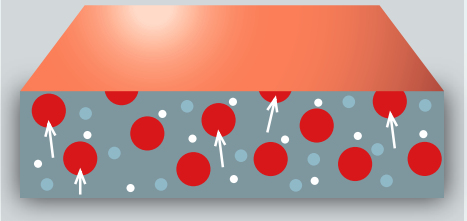
Ageing Paint

A combination of (simultaneous) processes makes paint go dull and dusty, erode, and finally flake.

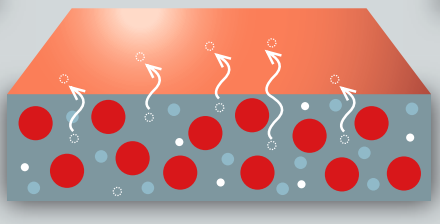
1. Undamaged coating shines brightly.



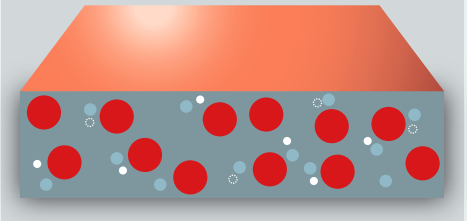
2a. As pigment particles become dislodged, the paint becomes dull and dusty.



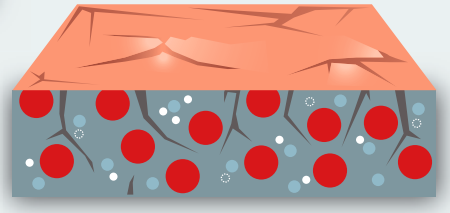
2b. Molecules of the medium break down into smaller, volatile molecules, and evaporate.

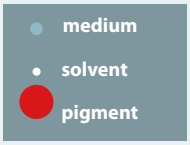


2c. Molecules of the medium coagulate, making the paint brittle.



3. The brittle paint starts to crack, and finally flakes off.





Infographic: Karin Schwandt

of the medium are affected by UV radiation and become damaged, the end groups of the molecules in the medium become detached, allowing water molecules to penetrate the paint coat. The higher the amount of water that penetrates into the coating, the higher the degree of weathering. The extreme sensitivity to water molecules makes the dielectric test very sensitive to deterioration in paint coats. "It is a fast test," Picken says. "The difference shows up after only two or three days of exposure to light."

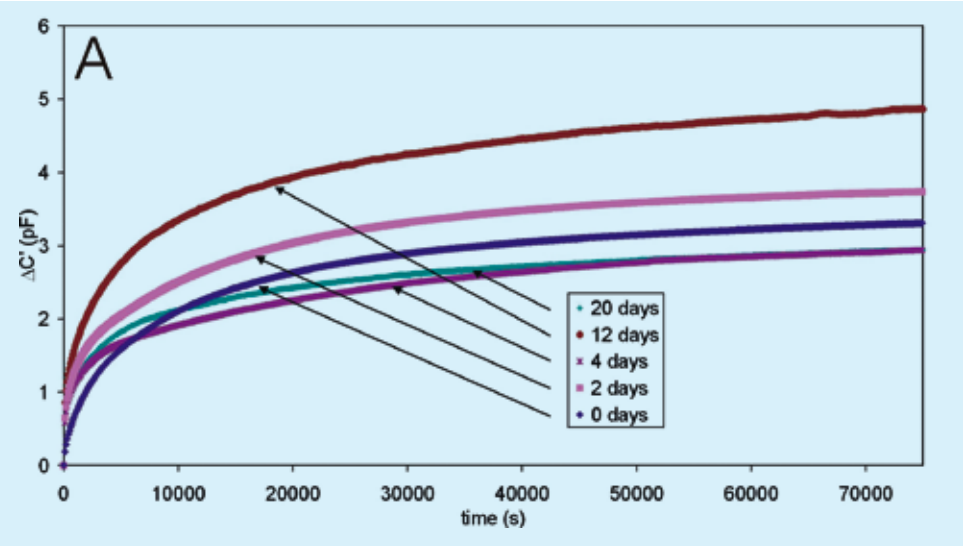
Dielectrical Sorbtion Analysis

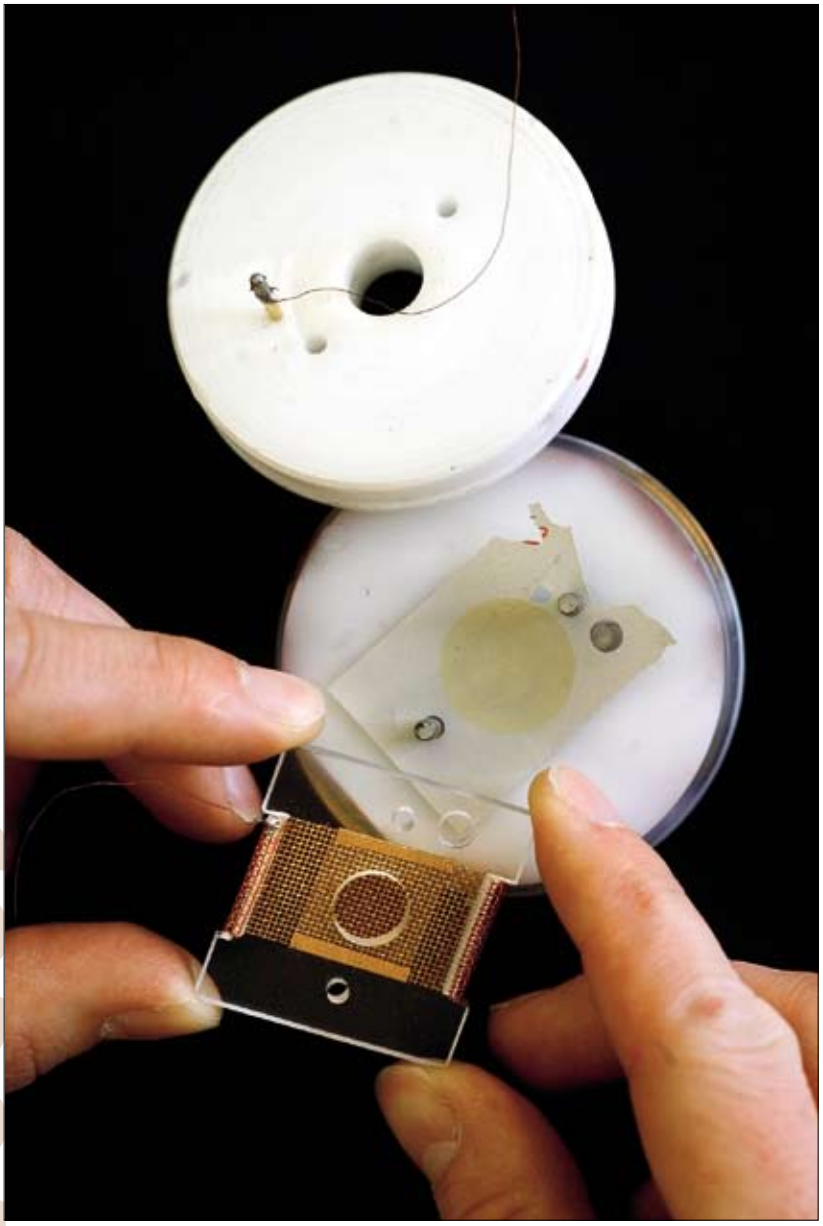
"We did have quite a bit of trouble getting this far," Picken admits. "Reproducibility was a problem," Giacomelli explains. "Ambient humidity, temperature, pressure, switches, and passers-by, everything affected our test results." Only once all the rogue factors had been eliminated could we finally obtain reproducible readings. As things turned out, the dielectric capacity of a coat of paint is a direct measurement of the amount of water absorbed by the paint.

The method has been named Dielectrical Sorbtion Analysis (DSA). In fact, rather than yielding a single value, the test shows a development over a period of time. Measuring the amount of water absorbed by a coat of paint takes a couple of hours. The reading is also affected by the AC frequency used. "That's the beauty of it all," Giacomelli says. "You can almost see the molecules respond one by one. At low frequencies the first to respond are the clusters of ten or more free water molecules. These are followed by the water molecules attached to the paint structure. At still higher frequencies you can see the moveable ends of the coating molecules respond, and when you go up far enough in the frequency range, you can see how the separate atoms are polarised. You can actually see how the water reacts with the coating," Giacomelli summarises. ▸▸

Massimiliano Giacomelli Penon received his doctorate on 15 October 2007. The title of his thesis is 'Dielectric Sorbtion Analysis on Polymer Films'.

Changing capacity as a function of time in coatings with increasing exposure to radiation up to 20 days.





The mesh electrode is open to water vapour. The paint sample is fixed with two pins. The fixed electrode lies under thte sample. When assembled, the measuring device is as large as a ice hockey puck.

What's inside?

Organic coatings contain four main ingredients, medium, solvent, pigment, and additives. The medium forms the backbone of the coating which keeps all the components together and binds them to the substrate. The medium usually is a polymer with a high molecular mass and consisting of long or linked molecule chains. The solvent dissolves the medium and ensures that it spreads evenly across the substrate without sagging or running. Apart from determining the colour, pigment can also affect the hardness of a coating. Additives are ingredients added in small quantities that have specific effects. Examples include flame-retardants, UV-proofing, or anti-mould additives.

So, DSA is a method that can provide a measurement of the ageing process in paint coats at speeds previously unheard of. But to what extent does the occurrence of the first damage provide an indication of the life expectancy of a coat of paint? "We would have to wait another five years for that," Picken laughs. Only then would we be able to correlate the first signs of weathering and the expected service life when exposed to the elements.

Nonetheless, it might not take so long. Using a unique set-up (a high-pressure cylinder on loan from Twente University), it has been demonstrated that paint exposed to a UV lamp under high atmospheric pressure will age more rapidly. "Higher temperatures had already been tried, as had added oxygen and increased radiation, but no one had increased the pressure in combination with UV light," Giacomelli explains. As things turned out, this made a lot of difference. At up to 50 times the normal atmospheric pressure, the rate at which the ageing process takes place is proportional to the pressure. Picken surmises that the amount of oxygen – which is proportional to the pressure – is the cause of the effect. Increasing the pressure 50-fold appears to increase the speed of the ageing process 50 times.

'DSA is a method that measures the ageing process at speeds previously unheard of'

Picken hopes that the invention, which at the moment exists only as a prototype in the basement, can be developed into a hand-held scanner that can be used to measure the quality of a coating on a bridge or a ship in situ.

Leo van der Ven of Akzo Nobel is less optimistic. "The technique is interesting," he says, "the approach is original, but not so easily adapted to use in the field. The invention could become one of the methods used to measure paint erosion, but the interpretation of the readings still requires too much specialist knowledge."

Picken has thought of another use for the method, measuring the condition of paint on aircraft from a remote position. This application is currently being developed together with Guus Coolegem of C-Cube International. A sensor could possibly be included in the coating, connected to a small printed antenna. The whole assembly would then be embedded in the coating. This would enable the condition of coatings in inaccessible places to be read remotely. Several monitors could even be read concurrently, which would enable a whole aircraft to be monitored in one go. ‹‹

Aircraft jet engines have to be able to withstand infernal conditions. Extreme heat and bitter cold tax coatings to the limit. Materials expert Dr Ir. Wim Sloof fits atoms together to develop rock-hard coatings. The latest invention in this field is known as ceramic matrix composites. Sloof has signed an agreement with a number of parties to investigate this material further.

