DELFT OUTLOOK
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TU Delft

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FLYING FOR SAFETY

JO COENEN
'It's a battle even with myself'

LEIDEN DELFT ERASMUS ALLIANCE
Sprint or marathon?

THEME
Big data

'Big Data is also used to survey human behaviour. For the cover I wanted to photograph a group of people anonymously by taking the picture from straight above. That gives the idea that they are being watched. '
(Photo: Sam Rentmeester)

REDACTIONEEL
Frank Nuijens

Big data

Relative to the global population, the *per capita* capacity for digital information storage has roughly doubled every 40 months since the 1980s. According to Wikipedia, 2.5 exabytes (1018) of data were created every day in 2012. Three years before, the amount of digitally stored data from sources like social networking sites, smartphones, remote sensing devices and government surveillance was estimated at 500 exabytes. According to a calculation by a journalist from *The Guardian*, if all of this data were to be printed in books it would make 10 stacks reaching from Earth to Pluto. So we are clearly justified in using the term 'big data'. All of this data presents opportunities to gain new insights into economic trends, disease prevention, crime fighting and other areas. Nevertheless, the analysis of all that data requires expertise. In 2014, the National Think Tank identified a shortage of data scientists in the Netherlands. In the effort to interest science students in the field, two Think Tank participants are organising the first workshop on data science. In *Delft Magazine,* Sabine Roeser, Chair of the Human Research Ethics Committee at TU Delft, cautions against forgetting the other side of the data mines: 'They often involve privacy-sensitive information. It is also important to consider how we can be certain that everyone from whom the data were collected has provided informed consent. The ethical aspects of working with big data are largely an unexplored territory'. In this issue of *Delft Outlook,* we explore how TU Delft is applying big data to societal problems.

Frank Nuijens,
Editor-in-chief

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Theme Big data

PHOTO: SAM RENTMEESTER

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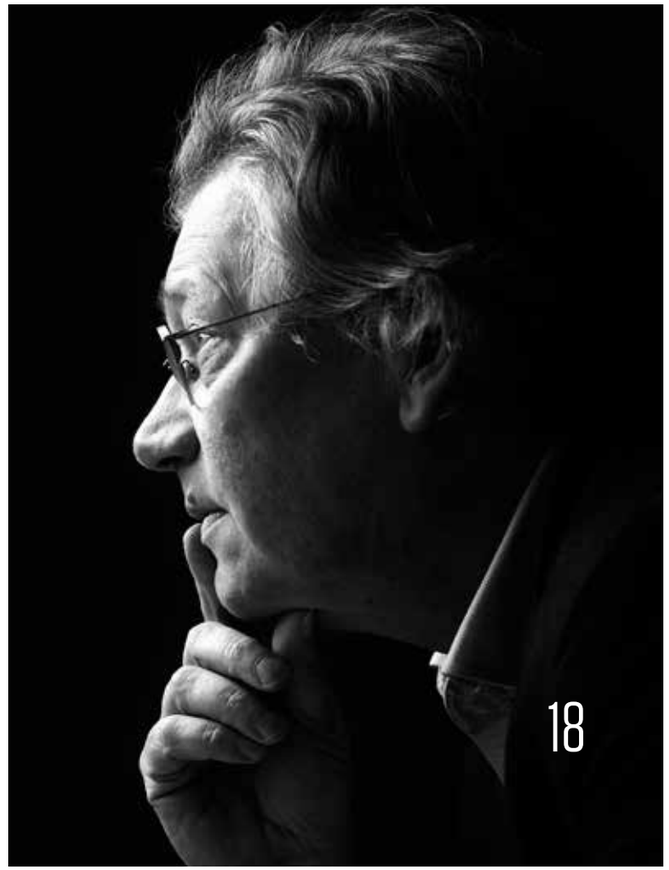

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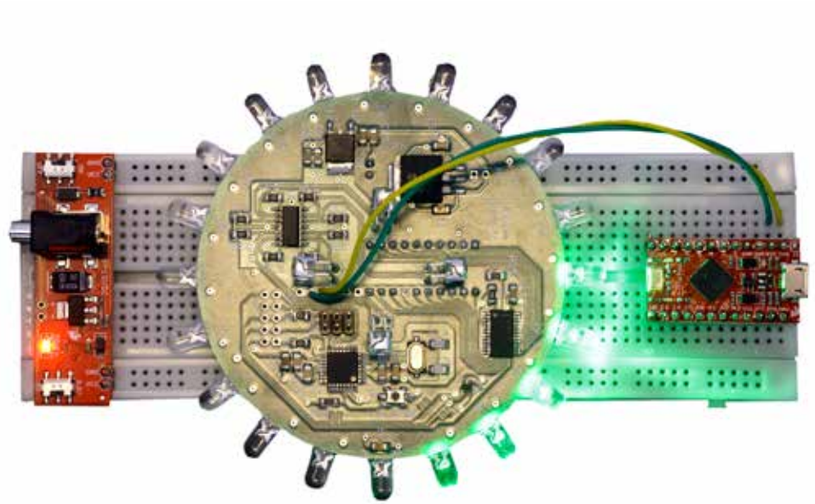