Rock-hard coatings

Jet engines require super strong material

Christian Jongeneel

The Paris Air Show is one of the leading events in the aircraft industry. Not only do hundreds of thousands of people flock to the show to gape at the latest aircrafts, it is also the place to be for signing production contracts. This summer Wim Sloof attended on behalf of Delft University of Technology. In Paris he presented a research agreement with a number of partners, including Rolls Royce, one of the world's largest manufacturers of aircraft engines. The subject was coatings. "We are working on high-temperature coatings for use in gas turbines, where temperatures can reach one thousand degrees Celsius," Sloof explains. "When people hear the word coatings, most of them think of some type of paint, but we're talking about a very thin protective coating of a very hard material. These coatings are indispensable inside aircraft jet engines. The conditions they have to tolerate are much more extreme than they are for say, gas turbines used to generate electricity." Because of these exceptional operating conditions (and the safety risk if an engine were suddenly to fail) jet engines are a great challenge to materials scientists. To begin with they have to withstand higher temperatures because these enable the engine to burn its fuel more efficiently. In addition, saving weight is of the utmost importance. This is a general trend in aircraft construction, prompted by the need for more efficient use of fuels. Service life also plays a major part. Engine maintenance is one of the main reasons why very expensive aircraft are grounded on a regular basis. Sloof: "The limitations of jet engines currently stem purely from the materials used."

Aluminium oxide

There are various types of engines in use, but their main principle is the same. The engine sucks in air at the front, compresses it, adds fuel, and ignites the mixture. This creates a high-pressure mixture of gases that escape through the rear of the engine to provide thrust. The escaping gases also drive a turbine, which taps off some of the engine's power to drive the fan that sucks in and compresses the air at the front of the engine. Due to the mechanical stresses and heat involved, the turbine wheels form the most vulnerable part of the engine. As the temperature inside the turbine increases, the number of suitable materials for its construction decreases. Materials scientists therefore have to solve increasingly complex conundrums, taking into account a material's resistance to enormous temperature changes. The interior of a running jet engine soon reaches temperatures in excess of one thousand degrees Celsius, but on the other hand the engine also has to withstand temperatures far below zero, as an aircraft might become grounded in a Moscow blizzard. On top of that the materials have to be lightweight and affordable, two reasons why tungsten, the most heat-resistant metal available and used to manufacture light bulb filaments, doesn't make the grade. Aircraft turbines are made of a strong nickel alloy, which although very heat-resistant cannot withstand temperatures in excess of one thousand degrees Celsius. The constant battering with hot oxygen causes rapid oxidisation, which weakens the structure. One good way of preventing this is to apply a protective oxide coating which keeps the hot oxygen away from the nickel surface. The best candidate for such a coating is a ceramic material, aluminium oxide. However, aluminium oxide and the nickel alloy have different coefficients of expansion. The repeated heating and cooling of the turbine components result in stresses between the coating and the substrate, causing the coating to peel away. This can be solved by adding an adhesion layer consisting of aluminium and nickel, which works by damping the stresses. The problem is that a mix of just nickel and aluminium also tends to oxidise internally. This can be countered by adding chromium. And since all these metals usually contain pollutants, yttrium must also be added to act as a scavenger element, binding sulphur for example.
Finding the optimal ratios for this quartet of metals takes ▸▸

Finding the right coating is an endless conundrum in which each new solution appears to introduce a new snag

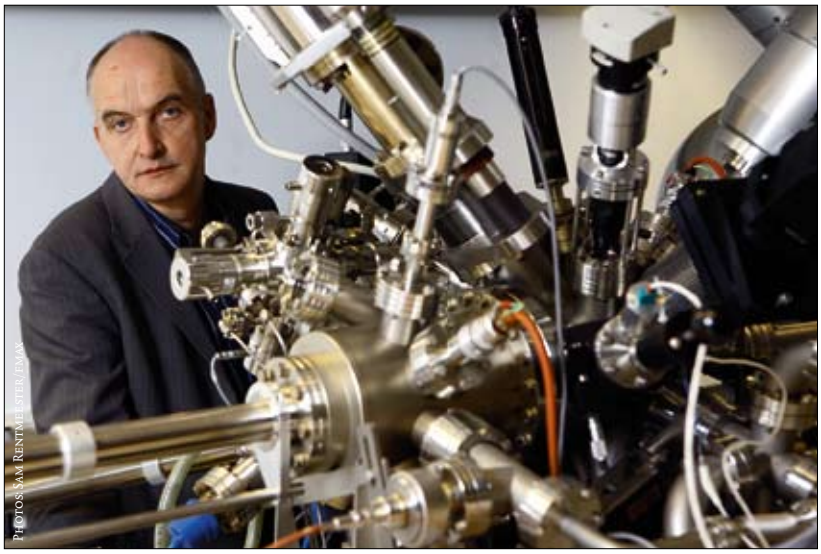


PHOTO: SAM RENTMEESTER/FMAG

Dr Ir. Wim Sloof uses the electron microscope to understand the atomic basis of hardness

a lot of research, for other variants are also possible, using zirconium or hafnium instead of yttrium. And even when you find the ideal composition, you're still not finished, as Sloof warns: "The microstructure of the crystals in both the underlying alloy and the coating is also very important. As the oxide structure become coarser, it gives better protection to the nickel alloy substrate."

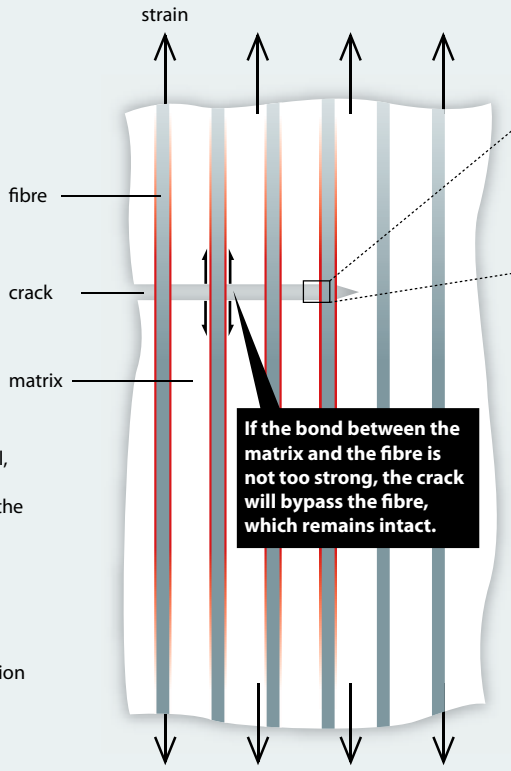
Self-healing

So, the coating of a turbine wheel consists of two layers. On top is a thin oxide layer, below which is a thicker adhesion layer. The resulting structure has self-healing properties, as tests conducted by Sloof revealed. Each cycle of heating and cooling increases the damage to the oxide coating," he says, "but there comes a point when damage starts to repair itself. This happens when aluminium from the adhesion layer starts to form a new aluminium oxide coating."

Although the coating with an oxide layer and an adhesion layer offers robust protection against the incessant pounding of the turbine with hot oxygen, it doesn't mean that the ideal coating has been found. True, the oxidising action of the hot air is held at bay, but the pure heat is not. The turbine wheel could even start to melt. In order to prevent this from happening, a third, insulating layer is needed to cover the other two layers. This layer is known as the thermal barrier coating (TBC). The TBC consist of feather-like crystals oriented at right angles to the coating surface and made from a material that does not conduct heat very well, like zirconium oxide. The size of the crystals and the distance between them are very important, since any space between the crystals could be used by the hot air to reach the oxide layer. Finding the right material and the right way to grow the crystals also requires a lot of research.

FOCUS

Ceramic Matrix Composites

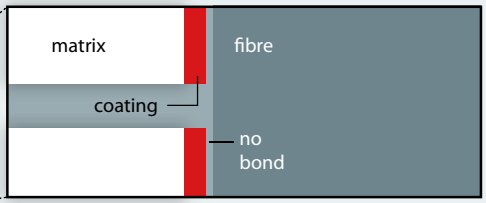


Throughout the bulk of the material, and at right angles to the probable direction of any crack, run fibres of the same material shrouded in heat-resistant material.

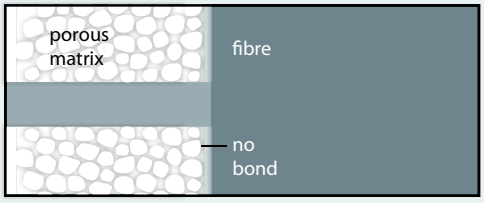
Ceramic matrix composites (CMC) could replace the current combination of metal and ceramics.

If the crack propagates around the cable, the cable will hold the material together like a reinforcing bar.

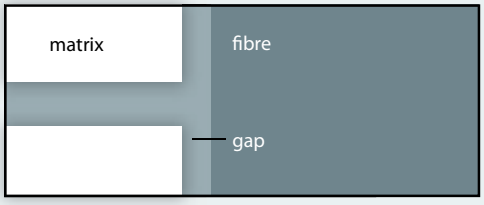
There are several different ways of preventing a strong bond forming between fibres and matrix:



1. A coating between fibres and matrix to make the two slide along each other.



2. A porous matrix that does not bond well with the fibres.



3. A gap formed by a volatile coating.

INFOGRAPHIC: KARIN SCHWANDT

A mechanic inspects a blade of the turbine of the F-100 engine, the engine of the F16 fighter

If the turbine wheel is cooled from within, the TBC can maintain a temperature difference of 150 degrees between the turbine blades and the hot air. In other words, if a turbine wheel can withstand a temperature of 1100 degree without a TBC, adding the thermal barrier will make the

'Jet engines need to be resistant to extreme temperatures, as well as weight-saving and reliable'

turbine suitable for temperatures up to 1250 degrees. This is a considerable improvement, although a useful property is lost in the process. "The TBC has no self-healing properties," Sloof explains, "so if a crack starts to form at the base of a crystal, the whole feather structure can come away." In order to make the material self-healing Sloof added a mix of molybdenum and silicon to the material. Now if oxygen penetrates the material through a crack, molybdenum oxide and silicon oxide are formed; the first evaporates, and the second repairs the crack. All in all, finding the right coating involves a seemingly endless juggling with atoms, with each new solution appearing to introduce a new snag. The conundrum relates not only to the chemical composition, but also to the production conditions that will produce the optimum material structure.

Cracks

The aircraft industry currently stands on the threshold of a new development: ceramic matrix composites (CMC). This is the research for which Delft University signed an agreement with Rolls Royce, the Dutch National Aerospace Laboratory, and Sulzer-Eldim, a part Swiss, part Dutch high-tech company with a reputation in the field of heat-resistant materials. CMC is like a woven fabric of ceramic material, e.g. silicon carbide, that could replace the current combination of metal and ceramics. Pure ceramics are fragile. CMC is a combination of ceramics with ceramic fibres that make the material tougher. Sloof: "CMC can take up more stress before it breaks." Through the bulk of the material run cables of the same material at right angles to the probable direction of any cracks. These cables are shrouded in a thin coating of another heat-resistant material. This coating prevents the cable from sticking to the rest of the silicon carbide. All this happens at micro and nano levels.

The effect is like that of stitching in textiles. As a tear forms in the bulk material, at some point it meets one of the ceramic fibres, a cable. This makes it difficult for the crack to propagate. And even if the crack does continue around the cable, the fibres will hold the material together, rather like a reinforcing bar in concrete. This process can only succeed if the shrouding coating ensures that the bulk material does not adhere too strongly to the cable, for if the cable and the matrix form a whole, the mechanism's value will be limited.

"However, silicon carbide is an expensive material, which also oxidises quickly at high temperatures," Sloof says. "We think that it is possible to create CMCs using aluminium oxide. This would be cheaper as well as being resistant to oxidisation, but would have the drawback of being less strong."

CMC is already being used in gas turbines for power stations, but the reliability has not yet been sufficiently tested for use in aircraft engines. Sloof estimates that this will take another five years or so of research. Nonetheless, the first application is already known, the advanced F-136 jet engine that will power the Joint Strike Fighter.

Photo: Sam Rentmeester/fmax (met dank aan NedCar Born)

No more scratching

No other industry sets its paint standards as high as the automotive industry. A strong paint that will retain its gloss for years on end, helps to sell cars. This is why both paint and car manufacturers spend lots of money on the research and development of automotive paints. In recent years the emphasis has been on nanopaints.

Jos Wassink

The latest development in car paints is the rise of nanopaint. The trendy name reveals the use of minute hard spheres, discs, or needles in the medium or resin. With dimensions ranging from 0.1 to 100 nanometres (one millionth of a millimetre), the particles involved are smaller than the wavelength of light (500 nanometres average), which is why they do not obstruct the flow of light. This makes nanopaints beautifully transparent. However, nanoparticles are bigger than the resin molecules to which they become bonded. The macroscopic result of these extra molecular bonds is a hard, practically non-scratch surface.

Progress

Although the ideal nanopaint – hard as rock, clear as glass, and impregnable – does not yet exist, the progress in car paints in the course of a century is nothing short of spectacular. The first purpose-made car paints date from around 1920 and were directly descended from the primitive paints that were used to finish coaches. These were crude mixtures of ground pigment dissolved in natural resins and oils. They dried extremely slowly, and several coats were needed to obtain an opaque finish. As a result, in the early years it could take six to seven weeks to finish the paint job on a car. Whole warehouses were parked full of slowly drying cars. In spite of all this trouble, the cars soon started to lose their polished look, and after only a few months the finish became dull and chalky. Polishing was the only available option to bring back the gloss. Of course this would wear down the paint coat. The only advantage in those years was the fact that the vehicle's owner could easily touch up the paint without anybody noticing.

A century later, the research and development of nanostructure car paints is in full swing. Toyota started this in the nineteen eighties, recalls chemical engineer Dr Ing. Marie Louise Nobel. Last February she received her doctorate for comparative research of the properties of various nanoparticles in water-soluble car paints. Toyota was looking for a way to produce a stronger type of paint, and scientists expected the nanoparticles to form invisible staked layers inside the coating, rather like a kind of built-in armour. Mercedes uses nanoparticles (minute glass beads) in the paints of its luxury range of cars. Other parties in the automotive industry are being slower to adopt the new technology, as they fear the risk of increasing the price of their products.

Adhesion

A whole range of different nanoparticles has by now become available, both from mineral sources and completely synthetic in origin. For her research Nobel took a close look at three different types of nanoparticles, platelets, needles, and discs, or for the informed reader, montmorillonite (a naturally occurring mineral); boehmite (aluminium oxide needles), and laponite (synthetic crystal discs). She studied the effect of adding these to dispersions of resin (the paint medium) in water and to resin in an organic solvent. Nobel saw the best chance of commercial application for the needles, which are the particles that have seen the least research so far. Compared with natural nanoparticles the artificial needles offer the advantage of moving freely through the solution without sticking together.

Nanopaints will not remain limited to cars, but would also be ideal to protect solar panels

According to Nobel the strength of nanoparticles is that they forge a bridge between macroscopic properties and molecular structures. Boehmite needles for example, improve the adhesion between the needles and the other ingredients of the coating. In combination with the alignment of the needles at the surface of the coating the additional molecular adhesion results in the coating's improved resistance to impact and scratching.

But, as Dr Ir. Fred van Wijk says, other factors also play a role. Van Wijk completed his doctoral research in molecular ▸▸

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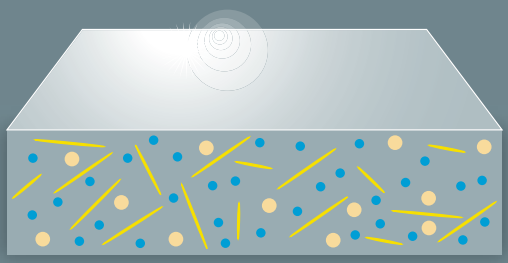
Photo: Nout Steenkamp/fMax

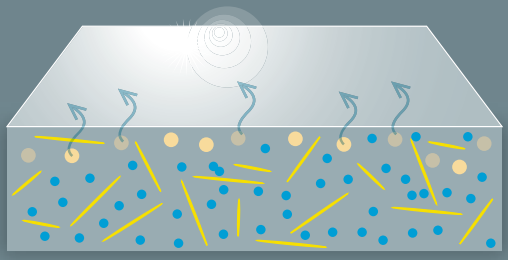
Nanopaint

1. Nanopaint consist mainly of solvent, resin, and nanoparticles.

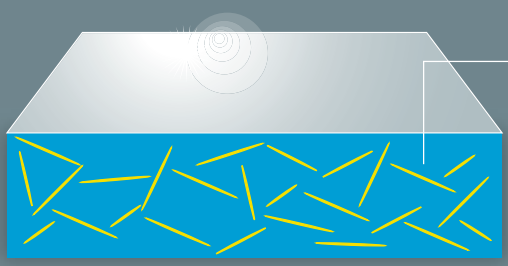
solvent
resin
nanoparticle

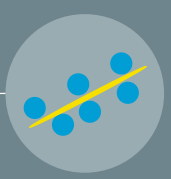


2. The solvent evaporates.



3. The resin adheres to the nanoparticles, causing clusters to form that bond together.





Cluster formed by nanoparticle and resin.

The macroscopic result of the additional molecular bonds is a hard, virtually scratch-resistant coating.

Measuring between 0.1 and 100 nanometres, the particles involved are smaller than the wavelength of light, which passes through unobstructed. Compare:

Particles measure approx. 50 nanometres.

Wavelength of light is approx. 500 nanometres.

Illustratie: Karin Schwandt

physics at Wageningen University and now works as an R&D manager for car paints at Nuplex Resins. He was involved in Louise Nobel's doctoral research as an industrial partner, as was Akzo Nobel Catalysts. "Nanoparticles affect the paint's viscosity," Van Wijk explains. "Large amounts of nano needles in the solution make the liquid thick and viscous when at rest. When the solution is stirred, the motion makes it thinner." Twenty years ago, long before the word nano was used, paint

'The strength of nanoparticles is that they forge a bridge between macroscopic properties and molecular structures'

manufacturers were adding long, corkscrew-like molecules to car paints to increase the viscosity. This helped the paint to stiffen the moment it was sprayed onto the bodywork, preventing sagging and running.

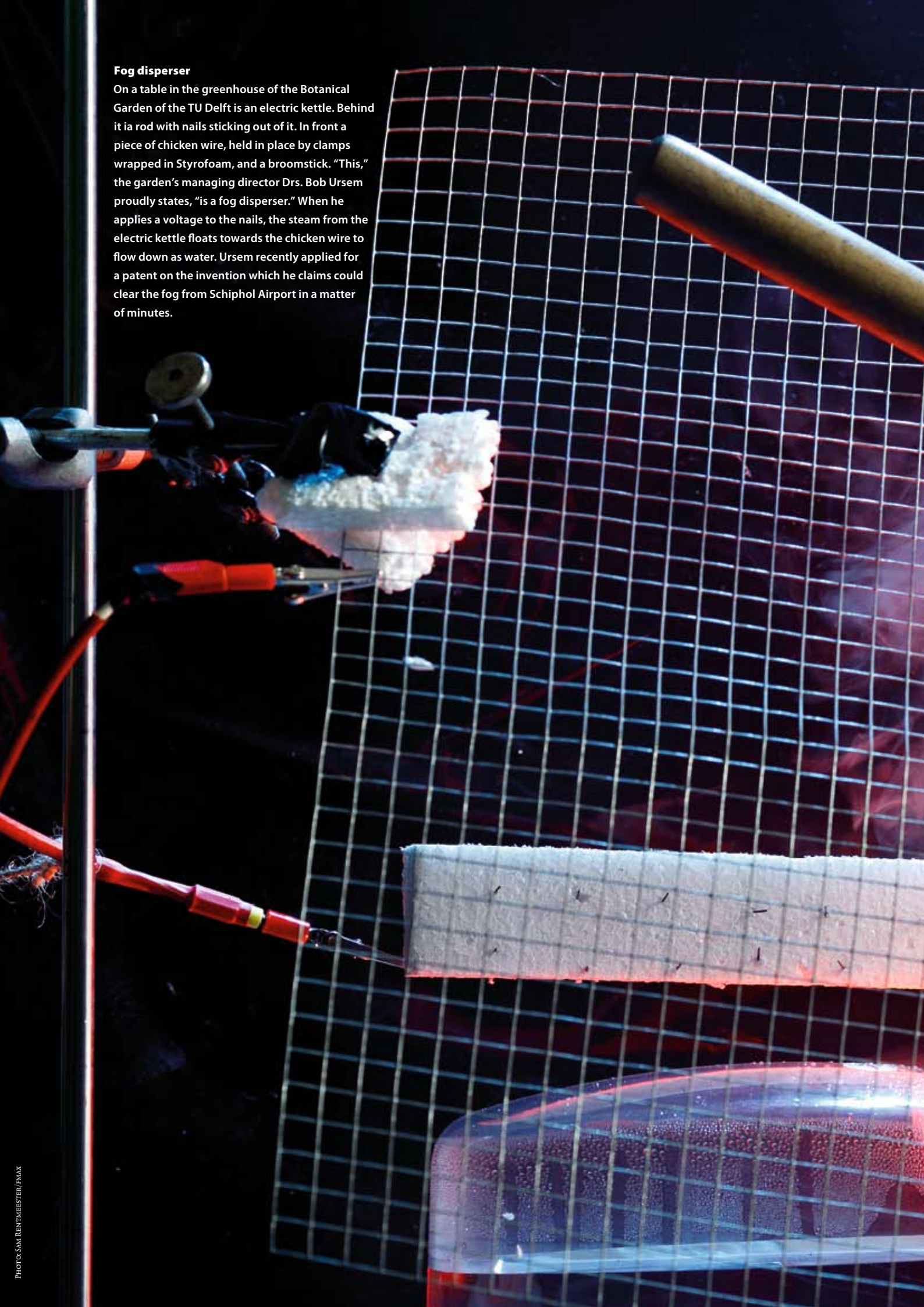
Gloss

These days such additives are given the nano tag, but the ideal additive still hasn't been found. If the impact-resistance of the paint is the object, according to Van Wijk the platelets (with a width that is 200 times their thickness) are the most effective, followed by the needles (up to 1000 times as long as they are thick), and finally the nanospheres. If sprayability is required, however, the order of preference becomes reversed. Too many needles or platelets make the paint too viscous. Choosing the right additive is therefore always a matter of compromising between handling properties and finish.

Meanwhile the standards keep being raised. According to Van Wijk car manufacturers these days inspect the quality of finish of their products after three or four years. It is important to them that a high-gloss finish be maintained as long as possible. This is because the average lease vehicle gets sold off after three years, and if still-glossy used cars become easier too sell, so do new cars.

As it is, the use of nanopaints will not remain limited to the car industry, Van Wijk expects. Once a clear, hard, and self-cleaning top coat has been developed, it would also be ideal to protect solar panels. A light breeze would then be all it takes to clear the dust off the panel's surface. ‹‹