PHOTO: SAM RENTMEESTER

Communicating with light

If the technical computer scientist Lennart Klaver has his way, cars will soon be talking to their fellow road users through their headlights and tail-lights. This will take place through a type of Morse code, but at such high frequencies that the flickering cannot be seen by the human eye. Klaver: 'Nearly all cars now have LED lights, and these can communicate information. For example, they could signal the speed at which the car in front is braking, allowing your car to adjust its own speed accordingly. One nice thing about light is that it can be directed. This is a very positive characteristic for network technology, as it translates into energy conservation. It makes a difference whether light (i.e. information) is directed towards a single receiver or towards the entire surrounding area'.
delta.tudelft.nl/29161

PHOTO: SAM RENTMEESTER

Resilient robot

Decelerating a robot arm converts motion into heat. An ingenious spring mechanism, which can store up to 80% of the kinetic energy, is making robots more energy-efficient. The buffering coupling developed by ir. Michiel Plooij and his colleagues in the 3mE faculty is the size of an espresso cup. The patented invention contains a spring in the middle, with the axles of a differential mechanism on either side. By locking one of the axles at the right time, the resilience slows down the motion. When it is time for the robot arm to return – repetitive motion is characteristic of robots – the extended spring sets the arm back in motion, after which the electromotors resume control.
delta.tudelft.nl/29177

PHOTO: MARCEL KRUGER

Guts

Driving straight through the Sahara to Dakar in a clapped-out old car: that takes guts. Master's students of Construction Management and Engineering Rutger Henseler, Xander van Schie and Terry van Roode are competing in the annual Amsterdam Dakar Challenge. If they reach their destination, they will sell their car. The proceeds will go to a good cause: Solar Foundation the Gambia, which provides lighting for classrooms. The trio departed on 7 February.
teammystery.nl

PHOTO: ROYAL CONCERTGEBOUW ORCHESTRA

Cyber concert

Cynthia Liem (EEMCS) has come up with an app designed to attract a new, younger audience to symphony concerts, currently the preserve of an ageing population. At special 'bring your tablet' events in the concert hall, pop-up messages will provide information about the music. It is hoped that this will appeal to young people. The programme is named Phenicx, an acronym for Performances as Highly Enriched aNd Interactive Concert eXperience. It is also possible to follow the score on the tablet, keeping time with the performance. The app is a technological feat developed by the Johannes Kepler-universität in Austria.
delta.tudelft.nl/29491

Larvae burger

As Jaco Jansen (IDE) explains, black soldier flies contain lots of protein and better fatty acids than meat, along with iron, zinc and other minerals. He would like to put dogs on a diet of insects, which would make a difference of 50% in their meat consumption. 'The black soldier fly is one of the best bio-converters in the world'. Jansen designed a compost bin that can be downloaded from the internet and printed using a 3D printer. The company Protix provides the fly eggs, the larvae eat their fill of compost and, after a week or two, you will have a collection of larvae. You can put these in the freezer and grind them up to make a healthy animal feed.
delta.tudelft.nl/29231

Blowing bubbles

Researchers at the wind tunnel are using soap bubbles to chart air currents. Two decades ago, American researchers attempted to do so, only to conclude that the helium-filled soap bubbles had not followed the air current with sufficient precision. As a result, the method was written off. Prof. Fulvio Scarano and Dr Andrea Sciacchitano of the AE faculty are now using very tiny bubbles (0.1 mm) that do remain captive in the air current. Thanks to the laser light reflected by the bubbles a very precise 3D record can be made of the air current. Until recently, this technology (particle image velocimetry, or PIV) was restricted to volumes equivalent to the size of an iPhone. It can now accommodate volumes up to the size of a beer crate.
delta.tudelft.nl/29503

Chemical fingerprint

A fingerprint is more than just the pattern of lines that our fingers leave behind. The print also contains many biochemical substances: DNA, oils, amino acids. According to the Dutch Forensic Institute (NFI), these substances combine to form a chemical fingerprint that can also provide considerable information about a perpetrator at a crime scene. Researchers from the NFI will be collaborating with TU Delft researchers from the ChemE/Organic Materials and Interfaces research group (Applied Sciences) on a small device that can detect these materials at the scene.
delta.tudelft.nl/29436

Smoke in the computer

Smoke from forest and savannah fires in Africa absorbs much more solar radiation than was previously thought. This has become clear from analyses conducted by researchers from the Royal Netherlands Meteorological Institute (KNMI) and TU Delft on smoke measurements made by the SCIAMACHY satellite instrument. The scientists have recently published their findings in Geophysical Review Letters. The research results are an important step forward in climate research, as it will make it possible to more effectively incorporate the radiation process between clouds and smoke in climate models. Sciamachy is a German-Dutch-Belgian satellite instrument aboard the ESA satellite Envisat.
delta.tudelft.nl/29441

PHOTO: NASA

Affordable graphene

Doctoral candidate Shouen Zhu is making millimetres of high-quality graphene for a fraction of the current price. Meet the man who would like to bring graphene out of the lab and onto the street. Until now, the most common method of producing the single-layered carbon has involved an endless process of peeling off pencil marks. Before any of the grandiose promises associated with this material can be realised, it will need to be quite a bit less expensive. 'A small piece currently costs €1000. In a few years, I think the price can be around €1'.
delta.tudelft.nl/29377

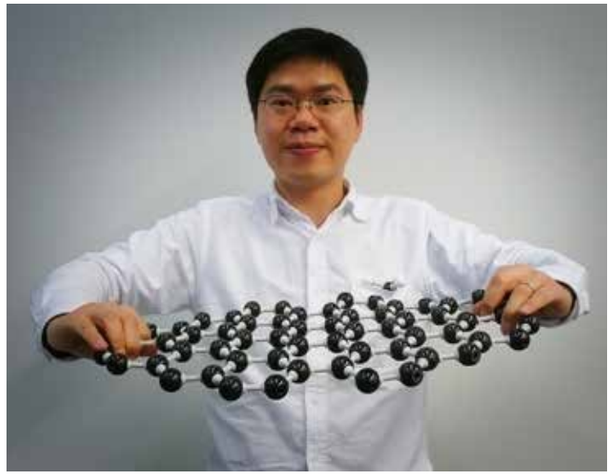


PHOTO: JOS WASSINK

Alcatraz mystery

On 11 June 1962, three prisoners escaped from the heavily guarded prison island of Alcatraz, to the north of San Francisco. The fate of Clarence Anglin, John Anglin and Frank Morris remains a big riddle: did they survive their journey with their rubber boat (which they had pieced together themselves) and, if so, where did they land? Dr Olivier Hoes, ir. Rolf Hut (CEG) and Fedor Baart, a hydrological engineer from Deltares, think that they may have found the answer. They investigated the mystery using a flow model for the San Francisco Bay. Their simulation work indicates that an escape would indeed have been possible and that the best time to depart from Alcatraz in a boat that night would have been around 23:30. According to this scenario, the convicts would have landed just north of the Golden Gate Bridge.
delta.tudelft.nl/29398

THEME
big data

'Big data' refers to the enormous increase in possibilities for generating, sharing, combining and analysing data, which can provide new insights and new ways of reasoning.

Definition of big data developed by the National Think Tank

PHOTO: SAM RENTMEESTER

AUTHOR: JOS WASSINK
PHOTOS: SAM RENTMEESTER

Dazzling data show proteins in action

A new technique for imaging biomolecules is generating more data than pathologists can handle. Dr Raf van de Plas of 3mE is developing algorithms for distilling useful information from terabytes of data.

The screen displays hundreds of tiny images of a mouse in longitudinal cross-section. Although they look alike, each one is unique. Each image shows the distribution of a particular protein, and each protein is separated from all others because it has a slightly different mass. 'The set consists of 2000 images, each containing 122 thousand pixels', explains Raf van de Plas. 'Each image shows the distribution of a certain molecule. This image shows that this molecule is less common in the liver, but more common in the intestines. And this molecule does not occur in the brain, although it is present in the skin and bones'.
The images are the result of a new imaging technique known as Mass Spectrometry Imaging, or MSI. Mass spectrometry is a commonly used analytic method that ranks molecules according to their mass. It is used in the identification, quantification and profiling of isotopes, molecules and molecule complexes in very small quantities of chemical and biological mixtures.

Crystal layer

Although the principles of mass spectrometry have been known for a century, it is only relatively recently that it has been possible to apply the technique to larger quantities of biological molecules (e.g. fatty lipids and proteins). In the past, the problem had been that the process of ionisation, which is necessary to separate molecules from there surroundings and apply a charge to them, would cause large biological molecules to be broken into pieces. In 2002, researchers received the Nobel prize in physics for an invention that made it possible to use mass spectrometry to examine biological macromolecules intact. In essence, the invention involves coating the biological sample with a layer of crystal, which absorbs the energy of the UV laser and transfers it to the underlying tissue. 'It could be compared to the crumple zone in a car', explains Van de Plas, in reference to the technique known as matrix-assisted laser desorption ionisation (MALDI). 'Without the crumple zone, the shock would break the bones in your body. If the energy is distributed, however, you come out without a scratch'. This has also proven to be the case for biomolecules in a sample. They are released, receive a charge and are sorted and counted by a mass spectrometer according to their mass.

Petabytes

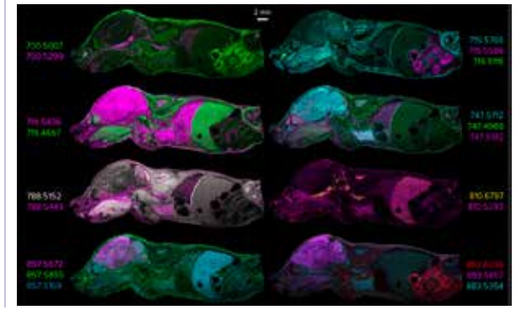
The spectrum of molecule mass ranges from 500 to 30,000, with a maximum resolution to distinguish between the various molecules. For each location of at least 5 x 5 micrometres in the tissue, the technique registers all detectable molecule masses across the entire spectrum. A slice of mouse brain measuring 1 x 2.5 centimetres could easily generate 1.5 terabytes of raw data - for a single experiment on one strip of tissue, that is 1.5 times more data than could fit on the hard drive of an iMac.

> Although MSI is currently used primarily as a tool for research it also has clinical applications

This is only the beginning, however, because one measurement is not enough. Multiple records of the same mouse (technical replicates) are thus needed, along with multiple records of different mice (biological replicates), as it is impossible to conduct research and draw conclusions based on a single measurement from a single mouse. Comparisons between healthy mice and diseased mice are needed as well. It would also be nice not to be limited to a single 2D cross-section, but to have a 3D volume consisting of a hundred cross-sections. The size of the datasets generated with this technique could thus amount to several petabytes (millions of gigabytes).