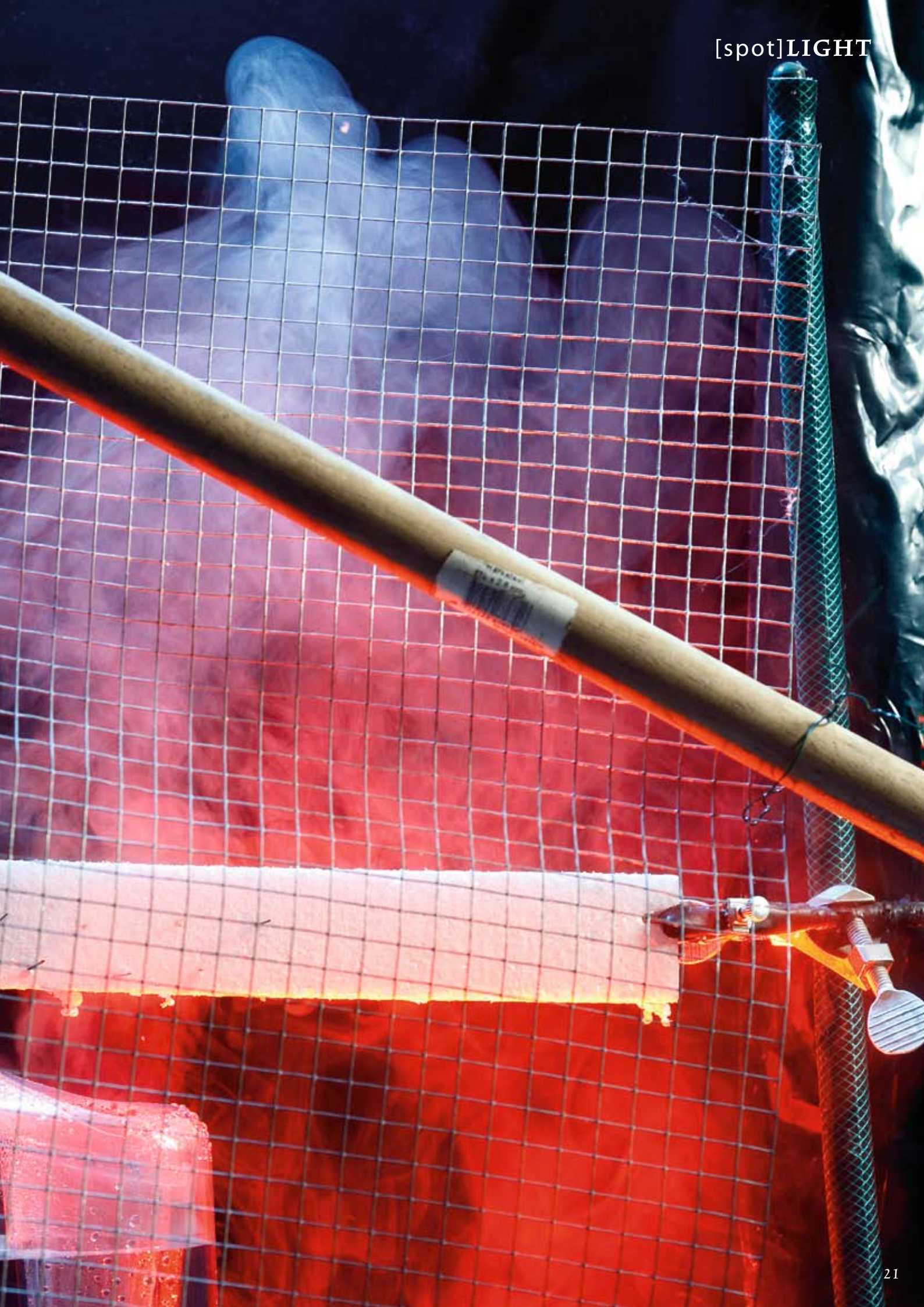
Photo: Sam Nentmeester/fmax [met dank aan NedCar Born]



Fog disperser

On a table in the greenhouse of the Botanical Garden of the TU Delft is an electric kettle. Behind it ia rod with nails sticking out of it. In front a piece of chicken wire, held in place by clamps wrapped in Styrofoam, and a broomstick. "This," the garden's managing director Drs. Bob Ursem proudly states, "is a fog disperser." When he applies a voltage to the nails, the steam from the electric kettle floats towards the chicken wire to flow down as water. Ursem recently applied for a patent on the invention which he claims could clear the fog from Schiphol Airport in a matter of minutes.

Photo: Sam Rentmeester/pmax



Photos: Sam Rentmeester

Modelling in air

Designers like to use gestures when they are talking about new shapes. Computers on the other hand can only understand the input they receive from something like a mouse. Researchers at the faculty of Industrial Design are working on a computer system that can understand gestures. Its purpose is to facilitate an intuitive way of 3-D design, interactively and remotely.

Jos Wassink

In the laboratory on the third floor of the Industrial Design faculty building the computers are humming. Big metal boxes hidden under the design table, they emit a purplish light. On either side of the table a set of three cameras are mounted on a high stand. Each camera looks down through a lens surrounded by a ring of red LEDs. Researcher Ir. Edit Varga has glued little pearl-like beads on her hands. When she moves her hand, a sphere on the computer display moves with it. "Designers like to work intuitively, sketching with their favourite pens and pencils. Until now, it was impossible to use intuitive design methods for 3-D designs," she says. Varga studied informatics in Miskolc at Hungary's oldest university, and is now working on her doctoral research in Delft. "We are trying to create a system that will let you quickly design and store a three-dimensional shape. Imagine an architect being able to design things together with his client. He would be able to position columns, sketch a roof shape. His client could then move the columns, or extend the roof a bit." Together they would be able to model a design within a virtual space. Varga: "It would make three-dimensional communication a lot easier, as well as more fun."

Gestures

Varga picks up an implement that looks a bit like a small rake, except for the fact that instead of tines it carries three tiny white spheres the size of matchstick heads. As soon as she starts to move the rake in the air over the table, a string of dots appears in six windows on the computer display. These are images produced by the six cameras as they observe the moving rake. Two hundred times each second, the system notes the position of each sphere with an accuracy of a tenth of a millimetre. Varga waves the rake about between the cameras, doing her best to fill the virtual space with dots. This ritual forms part of the calibration process of the system produced by the Motion Analysis Company.

This 3-D detection system is known mainly from its use in the animation industry to map actors' movements onto animated characters.
However, it takes more to use the system for 3-D design. Varga's assignment was to make the system understand gestures, and to make it communicate with a 3-D design program. Her supervisor, Professor Dr Imre Horvath of Computer Aided Design Engineering designed an alphabet of gestures, known as Hand Motion Language, or HML. It is a set of 39 gestures that can be used to describe a surface, pick up and move something, manipulate objects, resize things, orundo the previous step.

Virtual hands

Varga asked test subjects to create a hill in the virtual space, then place a cylinder on top of it and cap it with a roof. The result is like a Teletubbies lighthouse. Test subjects needed four gestures to complete the assignment. A flat palm can be used to pick up an object and move it about. As soon as you bend your fingers and pull back, the virtual design becomes detached from your hand and remains in place. A flat palm with the thumb stretched at right angles to the fingers indicates that an object is to be rotated,

The system lets you sketch in 3-D with all the spontaneity you want

and a fist marks the start or end of an action. The limited vocabulary proved to be easy to learn by the test subjects, who were soon able to start constructing their towers in virtual space. Varga conducted that part of her research at Iowa State University, because Delft was unable to provide a suitable stereoscopic display.
In the virtual space the test subjects see virtual hands that copy the movements of their own hands. The experience is one of total immersion in the virtual world, although the illusion tended to be be shattered from time to time when the connections in the data gloves worked loose. "You move your hand and you can immediately see the surface form under your hand, with the undulations following your hand exactly," Varga says. The demonstration is still a bit rough round the edges, and the number of gestures is limited, but the concept is clear. Varga: "We want to use the body to communicate with the computer because it is a more natural and intuitive way of working. To me intuitive means that you don't have to think too much about it, and that you get used to it very quickly."

Playing

According to Varga, the standard 3-D design programs are anything but intuitive. Open a CAD/CAM program, and you're immediately lost in a jungle of menus, unless you happen to be an expert. The new system can be used to sketch in 3-D, modelling air with all the intentional roughness and spontaneity you want. The 3-D shape is created in a program with the provocative name of Vague Discrete Interval Modeller, an invention by Dr Zoltan Rusak, who also works at the same Industrial Design department.
"It is a quick way of getting ideas into a computer," Varga says. "Shapes can be stored to be remodelled later. Designers like to be able to play with different ideas during the early design stages. That is the main idea."
At a later stage, it should be possible to export the 3-D sketch to a conventional CAD/CAM program for further processing.
The test set-up at the Industrial Design lab has recently been expanded with a holographical display. This Holovisio device is the eighth of its kind in the world. It consists of a flat, black box that somewhat resembles an oversized flatbed scanner. But when you look down into the box, you can see deeper than it actually is. To demonstrate, three interlocking gears are displayed floating 'inside' the display. The viewer doesn't have to wear special goggles and can still see depth. "This is just a manufacturer's demo," the researcher says. "We intend to use it to design quite different things." It's a remarkable machine. Since its 'contents' can be viewed from all sides, the Holovisio seems to be ideal for working in a group.

As a prototype, the current system is of course very expensive, but whether there is any demand for such a system and what it would have to costs are the least of Varga's worries. She had to bridge the gap between Horvath's gesture language and the 3-D sketching system devised by Rusak. And she is the first to admit that marketing all this know-how is not her forte. What she did do though, was to give a demonstration of the 3-D tracking system to the manufacturer of the detection system, who was suitably impressed and hadn't believed it possible.

Architect and client can now model a design together in virtual space

Photos: Nout Steenkamp/fmax

‘People are living in a car park’

You can get away from the stifling world of look-alike residential areas where traditional family dwellings have been elevated to the status of all-pervading standard. Part-time professor of housing construction Professor Ir. Dick van Gameren is convinced of it. “There is no need to stop at the outside.”

Joost Panhuysen

The Dutch embassy in Addis Ababa is one of those buildings that you feel you’ve seen somewhere before – in a dream, or in an Antonioni movie. It looks like a hybrid of an elegant, modern villa and a temple for a mysterious religion. Never before did a concrete building manage to look so earthy, with the outside being the same colour as the Ethiopian red earth. Architects Dick van Gameren and Bjarne Mastenbroek received the Aga Khan Architecture Award for its design in September.

Most people probably remember that the Aga Khan is a prince from a prominent Iranian-Indian family, but here in the West not so many people know that as a philanthropist he is on a par with people like Bill Gates and George Soros.

“We were happy when we received the award, but it wasn’t until the actual ceremony in Malaysia that I realised what an honour it is. Here in Europe the award is not very well known, but in Asia it is. Every three years the jury draws up a long list of thirty projects, and they send inspectors to view them. A building has to be in use for several years before it can be nominated. The jury focuses strongly on sustainability and sets great store by the links between traditions and innovation. This award was a statement against the garish architecture in Dubai. We intentionally introduced local influences. Ethiopia has a centuries-old Christian culture, with monolithic churches hewn from the bedrock in the Middle Ages. These buildings are in perfect unison with the landscape. The embassy building harks back to these magnificent churches. It contains cavern-like alcoves, and offices finished with timber panelling and marble. On the other hand, it also has glass facades. It combines the modern and the archaic.”

The eucalyptus woods surrounding the embassy must be the perfect backdrop to the building.

“The woods of Addis Ababa have almost completely given way to the endless urban sprawl. The few remaining hectares of woods around the embassy form a sort of oasis. Our intention was to make the architecture complement the landscape.”

Was it a difficult project? You couldn’t be in Ethiopia all the time to supervise the job.

“We were lucky that we were able to put together an excellent team on the spot. The one thing we wanted to avoid was to produce prefab buildings in the Netherlands. Collaboration with the locals was a major prerequisite. It demands a design that can be realised even in less than optimal circumstances.”

The local people must be proud of the result.

“Absolutely. We had about three hundred labourers on the site. Whereas in the Netherlands the labourer’s wages make up most of the total cost of a building, in Ethiopia the costs of the building materials is what determines the price. A day’s wages is only a few euros. We intend to use the award money for a new project in Addis Ababa, using the same people. It’s going to be a housing project for the very poor.”

In your acceptance speech you signalled a dip in Dutch housing architecture, following the highs of the nineteen nineties. I quote: “How can we prevent the landscape from being overrun by nondescript and utterly interchangeable residential areas?”

“Let me go back a bit in time. When I started my architecture studies in Delft in 1981, we were also in a period of stagnation. When I was a student we kept hearing that we would be better off finding something else to do. There was little demand for architects. Even worse, in that year there was even talk of closing the faculty. That was the only time I joined a protest demonstration in The Hague. While I was at university you could see the change taking place. The Mecanoo firm of architects played a major role in the process. During the nineties architecture finally returned to its status as a cultural assignment.”

What does that mean?

“It means that the question is no longer just how many houses we can build for the least outlay.

Dick van Gameren (Amersfoort, 1962) at first thought he wanted to become an architect to restore old buildings. “I was fascinated by castles. But then in my first year at Delft I discovered how fascinating it is to come up with an idea of your own.”
Van Gameren, a builder’s son who ‘grew up in the building industry’, began his professional career in 1988 at the Mecanoo design offices. Three years later he and fellow student Bjarne Mastenbroek started an architect’s office in Amsterdam. Their collaboration would last more than twelve years. During that period the partnership won various awards, including the Europan II for their design to adapt the historic Hessenberg neighbourhood in Nijmegen, and the Schools Award for their extension to the Bredero College in Amsterdam North.
In 2005 Van Gameren started his own architect’s office and became the successor to Ir. Max Risselada, professor of housing construction at Delft University. He was a lecturer at the Berlage Institute and the Academy of Architecture in Amsterdam. In his book *Revisions of Space* he used examples to explain his views on architecture. Van Gameren is married to urban planner Annenies Kraaij and has two young daughters.