Machine learning

Van de Plas completed his engineering degree in Leuven, where he also earned a Master's degree in artificial intelligence, as well as a doctorate. He then started to work at the Mass Spectrometry Research Center at Vanderbilt University in Nashville, Tennessee. He has recently become active as an assistant professor within the Numerics for Control and Identification group at the Delft Center for Systems and Control (3mE faculty). In this facility, he is focusing on the development of algorithms that could derive useful information from gigantic datasets, like those from MSI. One of the directions that he is pursuing in this regard is machine learning. In machine learning, the computer interprets such matters as the distribution of proteins according to an anatomic atlas, stating in medical terms whether the quantity of particular molecules is increasing or decreasing in a particular organ. Another approach is that of correlated behaviour. If a researcher is interested in an increase or decrease of a particular protein, Van de Plas can show which other substances are associated with that protein, as their concentrations show a simultaneous increase or decrease.
Although MSI is currently used primarily as a tool for research, it also has clinical applications. One example is the pathological tissue studies conducted in tumour operations. Here a pathologist assesses a piece of tissue in order to determine whether all of the edges of the surrounding the tumour material that has been removed consist of healthy tissue – if so, the tumour has been removed successfully. Van de Plas: 'In some cases, MSI also reveals chemical changes in tissue that appears healthy to the naked eye'. Pathologists could make better assessments if they also had access to this biochemical information.



Caprioli R.M., Spraggins J., Van de Plas R. (Vanderbilt University)

Fishing in governmental data

An open data lab containing all information about citizens with regard to the government – Stefan de Konink thinks this would be a nice testing ground for detecting fraud.

For example, consider the data from North Brabant from the past five years: data from the Tax and Customs Administration, driving licences, municipal basic registration, the Employee Insurance Agency (UWV), citizen contacts with the police, vehicle registrations – in other words, all interactions between citizens and the government. Only the names have been deleted and the citizen service numbers encrypted. 30-Year-old computer scientist De Konink estimates that this would amount to about 1 terabyte of data for one province. .

'There are open datasets (e.g. Facebook, Twitter and LinkedIn), and there are closed datasets, including those of the municipality and other government bodies, but there is no testing ground in which all social data are brought together. Where this does occur, it is in the context of secret services. I think that it would be better to have this type of research conducted within an open academic environment, based on clear questions regarding what is to be investigated, with clear indicators as outcomes'.

This is not allowed under the Data Protection Act. The provision that data must be 'bound to specific purposes' prevents us from drawing connections between sources (e.g. driving licences and vehicle registrations). De Konink would like to receive a local exemption from this law, which would allow him to 'go fishing' for interesting 'indicators' within a closed network. Examples of such indicators would include the registration of dozens of vehicles at the same address, foundation directors receiving benefit payments, dozens of citizen service numbers linked to the same IP address and the registration of hundreds of companies in the same 20m2 office.

> 'I'd rather monitor the government than help the government monitor me'

The data lab envisioned by De Konink would allow computer scientists to search for relationships between actual data. They could develop algorithms for filtering out vehicle thieves, benefit fraudsters and front men. Such connections do not constitute evidence - it is conceivable for someone to have 12 cars in the backyard as the result of a hobby that has got out of hand – but they could provide a starting point for investigating officers from the Fiscal Information and Investigation Service (FIOD) or the Tax and Customs Administration.

De Konink has received funding from the platform for research journalism, Transparant Nederland, to establish such a data lab. The Netherlands Press Council is also interested. 'I'd rather monitor the government than help the government monitor me. A better Public Records Act would be helpful in this regard'. JW

They could develop algorithms for filtering out vehicle thieves, benefit fraudsters and front men.

Het KNMI-meetstation voor Rotterdam staat net buiten de stad, waar het altijd iets koeler is dan in de bebouwde omgeving.

Predicting overheating

The temperature in a house affects the health of those who live there. To learn more about interior temperature, scientists installed a thousand temporary sensors in Rotterdam.

To document the temperature in our country, the Royal Netherlands Meteorological Institute (KNMI), has set measuring stations in many places. The one for Rotterdam is located just outside the city, close to the airport, where it is invariably slightly cooler than it is in the built environment. We therefore do not know much about the heat of either the port city itself or the buildings within it.

Such knowledge is relevant. For example, when temperatures are higher, the death rate amongst people 75 years of age and older increases, and the birth weight of newborns is lower. For this reason, Alexander Wandl and Frank van der Hoeven from the department of Urbanism (Architecture and the Built Environment) are conducting a more precise investigation of how temperature affects the health of Rotterdam residents. They would also like to explain why it is warmer in one part of the city than it is in the other.

> At night, the western part of Rotterdam remains 5–6 degrees warmer than in the rest of the city.

They sent students into the city to install 800 sensors in households and 200 in public spaces. After each sensor had recorded the interior temperature every five minutes (both night and day) for two months, the scientists were able to compare the data. Wandl: 'What I found most surprising is the overwhelming amount of data. I received no fewer than 18 million data points. At first, my software was unable to process them.'

Results from the analysis of the big data showed among other things that at night, the western part of Rotterdam remains 5–6 degrees warmer than it is in the rest of the city. 'In the Spangen and Bospolder communities, it does not cool off at night', notes Van der Hoeven. 'This is because of the high building density and paved surfaces in these communities, which absorb a great deal of warmth during the day and release it again at night. This means it remains warm in the houses as well'. What can be done about it? 'In the Netherlands, when we make buildings energy-efficient, we pay attention only to the situation in de winter, while we should also make sure that no energy is needed for cooling in the summer. The municipality could help in this regard by having more water and trees in the city'.

To be able to better monitor the relationship between the energy-efficiency of buildings, the heat in the city and the health of younger and older people, the researchers would like to conduct permanent measurements of interior temperatures. 'But that is a dream for the future. At this point, we are appealing for large-scale collaboration through crowd-sensing', explains Wandl. DH

Predicting traffic

Nearly all of the vehicle traffic in the Netherlands is registered continuously. In the computer lab of Prof. ir. Hans van Lint, researchers are using this source of big data for mathematical models that describe and predict traffic.

“In the DiTT lab (Delft integrated Traffic & Travel Laboratory), we are collecting as many data as possible on traffic and transport to serve as a foundation for simulation models of various scales’, explains the Professor of Traffic and Transport Simulation. The data that Van Lint is collecting come from various sources, including the induction loops in the road which measure the presence and speed of vehicles. ‘Another source is data from the vehicles themselves. More and more cars are equipped with loggers, which transmit data periodically. This functionality is also included in many apps, including the popular Flitsmeister’.

The DiTT lab is also the research laboratory for the the National Data Warehouse for Traffic Information (NDW). All data from the road network in the Netherlands are brought together in this context. In addition to the data from the loops, it includes data on road construction and the locations of accidents, as well as data on weather conditions and major events. ‘This should yield smart tips that would be useful to road authorities, municipalities, provinces and services providers (such as the ANWB)’.

Van Lint gives the example of a province that would like to improve traffic safety. ‘They first want to identify accident hotspots and the factors that are associated with them. These could include events or local weather conditions, possibly even in relation to each other. In the ideal situation you would have a map containing all data in a form that can be run backwards and forwards in order to determine how such situations emerge and how conditions change during the situation. This is what we will be building’.

In the meantime, the researchers have learned how traffic flows and how tailbacks are formed. However they have less insight into motorists. ‘Social media can provide contextual information, as can observation systems in vehicles. These systems record acceleration, braking and steering behaviour, and they film what the driver is looking at. These data can be used to create predictive microscopic traffic models. The combination of these models with studies of behaviour in a driving simulator can contribute to the improvement of theories and models of driving and travelling behaviour’.

The DiTT lab is receiving support from the ICT company CGI, which provides and configures the necessary hardware and software. ‘We have several racks of servers here’, explains Van Lint. ‘The server that we will be using next year is in a refrigerator at CGI. It is an IBM Netezza, a monster of a machine, with 256 processors coupled to dedicated hard drives. That thing is fast enough to run experiments on all data from the road network in the Netherlands for an entire year in no time at all’.

Van Lint has applied for funding from the European Research Council (ERC). ‘It would be great if I could receive that grant. Then we’d be able to couple two driving simulators to the system, and I’d have enough money to add more doctoral candidates’. JW

Intelligent cities

The city of the future will solve problems by collecting data in many different ways. The newly established Amsterdam Institute of Advanced Metropolitan Solutions (AMS) is focusing on this.

Within this institute, TU Delft is collaborating with Wageningen UR, the Massachusetts Institute of Technology (MIT) and other partners. The participating parties will be providing education to students, in addition to conducting multidisciplinary research. For example, data on flooding can be obtained not only from classic weather stations, but also from sensors on lampposts and umbrellas, as well as from data collected by citizens. Smart processing of these data will improve the ability to intervene. Many other interesting fields of research are conceivable as well. For example, waste companies are interested to know where rubbish ends up. This has already been examined in the United States, using RFID tags to trace the route of waste. The researcher Carlo Ratti (MIT) spoke about this recently during the opening of the AMS. Measuring air quality and fighting traffic congestion also play a major role. ‘Big data are extremely important for all of these topics. We are collecting a large amount of data in order to conduct research, to map the city and to demonstrate the effects’, explains Paul Althuis, a member of the AMS board and director of the TU Delft Valorisation Centre.

> Amsterdam is large enough to collect a great deal of data and small enough to remain manageable

Beginning in 2017, the AMS will also be offering educational programmes. ‘At that time, we will be launching an independent Master’s degree programme in Amsterdam’, notes Althuis. ‘We would like to attract both Dutch and international students. After they take their degrees, we hope that they will stay in the Dutch capital and start their own companies based on innovations for intelligent cities. This would generate interesting applications’.

According to Althuis, Amsterdam is an excellent location in which to look for potential to deploy big data in initiatives related to intelligent cities. The city is large enough to collect a great deal of data and small enough to remain manageable. The study in Amsterdam is intended as a springboard. ‘Things that work here could be applied in larger cities, like Rio de Janeiro or Shanghai’.

The AMS was established with an investment from the City of Amsterdam. In the coming decade, the city will be investing € 50 million. Althuis: ‘The universities of Wageningen and Delft have signed a contract pledge to raise € 200 million in public and private investments. We are working closely with various companies, including Shell, KPN and IBM’. RV

Point clouds

Point clouds yield highly detailed information. For example, the second Dutch Elevation Dataset (AHN2) is so precise that even lampposts are visible. This degree of detail demands a large amount of storage and calculation. For this reason, researchers are working to develop several solutions using efficient data management.