'We used to have a fine housing tradition, but we have squandered our reputation abroad'

Architecture became an item on the political agenda. My generation was able to ride the wave of these changes. During the nineties architects had lots of work, and there was ample room for experiments."

Where did it all go wrong?

"That was when the economy went down in 2001. Architecture is extremely sensitive to changes in the economy. As soon as things take a turn for the worse, everyone, and building principals in particular, starts to play safe. Another factor is the way clients themselves have changed. During the seventies and eighties, housing was to a great extent a matter for the government. Today housing corporations have become independent, and housing construction has become much more the territory of private developers."

Is that a bad thing?

"Yes. I know that the free market has become a buzzword, but it means that innovation becomes bogged down as soon as the economy starts to falter. In my opinion housing architecture is stagnating. Quality is deteriorating fast. We just keep laying out whole areas with run-of-the-mill housing."

In your acceptance speech you showed an example of this development, Oosterheem, a housing development in Zoetermeer.

"That development is the stuff that nightmares are made of. Endless rows of family homes. Just because that is what the market demands. The problem is that given the current conditions, it is no longer possible to create a proper suburb. A normal house of that type should have a front garden and a back garden, but now that the price of building plots has soared, the number of houses per square metre keeps rising if the plan is to be financially viable. The front or back garden, and sometimes both, are sacrificed to leave room for the family car. Lots of houses, and then lots of cars, all crammed into a limited space. Today's family house no longer has the quality it used to have in traditional suburbia. Instead of living in a green belt, people are living in a car park. It's neither town nor country."

There is nothing new about that last problem.

"True, but it has become worse. We used to have a housing tradition we could be proud of, but I think we have squandered our reputation abroad by now. A staff member of my department was recently invited by a German magazine to write an article to answer the question, what had happened to housing construction in the Netherlands?
It sometimes looks as if people are trying to compensate for the endless repetition of identical family homes by varying the architecture of the facades. But it's all about what is behind the facade, and that is the same everywhere you go. Downstairs living room, three bedrooms upstairs, and a small open kitchen on the ground floor at the front with a window over the sink. That's the thing people will buy. You don't run any risk with that. And to ensure that the variation in facades remains economical, the insides of the houses become even more standardised!"
Another major drawback to this housing monotony is their rigid layout leaving no room whatsoever to change with the times. Everything has been built up, and every minor thing has its proper place in the overall plan. If people in ten years' time were to discover that they preferred living in a slightly larger house, but without a car, the area will have become outdated. With my department I want to develop models for houses and neighbourhoods that have future value." He grins: "The life-span of neighbourhoods continues to decrease. Who knows, today's housing developments might be ready for pulling down in ten years time!"

Are there any examples of good housing developments?

"A lot of criticism has been levelled at IJburg, but it is nonetheless a good example of a neighbourhood in which an attempt has been made at variation. The building density varies – because the housing density is higher than average in places – and the types of houses aren't all the same. It also has a mix of residential and commercial functions. Unfortunately the ambitions for IJburg have now been tuned down a bit. The later parts are more uniform."

What do you think of today's penchant for retroarchitecture?

"I can understand why housing developers like to fall back on styles and appearances from the past. The old neighbourhoods weren't so densely built up and could offer more variation, especially in town centres. But retroarchitecture is false. It suggests that you are living in a neighbourhood that has slowly acquired its own character over the years, but that's only on the outside.
I would like to make a case for not stopping at appearances. Architecture is all about the use of space. How can you ensure that a space can later be used in an entirely different way? How can you create the best transition from open to built-up space? How do you create attractive communal areas that render less abrupt the transition from private space to public space? The past has some magnificent examples from which we can take inspiration without indiscriminately copying the image.
My buildings are far from traditional, yet I have never felt the past to be a burden. Architecture cannot evolve out of nothing. There is always some sort of precedent, and a building can be much better and richer if you're aware of the fact. In 2000 I designed an office building in Steenwijk in which I incorporated the 'motion' through the building in a quite complex manner, as a route with constantly changing perspectives and views. This is one way of giving a building a character of its own. That building's design was strongly influenced by Hardwick Hall, the sixteenth century English country house. On the outside it looks nothing like it though."

As professor of housing construction, you now occupy the chair of a teacher from your student days, Max Risselada.

"This is very special for me. I have had two major teachers. There was Risselada when I was a student, and afterwards there was Francine Houben of Mecanoo, where I worked for a number of years. Max has the knack of making his students recognise the qualities of a particular design by having them look very closely at it. Architects, and teachers of architecture in particular, tend to put their own view foremost, but Max didn't. It wasn't until later that I understood how unusual that is, and I now try to do the same. Of course I like to bring my own views across during my lectures. But when you are supervising students one on one in a graduation project studio, the trick is to put yourself in de students' shoes. Francine Houben taught me how to survive as an architect, and how to make sure your ideas actually become realised. That is something you can only learn out in the real world."

Should you be able to stand up for yourself, or is it a matter of enticing others?

"A bit of both, actually. You have to be an all-round therapist. Sometimes diplomacy is called for, and at other times you have to show them where the buck stops. The trick is to find the right approach for each different occasion. You have to be a strategist."

Can you name a typical beginner's mistake for an architect?

"The weird thing about this occupation is that everybody seems to have an opinion about it, whereas a physicist's authority in his field is taken for granted. As an architect you have to be able to avoid obstacles. Even though a client asks you to be the architect, you cannot simply defend your choices by stating that you are the designer making the decisions. That is a common beginner's mistake. If you're capable of developing ideas that can survive the criticism of all the parties involved, you are a good architect, if you ask me."

So when did you manage to do that best?

"Perhaps it was when I did the Addis Ababa embassy building."

www.vangameren.nl
abeba.html

Photos: Sam Rentmeester/FMax

Professor Dr Ir. Jan Buijs

"I think of first-year students as future colleagues, too."

Inspiring

Professor Dr Ir. Jan Buijs (1948) graduated in 1976 at Delft University of Technology on the business management variant of industrial design. He spent the next ten years working as a business consultant at TNO. In 1984 he was the first Industrial Designer to receive his doctorate, for 'Innovation and Intervention'. Two years later he became professor of product development policy and organisation at Delft University. He researches collaboration between different kinds of designers. With Rianne Valkenburg he co-wrote 'Integral product development', an elementary textbook for industrial design students.

In the **Mastermind** series a professor and a (former) student each answer the same questions to create a double portrait.

How would you describe one another?

Buijs: "Rianne is enthusiastic and driven. She can enthuse people. What I missed most about her when she had left, was her laughter. We really have a nice atmosphere here, people laugh a lot."

Valkenburg: "Jan is very creative, he always comes up with things you don't expect. I have never caught him out not wanting to do something. He is never bad-tempered. Jan teaches a ridiculous number of classes, but I have never heard him say he did not feel like taking a group. There is a kind of passion behind it. He loves his subject and wants to put that across to others. Sometimes we're teaching together and I look at the students and think how passive they are, but Jan always understands, and says things like, 'Never mind, they must have been out on the tiles last night'."

What sets the other person apart?

Buijs: "Rianne stands out because of her Rotterdam way of thinking, the no-nonsense, go-getter approach. She is autonomous, claims her space. Don't dawdle, just get the job done. I knew what I was doing when I asked her to be my student-assistant. She gets things done."

Valkenburg: "Jan does not control you, but he is inspiring. He always tries to get you brainstorming, and he will never push you in one direction. The same goes for his doctoral teaching. You get your subject and you go your own way. I believe I once shouted out at him that I couldn't be expected to predict the consequences of my actions. It takes getting used to. After all, it's much easier to have someone give you a list of books to read. Freedom, that's what Jan is about. Mind you, he is there to help, he wouldn't let you drown."

What did you learn from one another?

Buijs: "Rianne has taught me that any confidence you put in people repays itself. I give students, trainee assistants, and doctoral students a relatively high degree of freedom, and I need to feel that my trust is not abused. In that respect Rianne has restored my confidence in humanity. On a professional level she was the first to really work with design teams, even though we did not have a research tradition. She has taught me that industrial designers are perfectly capable of doing research."

Valkenburg: "Jan has taught me in particular to stick to my principles. Do that, and everything will be all right. Jan is very consistent, which gives him credibility. The two go together. You know in advance what his response will be. Sticking to your principles also has to do with the freedom Jan gives. Creativity is in his blood. If you can use that in the right way, you can go a long way."

Dr Ir. Rianne Valkenburg

"You have to want to learn something from one another, and to achieve something together."

Driven

In 1992 Dr Ir. Rianne Valkenburg (1966) graduated as a student of Jan Buijs to become his student assistant. She then worked ten years as a lecturer of Innovation Science, and with Buijs she co-wrote 'Integral product development'. She received her doctorate in 2000 for her research on the collaboration in design teams. In 2003 she moved to Groningen to become lecturer of Human Technology at the Hanzehogeschool. In 2007 she went to work for Partners in Perspective, a business consultancy firm in Amsterdam.

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

Buijs: "Giving and receiving trust. Being one another's equal. I don't think of the teacher-student relationship as a hierarchy. I think of first-year students as future colleagues, too. I know more about some things, and they know more about others. The word 'pal' implies another type of relationship, and the word 'pupil' never strikes me as quite right. In my book there is very little between us. Distance has never played a role between Rianne and me. Rianne was the youngest of four girls. I believe her sister's boyfriend is my age."

Valkenburg: "Mutual respect. You need to want to learn from one another, and to achieve something together. In discussions, Jan treats you as his equal. This teaches you to form your own opinion, something you can only do if a person is genuinely interested in what you have to say. Jan also is genuinely interested in your opinion."

Was your relationship more like that of a father and daughter, or like a married couple?

Buijs: "Neither. I consider even the word 'pal' too personal. I don't think family analogies work. They don't fit. Father, daughter, spouses, these things don't matter. It is a professional working relationship. Perhaps it is like a trainer-player relationship. Like in tennis, but not the way you see with certain women coaches. The words 'team members' describe the relationship most closely."

Valkenburg: "Certainly not father and daughter. I sometimes rib him over the fact that he started as a student in Delft in 1966, while I was born in 1966. He doesn't like that. So yes, our relationship is more like that of a married couple, but it's a couple that's still on speaking terms."