The size of the AHN2 is gigantic; in all, it contains 640 billion data points. 'In the future, we will have datasets containing tens of trillions of data points', states Professor of GIS Technology Peter van Oosterom. He shows an image of a roundabout, resembling the Street View on Google Maps. 'There are so many separate points that it is almost like a photograph. The point clouds are not easy to store in datasets, due to their size. It would be very convenient to be able to combine data. For example, the AHN2 could also show the owner of a building or select the high points along the route of a railway line'.
Van Oosterom and his colleague Oscar Martinez Rubi, on secondment from the Netherlands eScience Center, are investigating various solutions for improving accessibility. 'For example, one solution involves the spatial clustering of data using so-called Morton or Hilbert code. We use a code with a value close to that of another code, which means that the associated points are also in close proximity to each other. This a a smart mathematical trick.'
The researchers also know that the transmission of data could be improved by transmitting the most characteristic points first. 'For example, the highest and lowest points could be sent first, preventing the transmission of redundant data and giving the receiver an initial image of the surroundings'.
Van Oosterom and Martinez Rubi are also examining the desired and effective levels of detail. As anyone requesting information from the AHN2 can see, in 3D, everything that is close by is highly detailed, while objects that are farther away are much more vague. Van Oosterom is investigating whether it would be convenient to classify files according to their relative importance. For example, he assigns greater importance to the highest and lowest points. 'With these and other adjustments, we hope to make the data much more accessible'. RV

pointclouds.nl

IMAGE: FUGRO

Weather ra dar at street level

Heavy rainfall can lead to flooding in cities. In order to prevent damage, it is necessary to know how much rain falls and where. Dr Marie-Claire ten Veldhuis is investigating reliable ways of collecting this type of data.

Cities in the Netherlands can be characterised by more and more paved surfaces, fewer green spaces and less open water. Anyone can see what happens during a cloudburst: the sewers are unable to cope with the enormous amount of water, drains overflow and streets and cellars become flooded. The warming of the North Sea is expected to increase the frequency of flash flooding in the Netherlands.
It is time to find solutions that are capable of coping with such peak loads. First, however, we need to identify the places where these solutions are needed. In other words, we need to know where the rain actually reaches the ground, and in what quantities. 'We currently do not have enough information about that', explains Assistant Professor of Urban Water Systems Marie-Claire ten Veldhuis, of the Department of Water Management (Civil Engineering and Geosciences). Weather stations, rain radar and a mobile app are expected to change this situation.
Ten Veldhuis is currently testing 20 weather stations on the campus in Delft. These types of stations are never installed in cities, because they would be too close to the built area, according to the rules set by the World Meteorological Organisation. 'But for urban water management, they do need to be built in the city. We are investigating how many weather stations are needed in order to generate a representative image'. Several primary schools in Delft are participating in the project as well.
After the testing phase, weather stations will also be installed in Rotterdam and Amsterdam. Ten Veldhuis plans

> Ten Veldhuis wants to use people as rain gauges

to combine the data generated by the stations in Rotterdam with those from the advanced rain radar, which the City of Rotterdam installed on the Nationale Nederlanden building this year, in collaboration with the department of radar expert Herman Russchenberg. This system is capable of measuring rainfall by street, at a height of 150 metres above the ground. It is not able to establish with any certainty where the most raindrops hit the ground. The influence of the wind is difficult to predict, as the wind is affected by buildings. For this reason, Ten Veldhuis wants to use people as rain gauges in Amsterdam – a system she refers to as citizen sensing. Participants receive an app with which they can report how much rain is falling (or has fallen) in their streets. Ten Veldhuis developed this app in collaboration with the intelligent systems group (Electrical Engineering, Mathematics and Computer Sciences). Her Bachelor's students will be testing it. 'In this way, we hope to combine a large amount of information, which can then be used for modelling'. The ultimate goal is to develop something that will be of benefit to everyone: weather radar at street level. SB

The end of piecemeal research

According to the Netherlands Organisation for Scientific Research (NWO), both publications and the data underlying them should be accessible to everyone. Where will you store your data? How will you make them searchable? How will you make them suitable for re-use? Scientists will have to answer these three questions in order to qualify for the € 1.5 million NWO grants known as Vici grants.

Atmosphere researcher Prof. ir. Herman Russchenberg (CEG) approves of the NWO's philosophy. 'But it takes time to make data accessible. Data cannot be used by others unless they are equipped with good meta-data. At Cabauw in Lopik, we are conducting research on the atmosphere. We have to make sure to provide good documentation of the context in which we perform measurements (e.g. wind direction and the settings on the instruments). This is quite complicated'.
He continues, 'A 20-year measurement programme allows us to research good agreements with each other'.
'When individual researchers develop new measurement techniques, however, it can quickly take on a piecemeal character. Then you have to decide for yourself how to ensure that the data can be used by others. And we should also give much more consideration to file types. No one works with floppy disks anymore'.
Prof. Alan Hanjalic (EWI) predicts problems. He is developing algorithms for making video files searchable. 'We need huge mountains of video files in order to test algorithms. We are dependent upon Google, Yahoo and other companies in this regard. They make data available to us if we can help them. We can subsequently make the algorithms that we develop open to the public, but not the data underlying them, as these data belong to the company'.
Dr Johan Molenbroek, an ergonomist in Industrial Design Engineering, is a staunch advocate of open data. Last year, he was awarded the data prize from the Research Data Netherlands foundation for developing Dined, a database for designers concerning variations in human dimensions within the Dutch population.
Privacy is a thorny issue. 'How can we ensure that people who have been photographed are not recognisable? We can't simply post these three-dimensional images on the internet. I've made the people unrecognisable by using Photoshop to remove certain layers from the photos without affecting their usability'. TvD

TU Delft data scientists are on their way

According to the National Think Tank, the Netherlands has a shortage of data scientists. Professor of Web Information Systems Geert-Jan Houben has noticed this as well. Almost every day, he is called by companies who are willing to pay for knowledge and talent from TU Delft.