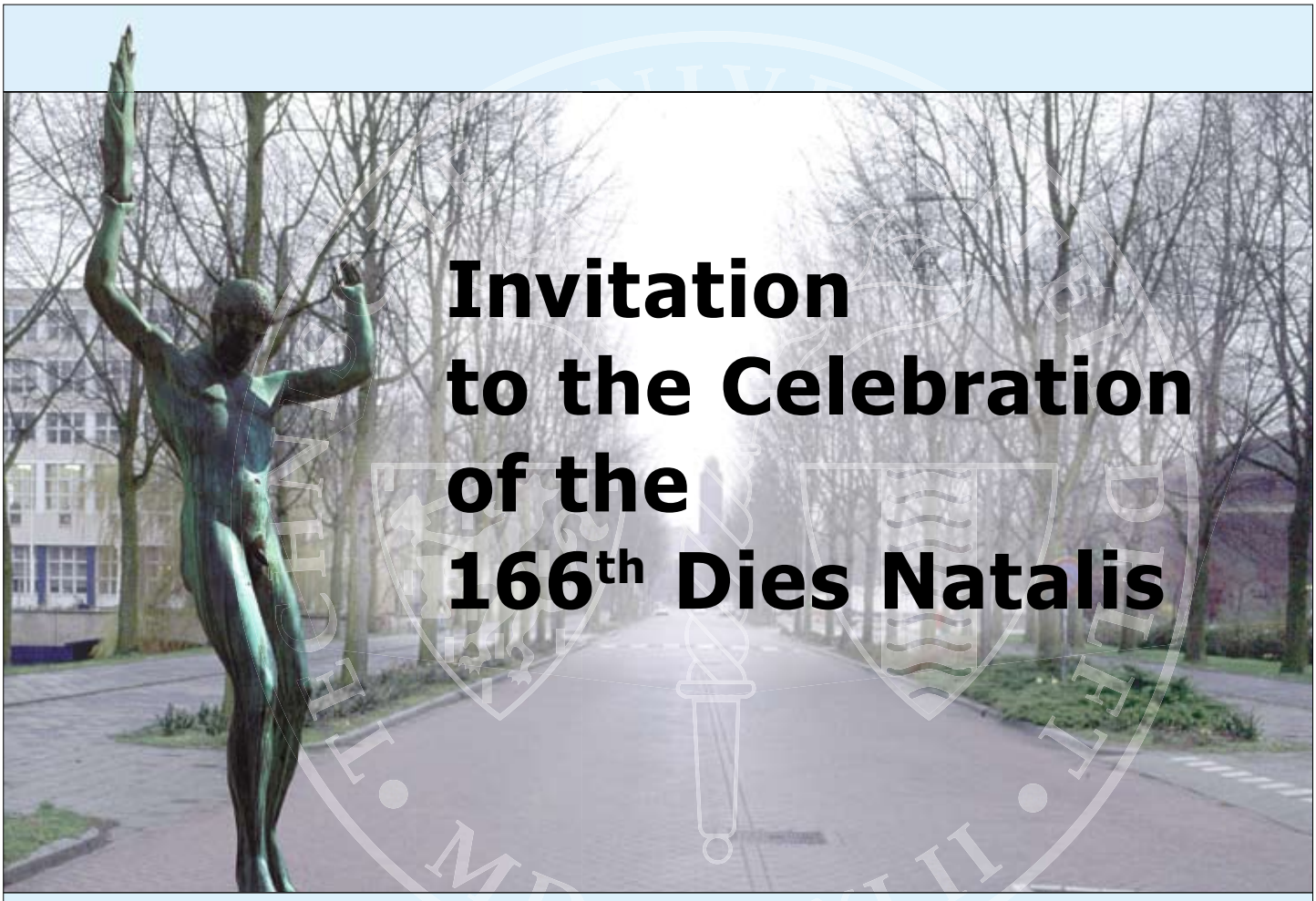
Are you ever at odds about the direction your research should take?

Buijs: "I never fall out with people. We do fight for our opinions though, and that can lead to heated discussions, but fall out? No. Again, it is all about freedom and trust. In our book you cannot tell which one of us wrote which chapter. We don't mind letting the other work on our texts either."

Valkenburg: "I don't think we ever have. Neither of us is aggressive. We're builders. If there is an idea, we both tend to improve it a bit. There is a lot of synergy."

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

Buijs: "The greatest disappointment was when Rianne moved to Groningen. I was overjoyed on her account, but it meant losing one of my most experienced and dyed-in-the-wool staff members. It was rather a blow."



Invitation to the Celebration of the 166th Dies Natalis

On behalf of the Executive Board, the Rector Magnificus, has the honor of inviting you to attend a ceremony marking the 166th Dies Natalis, of Delft University of Technology.

This year's program will include a farewell speech to Mr. G.J. van Luijk, President of the Executive Board, on the occasion of his imminent retirement.

Following the ceremony, there will be a reception to meet the Dies Natalis lecturer and also to meet Mr. D.J. van den Berg who is appointed President of the Executive Board as from March 1st, 2008.

The ceremony and the reception will be held on **Friday 11 January 2008** in the Aula Congress Centre at Mekelweg 5 in Delft and will commence at **15.00 hours**.

Since access to the ceremony is by invitation only, we kindly request you to return the enclosed reply card no later than **Wednesday 2 January 2008** if you wish to attend.

Please be seated in the auditorium by 14.45 hours at the latest.

Programme (Auditorium)

Opening
Prof. Jacob Fokkema, Rector Magnificus

Keynote speaker
Dr. Charles Vest, President National Academy of Engineering, Former President MIT:
The University of Tomorrow: Innovation, Competition, and Cooperation in the Knowledge Age

Musical interlude

The Dies Natalis lecture
Prof. Inald Lagendijk, Professor at the Faculty of Electrical Engineering, Mathematics and Computer Science: *Get Real! Reflections on Trustworthy Virtuality*

Speaker
Drs. Loek Hermans, Former Minister of Education, Culture and Science in the Netherlands, President MKB-Nederland: *Van plank tot plank*

Interlude

Closing speech
Hans van Luijk, President of the Executive Board

Closing of the ceremony
Prof. Jacob Fokkema, Rector Magnificus

Reception (Foyer)

To attend the ceremony please send an e-mail with your name and contact address to: m.a.schrijvershof-vink@tudelft.nl

VALKENBURG: "I think our book is one of our major milestones. There was no book for first-year students, so we thought we'd write one. It has become a standard."

Do you socialise?

BUIJS: "When we have something to celebrate, we invite one another. Rianne lives in Groningen, I live in Utrecht, and this evening she will come to dinner at my place. We socialise on a regular basis within my section. We are on an equal footing."

VALKENBURG: "Yes, Jan does come all the way up to Groningen. Only recently he showed me all over Utrecht when I was house-hunting."

Name one another's best habit.

BUIJS: "Her infectious cheerfulness. That laugh. I think that is her best quality."

VALKENBURG: "His positive outlook. You never get a chance to grumble. Things will always get better. According to Jan there is always a bright side to whatever you're grumbling about. Everything has a bright side in his world."

And the worst?

BUIJS: "I couldn't think of a bad quality in Rianne."

VALKENBURG (laughs): "The answer he just gave. He's always telling white lies. No, I wouldn't know what his worst habit is. Or wait, the freedom Jan always gives can be difficult from time to time. Sometimes it's easier to have a boss simply telling you what to do."

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

BUIJS: "Rianne's doctoral thesis made us take the phenomenon of design teams seriously. It was a field of research that nobody had studied, even though everybody knew you never do things alone. That was Rianne's breakthrough for the profession."

VALKENBURG: "Jan was the first in the profession to introduce a systematic approach to innovation, as well as attention for the people who have to do the work. So in addition to the 'hard' side of processes and methods, there was attention for the 'soft' side as well: teamwork and creativity. In fact, it makes industrial design students trained at this place rather unusual, non-typical engineers, who also look at things from a human perspective."

What more can we expect from the two of you?

BUIJS: "We have this idea in our heads that we need to publish another book, but there's no telling whether it's actually going to happen. If we get the chance to work together on projects, we will certainly do so."

VALKENBURG: "We intend to publish a new version of our book every couple of years."

Marital status
Buijs: Married
Valkenburg: Live-in partner

Favourite book
Buijs: *Synectics* by Bill Gordon
Valkenburg: *The reflective practitioner* by Donald Schon

Favourite newspaper and magazine
Buijs: de Volkskrant, BusinessWeek
Valkenburg: NRC Handelsblad, readers' letters in magazines

Invention you'd like to be yours
Buijs: the DAF Variomatic
Valkenburg: A cure for AIDS or cancer

Photo: Nout Steenkamp/fmax

Ethics for engineers

From obscure subject to compulsory part of the curriculum

About ten years ago ethics became a compulsory subject for most of the students at Delft University of Technology. It was a paradigm shift. Until then, ethics had long been viewed as an obscure subject, one that scientists had better steer clear of. After all, ethics is all about subjective judgements.

Henk Makkink

A wastewater treatment plant removes certain, statutorily defined, hazardous compounds from wastewater. Other hazardous compounds exist that are not mentioned in the applicable laws. Should these also be removed? And if so, who is responsible for doing so? Should you design medical equipment that can be used to keep vastly premature babies alive, who as a result will remain handicapped for life requiring constant specialist care? What conditions can be set if you're asked to help develop aircraft, cars, or air-conditioning units that run on energy provided by fossil fuels, thus adding to the greenhouse effect?
These are the kind of questions pondered by Delft master students attending the compulsory Ethics and Technology lectures. They are not required to come up with cut-and-dried answers. Nor are the lecturers. They are not there to impose their own set of moral standards. But matters of conscience and questions about what is and what is not morally acceptable are not shirked.

Recognising dilemmas

Engineers in the making have their own responsibility and they require a certain mindset, knowledge, insight, and skills to handle this properly. The ethics group of the Philosophy section at the Faculty of Technology, Policy, and Management provides these. "We think it's important for future engineers to start considering any ethical issues and dilemmas they may encounter in their professional career while they are still at university," is how the Board of the University justifies the focus on ethics. It is a view that until the early nineteen nineties was far from ubiquitous. The thinking in Delft at the time was that ethics is about subjective judgements, and that did not fit in with the subject of philosophy, which had to be about neutral logic. Any connection with the regular engineering education was regarded with the utmost suspicion. Philosophy classes were attended only by a handful of enthusiasts, and then without any obligations, the way a professor might occasionally consider the ethical side of his profession.
Up until the Second World War, the classics were only allowed to creep into the curriculum piecemeal. To counterbalance the one-sidedness of the technical curriculum, a professor from Leiden University, J. Huizinga gave cultural philosophy lectures between 1928 and 1932. A new impulse was given in 1946 with the establishment of the Studium Generale foundation, whose many talks on such themes as religion, philosophy, art, and psychology found great favour among the students. Its foundation had been stimulated by the horrors of the Second World War, which had become so grotesque mainly as a result of the advances in science and technology.

Chairs

The need for reflection at what was then the Delft Academy of Technology about the meaning and the possible effects of the developments in science and technology in 1952 resulted in the introduction of a chair of Philosophy 'in particular in its relationship to technology'. The chair became permanent with the appointment – in true Dutch denominational fashion – of three associate professors, Dr Ir. H. van Riessen for Calvinistic philosophy, Dr L.G. van der Wal for humanistic philosophy, and Dr Ir. F.P.A. Tellegen for Thomistic (Catholic) philosophy. There was an 'Introduction to philosophy' for all students, and for the more advanced students there were such subjects as 'Technology and culture' and 'From technology to philosophy'. Van Riessen gave lectures in 'philosophy ▸▸

Professor Doorman

Professor S.J. Doorman MSc, Delft professor of philosophy (logic, methodology, philosophy of science, scientific critique) from 1972 to 1994, and former chairman of the VPRO broadcasting association. He advised on how to set up the Ethics and Technology programme. His opinions on the subject include: "Moral issues are often camouflaged by practical concerns. The first person to try to decode our genetic makeup could not envisage what the consequences in our time would be. Just think of the possibilities offered by cloning. And the same goes for many discoveries and inventions. We used to think in terms of neighbour ethics, i.e. what would be the effects of this development on for my neighbour? These days you have to think in terms of predicting the effects on generations to come."

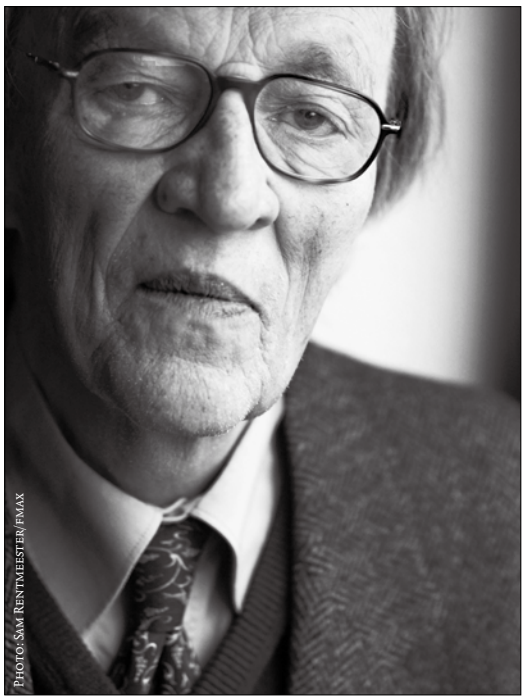


PHOTO: SAM RENTMEESTER/FMAX

Platform for Ethics and Technology

On 7 November 1996 the University's Board established the Platform for Ethics and Technology with the purpose of 'identifying ethical issues that crop up engineering practice and developing methods for systematically addressing these issues'. For this purpose the Platform regularly organises activities throughout the university such as annual working conferences on ethical aspects of the engineering profession. The Platform also stimulates discussions at faculty level and Awards annual and biennial Mekel Prizes for the best essays on the ethics of technology.

of technology'. Starting in 1966 Professor Dr W. van Dooren lectured on humanistic philosophy in 'modern philosophical problems'. In 1968 Professor Dr W.A.M. Luijpen at the Roman Catholic St Radboud Foundation started with lectures on philosophy in which existentialism and phenomenology received ample attention. In 1972 Delft University instituted a normal Philosophy professorship, and Professor S.J. Doorman MSc became the first professor of philosophy.
Following the student revolts in the late nineteen sixties, the social sciences became more popular than ever. During the seventies, one faculty after another introduced the compulsory subject of Technology and Society, which has remained part of the curricula ever since. Philosophy lecturers also spent time dealing with the ethical aspects of technology. For example, Van Dooren considered the ethical problems resulting from the development of science and technology, and he discussed current issues with his students. In 1974 Professor Dr Ir. E. Schuurman continued the cultural philosophy lectures started by Van Riessen, using one series to focus on philosophical observations on the development of computers and cybernetics, and the growing influence of the computer on the cultural and social aspects of life in general. This later became the Ethics of Technology subject. Dr L.C. Fretz also investigated the ethical aspects of technological developments during the nineteen seventies and eighties.

Responsibility

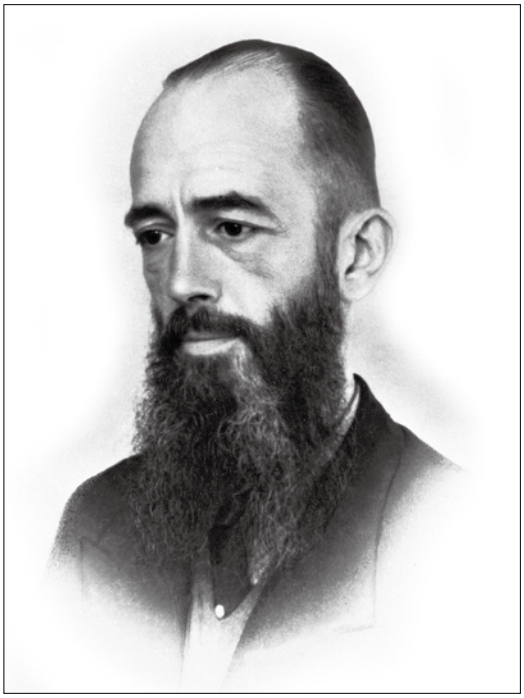
The subject of Ethics of Technology was approached in a theoretical and abstract manner, remote from the daily practice of the engineering profession. For a future engineer it had little to offer. During the early nineties, Parliament and Dr Ir. J.M.M. Ritzen, the Minister of Education, Culture, and Sciences, initiated the discussion about the ethical aspects of science and technology. Prompted by a parliamentary resolution, the minister in 1991 issued the memorandum, 'Framework for discussions about ethical aspects of scientific research', with contributions by seven other departments. One year later, a passage was included in the Higher Education and Scientific Research Act addressing the ethical aspects of scientific research.
The Board of Delft University accepted its responsibility and in 1993 appointed an advisory committee for ethical guidelines, led by the philosopher Professor S.J. Doorman MSc, to provide recommendations on the purpose, nature, planning, and methodology for the new subject. The university adopted the recommendations, and in 1995 decided that the latter stages of all curricula, i.e. today's master's degree, should include compulsory subjects dealing with the ethical aspects of technology, the natural sciences, and the engineering profession.
In this way Delft University of Technology could contribute to the education of engineers with a professional sense of morals. In the following year, the Philosophy section was given the task of developing and teaching these subjects. By then Professor Doorman had passed the supervision of the Philosophy section on to Professor Dr Ir. P.A. Kroes. This helped to change

Denomination education

The chair of Philosophy was established in 1952 in true Dutch denominational spirit. Dr Ir. H. van Riessen (right) was engaged for Calvinistic philosophy, Dr L.G. van der Wal (left) for humanist philosophy, and Dr Ir. F.P.A. Tellegen (centre) for Thomistic (Catholic) philosophy.

Source of the Photographs of Van der Wal en Riessen: Archief TU Delft,

Source of the Photograph of Tellegen: Katholiek Documentatie Centrum, Nijmegen



Professor Mekel

Delft university professor Dr Ir. J.A.A. Mekel, member of the Dutch resistance during the Second World War, was executed in May 1942. To commemorate him, Delft University of Technology has instituted the Mekel Prize. The purpose of the prize is to stimulate students to think about the ethical issues connected with technology, and is awarded to the person who writes the best essay on the relationship between ethics and technology. In fact there are two prizes, an annual Mekel Prize of 500 euros to be awarded to a student, and a biennial Mekel Prize of 1000 euros for which doctoral students, trainee teachers, and trainee designers can compete.

Professor Dr Ir. E. Schuurman lectured about the increasing influence of the computer in society

the subject from an abstract course into an application-focused philosophy of technology.

One of the first

After the two-year initial phase, other faculties also started to include Ethics and Technology in their curricula. During the 1998/1999 academic year, some seven hundred students from nine out of fifteen courses were attending Ethics and Technology. This made Delft one of the first European universities to make compulsory ethics education a major item on the curriculum. With the increase of ethics education and research, and with the development of the Philosophy of Technology foundation, the Philosophy section grew from an academic staff of two in 1995 to 25 today.
The development of the Ethics and Technology course made good use of the experience the technical faculties had gained with the project-based Technology and Society curriculum, which is maintained and supervised by the technology staff themselves. The course uses a technology-based approach that appeals more to students than purely non-technical courses. The Ethics and Technology department's own staff work in close collaboration with lecturers from the Philosophy section on real-life examples from the faculty's field. Faculty staff ensure that the content has the required level, while philosophy lecturers provide knowledge about the theory of ethics. Knowledge of ethics is required as the course focuses on the responsibility of the engineer as an individual who can be held accountable for his actions. This so-called joint venture teaching model has proved successful.

Satisfied

The master's programmes in Biochemical Technology and Life Science and Technology, Ethics and ▸▸

Ethical parallel research

Besides providing teaching, the ethics group of the faculty of Technology, Policy, and Management in 2002 set up a research programme. The ethics groups of the three Technical Universities in Holland (Delft, Eindhoven, Twente) recently combined forces in the 3TU Centre for Ethics and Technology, which was opened by Dr P. Winsemius, former Minister of Housing, Spatial Planning and the Environment on 24 January 2007. The centre found accommodation on the Campus The Hague in the town centre, an initiative of Leiden University and Delft University of Technology where it would be in a position to inform the government in The Hague about ethical issues involving technology.
The three ethics groups take it in turns to run the centre, which is a joint effort. For the next three years, it will be Delft, with Professor Dr Jeroen van den Hoven as Scientific Director and Dr Ir. Ibo van de Poel as Managing Director. The ethics centre focuses on the five main areas of interest for which the 3TU Federation has established Centres of Excellence: sustainable energy, nanotechnology, information and communication technology (ICT), high-tech systems (mechatronics), and dynamics of fluids and solids. An excellent assessment by the Association of Universities in the Netherlands VSNU enabled the 3TU ethics centre to become the sixth Centre of Excellence. The ethics centre will conduct what is known as ethical parallel research at the other centres. This is research in which ethicists actively observe the engineers at work, helping to identify and address ethical issues, and to improve the handling of such issues, in order to ensure that innovation follows a responsible course. The centre is the first in the world to use this approach. More information about the centre can be found at www.ethicsandtechnology.eu.

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

The prizes for the best student essays on technology and ethics were awarded early in November to **Ir. Taco Broerse** (Aerospace Engineering) and **Ruud Brands** (Civil Engineering). Broerse wrote about the dilemmas facing the Google company, which has installed a search engine with built-in censorship in China. Brands scrutinised biofuels and discovered a badly run industry. The Mekel Prizes are awarded each year by the Platform for Ethics and Technology.

On Friday 19 October lecturer **Ronald Slingerland** (46) and test pilot **Poppe de Lange** (70) were killed when their pleasure aircraft collided with another aircraft near Lelystad airport. De Lange used to conduct flight tests for Delft University and after his retirement continued doing introduction flights with students on a freelance basis. In addition to supervising flight tests, Slingerland gave lectures in basic aircraft design at the Design of Aircraft and Rotorcraft section.

The eighth guest writer of Delft University of Technology is to be **A.F.Th. van der Heijden**, who succeeds the 2007 guest writer, Tommy Wieringa. In 2008 Van der Heijden will work on a movie scenario together with twenty students. The new guest writer's proposed movie project was inspired by the German Cultural Philosopher Walter Benjamin, who in 1936 analysed the influential social role of the medium of film in his book, 'Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit'. Van der Heijden is to discuss the subject in his introductory lecture.

The Dutch ambassador in China, **Dirk Jan van den Berg** (53), is to succeed Hans van Luijk as chairman of the University's Board. De University Supervisory Committee has approved Van den Berg's appointment as per 1 March 2008. Van den Berg has over twenty years of managing experience at very high executive levels. In his capacity of secretary-general he has reorganised the Foreign Ministry. Above all, Van den Berg is an exact scientist, who graduated with honours in 1980 at Groningen University, where he studied econometrics.

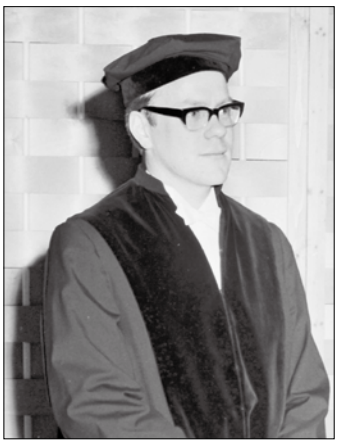
The Delta Committee, which was appointed this autumn by the Minister of Transport, Public Works, and Water Management, needs to urge the government to rapidly overhaul our sea defences, according to Professor of Coastal Engineering, **Professor Dr. Ir. Marcel Stive** of the faculty of Civil Engineering and Geosciences, who is a member of the committee. According to the professor, half of our dikes do not meet the safety criteria for flood protection, and of a quarter is unknown whether they are high and wide enough.

People used to laugh at the ornicopter, a flapping-wing helicopter without a tail rotor constructed by Professor **Dr Ir. Theo van Holten** at the faculty of Aerospace Engineering. "They used to come up to me to ask whether I'd ever heard of Newton's laws." On 5 October the professor of aircraft performance theory retired from his university work. Van Holten (65) studied aircraft engineering at Delft University in the nineteen sixties. He then came to work for what was at the time the Technical Academy to lecture on, and conduct research into, helicopters.

On the occasion of his retirement as education co-ordinator for offshore engineering in September **Ir. George Lagers** of the faculty of Mechanical Engineering, Maritime Technology, and Applied Material Sciences, received a knighthood in the Order of Orange Nassau. Lagers was knighted for his efforts to promote the masters course of offshore engineering, which was introduced in 2004, and for his endeavours in the offshore industry.

The Betuwe railway line construction project is a prime example of good cost management. It is in fact exceptional, since budget overruns are the order of the day where infrastructural projects are involved. This is the opinion of **Professor Dr Bent Flyvbjerg**, professor of planning at Aalborg University in Denmark, who also holds a part-time post as professor of Technology, Policy, and Management since 26 September. For over twenty years, Flyvbjerg has been conducting research into large infrastructure projects such as the Franse TGV and the 'Big Dig' in Boston in the USA.

For twenty-five years he was professor of Urban Renewal at the Faculty of Architecture, during two of which he also held the deanship. In November **Professor Dipl.Ing. Jürgen Rosemann** retired. In his farewell speech at the symposium, that was held to mark the occasion, he looked out to the future rather than looking back. His message to the next generation of urban planners was to put thought into the concept of Permacities, cities that are sustainable not only in an environmental context, but also as social and economic entities.