The university is responding tot this with the Delft Data Science research programme and by launching a new Master's track in September: Data Science & Technology Part of the Master's degree programme in Computer Science, this track focuses on the analysis and use of the enormous quantities of data that we generate. The tasks of a data scientist consist of grouping these data, converting them to other formats and creating methods for analysing them. Students wishing to follow this Master's track have many options: 10 research groups are offering their own basic modules, from which students may choose five. Examples include modules in pattern recognition, cyber security analysis, software architecture, data visualisation, multimedia computing and web science. The Faculty of Electrical Engineering, Mathematics and Computer Sciences is collaborating with other faculties. So the data scientists from TU Delft are on their way. Where will they be able to work once they have their Master's degrees? 'The possibilities are endless: they can work for insurance companies, education institutions, hospitals, transport companies, energy companies, government agencies and, obviously, many areas of research', replies Houben. CvU

> 'The tasks of a data scientist consist of grouping data, converting them to other formats and creating methods for analysing them'.

Vision

'If something is free on the internet, you pay for it with your personal information', according to the philosophy professor Jeroen van den Hoven. He is serving on a committee that advises the Royal Netherlands Academy of Arts and Sciences (KNAW) on the ethical and legal aspects of computer science research.

Constant streams of data can reveal the most fantastic patterns. For example, they can reveal the spread of communicable diseases, the extent of confidence in the economy or how many people are withdrawing money from ATMs at a given time.
What Prof. Jeroen van den Hoven would like to say is that the big data revolution will help us to understand society.
There are also disadvantages, however, notes Van den Hoven. Privacy is becoming an enormous problem, and the current European laws are inadequate. One of the core principles is that permission is always required for using data. 'But this is fighting a losing battle. Companies want to know everything there is to know about you. As a rule, if something is free on the internet, you pay for it with your personal information'.
We also play into this by granting all sorts of permissions to apps. Van den Hoven therefore expects a number of Snowden moments. 'America lost a large share of it cloud market after Snowden. This data world is also bound to experience its own Chernobyls and Fukushimas. In response to Fukushima, Germany declared that it would stop using nuclear energy'.
Van den Hoven sees another threat in the area of security. If we can see the most convenient way to get rid of a virus, maybe we could also find the most deadly route that it could take.
Furthermore, if data are so valuable, who should be able to profit from them?

'In principle, data should be open to the extent that they yield useful information in the common interest',
asserts Van den Hoven.
The Royal Netherlands Academy of Arts and Sciences (KNAW) would like for there to be guidelines for research in this hi-tech domain using apps, internet, Facebook, Twitter and software (e.g. for facial recognition and emotion detection). In the future, will we see a shift towards restrictions on the generation of all these data? Van den Hoven thinks that we will. 'You could allow a critical group to examine what you are planning to do with your research. If the risks are too great, you will have to do something else'.
This would thus mean stricter assessment by the Netherlands Organisation for Scientific Research (NWO) and universities, or more intelligent solutions (e.g. data minimisation, academisation or problematisation). 'You don't have to know who was whom and who was where in order to study patterns of behaviour. Make technology such that it helps to prevent problems (e.g. with passwords, authorisation, deleting data after a certain time and saving log-in data. It is funny to see that information technology is also being increasingly used to determine whether big data are being abused (for example to investigate whether bank loan applications are turned down in particular postal code areas). Sousveillance: the watched watching the watchers'. CvU

‘It’s been a battle, even with myself’

Thanks to his talent and his vision that often clashed head-on with the spirit of the times, Jo Coenen has really made his mark on architecture. As an impassioned professor in the faculty of Architecture, he was able to achieve great things.

AUTHOR **JOOST PANHUIJSEN** PHOTOS **SAM RENTMEESTER**

Were you interested in architecture from an early age?
"I was definitely intrigued by some of the local buildings. In the 1950s, my parents took me to buy clothes at the Glaspaleis (Glass Palace), a department store in Heerlen. Forty years later with Wiel Arets, I returned to that superb building – by then horribly disfigured by disastrous renovations – to restore it and transform it into a culture centre. Even at the age of eight, I could not fail to be impressed by the entrance hall. Of course, I had no idea what architecture was. That was something that came gradually. I have often since wondered: what on earth have I got myself into?" (he laughs)

Do you regret becoming an architect? That will come as a surprise to many.
"So far, it has been quite a battle. Also with myself, of course. But the main cause of the conflicts was that I wanted to be a craftsman as well as an architect. As an architect, it is your job to create the conditions for people's well-being and that involves responsibilities. It may seem a simple principle, but if you stick to it, it can lead to difficulties."