Professor Dr Ir. W. van Dooren: humanistic philosophy in 'modern philosophical problems'

Technology combines theory with practice. The first section consists of a series of nine lectures followed by a series of nine group discussions about real-life examples. The theory offers analytical models and ethical ways of thought, based on normative ethical theories and professional ethics, providing a more secure basis for considering ethical issues and sharpening students' personal powers of moral analysis and assessment. Student participation takes the form of discussion, providing answers to questions, carrying out assignments, and participating in role-plays during fictional decision-forming processes. The second section consists of writing a thesis.
For most other university courses this subject is more limited in scope, while the second section is not compulsory.
Students are very satisfied with the Ethics and Technology classes. According to a survey conducted in 2003, 90 percent of them could clearly see the relevance of the subject to their study, while 70 percent thought the classes were useful. The general setup and teaching methods also received praise from the majority of students. The subject managed to survive the transition to the bachelor-master system completely intact in most curricula, gaining a place of its own in the highly technology-focused master's programme. This is indicative of the appreciation from the technical faculties involved. The Delft Ethics and Technology programme is now also being taken up outside Delft.

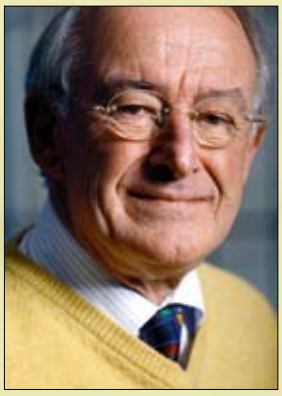
Over the past decades, Ethics and Technology has become increasingly practical, evolving into a subject that engineers can find a use for while, instilling specific skills required in the engineering practice. The development of the real-world focus of the Ethics and Technology programme has vindicated the old belief that philosophy needs a practical application in real life.

COLUMN

[SCHOONMAN]

Sustainable energy in Delft

Ever since Al Gore's movie 'An Inconvenient Truth' alerted the world to the catastrophic consequences of the greenhouse effect, sustainable energy has suddenly appeared high on the political agenda. Have we only now reached the point that we can make a start with the relevant research? Fortunately, things are not as bad as all that. Over the past decade, Delft University of Technology, together with other parties has put in a lot of work. However, state funding for sustainable energy has only decreased during the same period. Although the tide now appears to be turning.
In 1996 the University Board established the Delft Interfaculty Research Centres (DIRC), the brainchild of Board member Professor Dr Ir. Guus Berkhout, whose vision it was to use the DIRC system to create a 1 + 1 = 3 research condition with pan-faculty projects.
The Sustainable Energy DIRC received initial Board funding of 5.6 million guilders (2.54 million euro) for a period of four years. The DIRC focused on the decentralised conversion and storage of sustainable energy and demonstrated that certain problems of a material-scientific nature had to be solved.
Great progress was achieved. For example, the 3-D nanostructured solar cell was conceived, based on materials that were more economical than the expensive silicon previously used, and functional materials were discovered for rechargeable lithium-ion batteries. The company 'Advanced Photovoltaic Applications' is currently constructing a pilot plant in Leeuwarden and intends to commercialise the 3-D nanostructured solar cell in 2008. The DIRC also studied wind power turbines and laid the foundations for the Delft Energy Laboratory of Professor Ir. Lou van der Sluis, where silicon solar panels were connected to the national grid using special high-power electronics. In addition to lithium-ion batteries, hydrogen produced from water though electrolysis using green power could also be used to store energy. Safe and economical storage of hydrogen is a prerequisite before the hydrogen economy can be introduced, and so the DIRC has also focused on this issue. During its existence, the Sustainable Energy DIRC has managed to secure funds worth1. 135 million from autonomous public institutes as well as project-related funding.
After the DIRC period, Delft University of Technology established the Delft Institute for Sustainable Energy (DISE). The University's Board granted funding for research into the hydrogen economy, with again a strong focus on material sciences. On 1 January 2007 Professor Dr Ir. Tim van der Hagen succeeded me as scientific director of DISE. The institute has expanded to include DUWind and the Delft Energy Laboratory to become the Delft Research Centre for Sustainable Energy.
I have managed the DIRC and DISE for almost a decade with great pleasure and satisfaction. Together with excellent project leaders I am fortunate to have been able to shape the research into the decentralised conversion and storage of sustainable energy.
The financial support given to the Sustainable Energy Research in Delft is unique and it has given Delft University a leading position in the field of research into decentralised conversion and storage of sustainable energy. It should come as no surprise that the Laboratory for Inorganic Chemistry, together with ECN, two years ago managed to secure a part in a research project worth US$ 815,000 within Stanford University's Global Climate and Energy Project (GCEP), which focuses on clean use of fossil fuels.



Professor Dr Joop Schoonman Dr (h.c.) is professor of Inorganic Chemistry at the faculty of Applied Physics.

LHORA·EST

Propositions

Fun is useful.
Marco Rozendaal
Interaction Design engineer

An intelligent design is not necessarily designed by an intelligent designer.
Guus Roeselers
Biologist

The Dutch knowledge economy finds its fundaments in who do I know.
Willem van Driel
Medical Engineer

The worst decision is making no decision.
Thijn van der Heijden
Applied Physics Engineer

A wise man or woman does not have an opinion on everything.
Jeroen Wackers
Aerospace Engineer

The 'message in a bottle' is the original form of spam.
André van der Westhuysen
MSc in Engineering, University of Stellenbosch

Critics who discard Formula 1 races based on air pollution considerations only, should reflect on the many innovative products that are developed in the Formula 1 environment that are beneficial to luxury cars in terms of engine efficiency improvement and car safety.
Christof L. Lubbers
Applied Physics Engineer

"Since shaving while driving is more dangerous than using a cellular phone, it should also be penalised"
Frank Koppens, Physics Engineer

[Sound]bites

"The old idea of having an airport out at sea becomes attractive if you close down Schiphol Airport and redevelop the Haarlemmermeer area. Almere would no longer have to grow. On the other hand you would have to go through the barrier of dunes to create a road link, or use an area that's been messed up already. In other words, Hoek van Holland. That would create other problems. We tend to fantasise away about using open waters as a solution to our space problems, but the question is whether the existing space is being used to its full potential."
Drs. Enne de Boer, lecturer on public works and water management, in TROUW

"We either have a shortage of good quality public servants because they are being lured away by public and semi-public institutions, or get stuck with under-performers in the top jobs of the public sector."
Ir. Gert-Jan Kramer, chairman of the Supervisory Board, in NRC HANDELSBLAD

"Only by installing a wide-ranging and reliable measuring network in the vicinity of Schiphol Airport can we determine exactly how much noise air traffic really makes. Only with accurate readings can we determine the effect of the corrective measures we introduce, and so direct the effectiveness of the extensive research programme. And only by publishing the readings can we restore the trust between Schiphol and the residents of the surrounding areas."
Professor Dr Ir. Guus Berkhout, Professor emeritus of technology, strategy, and entrepreneurship, in TROUW


Photo: Bert Beelen

"At Dutch universities, it is acceptable that average teachers lecture in English. The bad and the very good teachers ought to use Dutch"

Defence

"As a teacher, you always express yourself better in your native tongue. Bad teachers are already difficult to follow in their own language; it would be disastrous if they were to teach in English. Average lecturers who don't quite hit the right tone would still be perfectly acceptable teachers, and so it would be acceptable for them to use English. Very good teachers manage to create a level of enthusiasm that has students and teachers alike leaving the auditorium with a twinkle in their eye. If those teachers were to switch to English, you might just lose that little extra. I have seen it reduce my best lectures to ordinary classes."

Jeroen Wackers
Aerospace Engineer

A TU alumni writes a column and passes on the pen to another alumnus of choice.

As a child I, quickly found out that I needed to find ways of becoming inspired. During my early years it were mainly my parents and grandparents who took care of this. During that phase I received plenty of inspiration. When I attained school age, things became more difficult. Only a few of the many teachers I had, managed to hit the right buttons. I discovered that I had a penchant for technology, and it would often be the more eccentric technologists that I would listen to in rapture, absorbing their every word like a sponge. I complemented this with encyclopaedic books full of illustrations and not too much text.

Just before my final year at grammar school, I took the plunge and together with my father, who also is a technically-minded man, we went to Delft to visit the Aerospace Engineering faculty's visitor's day. After the fantastic stories by Professor De Jong and the president of the Leonardo da Vinci Faculty Association there was simply no going back. It was to be Delft. Since reading had never been my forte – it still isn't – it was going to be tough. The first year in particular consisted mainly of reading. Having passed my first year, my relief was intense.

Delft University has offered me great sources of inspiration. In addition to the previously mentioned Professor De Jong, the names of Ir. Buize, Professor Arbocz, Professor Vlot, and Professor Beukers are forever engraved in my memory. Of course, there were lesser gods too, who had only cursorily glanced at the essentials of the teaching profession, or who simply did not have the knack. To me, Delft was a long and heavy road enlivened at intervals by great sources of inspiration that I was able to put to good use, enabling me to reach my destination.

During my career at the Dutch Royal Navy the same pattern seemed to repeat itself. During the first year in particular, I had to struggle to find pleasant work near people who gave me energy. After the first year, I was able to start to work as a dynamics policy maker for the Dutch Royal Navy. That is civil servant speak for a person who does dynamic structural calculations. It was a job near very good technical specialists who were at the top of their profession. I soon discovered that I am not the best of engineers, and that instead my forte lies in communication and bringing together people and technical aspects. I was lucky that after a few years there was a vacancy for a platform design team leader. I now supervise a team working on the preliminary designs of the ships for the Navy. Apart from the fact that this is satisfying work, it is the people who make the job. A time dawns when the roles will be reversed, and although I'll keep on looking forward, I now try to offer inspiration myself.

Paul Everts (38) studied Aerospace Engineering at Delft University of Technology from 1988 to 1999. He is team leader of Platforms (design) at the Defence Material Organisation (DMO). Everts passes the pen on to TU alumna Bianca Lambrechts, who works for the Aalsmeer flower auction.

Webcam projector

Photo: Sam Rentmeester/fmax

Designers and their clients like to be able to see different variants of a prototype and record their discussions of it. Ir. Jouke Verlinden, who lectures on innovative design support, came up with a device that combines a projector, a webcam, and a portable computer.

Connie van Uffelen

For his doctoral research, Jouke Verlinden (38) studied a trio of design projects: the design for a tractor, the development of a portable oscilloscope, and the interior design process for a museum.

It was the latter subject in particular that gave him the idea for his invention. A museum needs to know which route the visitors will follow, and what the effect will be of moving an exhibit. "Projection provides an easy means of moving a wall or a painting to study the consequences."

When discussing the interior design it was difficult to strike a common chord. Verlinden thought a digital projector would be useful. "But you wouldn't want to use a large projector on a separate mounting, since that would put the spotlight on the audience rather than on the subject under discussion. You also want to record the discussion."

During a conversation about the design with interior and furniture designer Jurgen Bey, Verlinden suddenly realised that technically speaking a projector was the way to go, but it had to be much more compact. "More like a pocket torch that would simultaneously project pictures and record conversations and images at the same time."

The same day, Verlinden went in search of the smallest components he could use. "On the Internet the smallest projector measured 14x10x5 centimetres and using battery-powered LEDs. I thought that if I wanted to go wireless, I would also need an ultra mobile PC. And for recording, I wanted a webcam with a microphone."

This is how Verlinden's invention came about. "The added value of my design is in the software that provides the link with software for modelling three-dimensional variants." This enables Verlinden to project designs onto foam models, which proofs to be very useful, and not only during model discussions. "The invention could also be used to project an echogram straight onto your skin to show you what's inside. Or it could be used for forensic research to film a crime scene and show exactly which position the camera is in at any given moment during projection."

And what about the future? "Watch a DVD using a device the size of a mobile phone. Making things smaller enables you to create things that use less energy too."

More information:
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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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Centre for Transportation Engineering
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Dutch Institute of Systems & Control (DISC)
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Koiter Institute Delft (Institute for Engineering Mechanics)
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Reactor Institute Delft
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Central Library

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

For further information:
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Information on facilities for foreign students:
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Liaison between business and research:
Liaison Office
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Information on research fellowships:
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General information on university education in the Netherlands:
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p.o. box 16375
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(Post Graduate) Courses

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For information on courses in the Dutch language:
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