Difficulties?
"Let me give you a practical example. If you discover that your design for an apartment block is about to be built in such a way that no daylight whatsoever reaches into the entrance hall, you will move heaven and earth to make sure a window is installed after all. But if, at a construction meeting, you discuss humane architecture and the importance of daylight in a building, some people will dismiss it as ideological bunkum. The third time you raise the issue, you are told that you will need to modify the plan – and remove the window – and that refusal could mean you will not be paid. I learned some very expensive lessons during meetings like that. If you embrace this view of architecture, you are not likely to earn much money."

Why? Because you earn yourself a reputation for being difficult that deters clients?
"That is part of it, yes. But mainly because, during the construction process, you are continually attempting to include the window in the plan, in a way that is acceptable for all parties. It can take weeks of careful thought. Afterwards, your client can say: I did not ask for that, so I refuse to pay for your time! I wanted to tell students about this kind of day-to-day practice. Because I know that young architects sometimes think they will become famous and not face this kind of problem. But that often turns out to be an illusion."

So the opinion of an acclaimed architect has no weight?
"Not everywhere. People will say to you: We need to earn money from your product. It is a case of selling architectural plans as if they were toilet rolls. That is also how I put it to students. To make it clear to them what kind of clients they will soon have to deal with."

So is it different in the Netherlands than elsewhere?
"Yes. In countries like Germany, Switzerland, Spain and even Belgium, the respect shown to me as an architect is many times greater than here. If you raise something like this at a Dutch construction meeting, you will not be popular. It is seen as arrogance."

Today, would you still have opted for architecture?
"No." Coenen hesitates for a moment. "Let's put it another way: perhaps. But I would have had serious doubts."

As well as buildings, you have also designed whole city districts, such as Céramique in Maastricht and Wilhelmsburg Mitte in Hamburg. What did it feel like being asked to design a whole city?
"That city – a satellite of the Indian metropolis Bangalore – was never built in the end. There were issues with land speculation and expropriation from farmers, and the Prime Minister, the driving force behind the project, lost office. But it was an interesting exercise working on that scale. My design, inspired by a variation on the Amsterdam cityscape, was rudimentary. It was a gigantic project: a city with a million inhabitants was expected to emerge from the ground in just five years. It was not possible to move the deadline. That caused me some inner conflict, because the pressure of time threatened to turn my design into a blueprint cast in concrete, with no room for modifications or new ideas."

CV

Prof ir. Jo Coenen (Heerlen, 1949) studied architecture and town planning at TU Eindhoven. He established his own architects firm in 1980. Coenen also worked as a professor at Karlsruhe University of Technology. In 2001, he became professor of public buildings in Delft. Some years later, he set up an influential research group focusing on modification, intervention and transformation. He also made a name for himself as an innovative Chief Government Architect. His architects firm in Maastricht opened up studios in in Berlin (1999), Amsterdam (2002), Milan (2007) and Bern (2012). Since 2014, he has been director and curator of IBA Parkstad, which aims to boost his native region by developing sustainable projects.

In your valedictory address, you explained how you have decided in the end not to work as an architect in countries like China and India, because you have insufficient understanding of the cultures, being European. But would Asian megacities not actually benefit from the urban design vision of an outsider?
"I did not rule out Asia completely. They could certainly use our knowledge and experience, and an agency in Asia would be an interesting venture for us. But if we ever go to work there, it will need to be in close alliance with local partners: architects, urban designers, architecture faculty professors. They have a much better understanding of the context."

As a professor, you enjoyed teaching individual students the most. Why?
"It is not possible to convey every aspect of the subject through books, readers, lectures etc. Designing is not only about technique, it is also a question of attitude. As a designer, you have to make decisions and choices all the time. Every student struggles with that. I might even say every designer. It is important for the student to be given mental support in that quest. At certain crucial and decisive moments in the design process, the student needs to make enormous leaps. That is when you need a mentor who understands the process and says: You are not going to fall. I will help you. That is the essence of teaching. I learned it from my father."

You also mentioned your father in your speech: 'a politically and socially committed teacher of didactics'. Where did he teach?
"He taught in an earlier version of teacher-training college. Teaching people who would later become teachers themselves. So I learned the basics in didactics at home. My father himself studied in Tilburg at Catholic teacher-training college, taught by professors who used bulky books. He learnt philosophy, religious education, pedagogy – all with strong emphasis on social commitment. I am currently studying his graduation thesis. It explores miners' families in Limburg, and the dangers of poverty, including spiritual poverty. He wanted to explore the best methods for effectively combating poverty."

'Designing is not only about technique, it is also a question of attitude'

A socially committed environment then.
"One evening in our house, important seeds were sown for the Radical Political Party (PPR), an offshoot from the Catholic People's Party (KVP) that would later become GroenLinks (the Dutch Green party). In a living room in a small miner's house. I don't want to become sentimental about it, but I was raised in a tiny house in a Limburg mining community. The mine railway was next to our front door, and you could hear a cargo of coal from the state mine trundling past every ten minutes. The noise was truly thunderous."

Making sketches is an essential part of the design process for you. Was your father good at drawing?
"He was a captivating storyteller, who drew the most beautiful illustrations on the blackboard in different coloured chalk. Eventually I started doing the same, drawing on the board. By the way, when I started teaching, my father also spent years giving me extra lessons in didactics. He taught me to keep a close eye on who you are teaching and whether they are capable of coping with the level of the material. He also taught me to respect people who may not be able to conjugate every verb accurately, but who are born craftsmen, with practical intelligence. A person is a vessel, full of unsuspected talent and potential and it is your job to awaken those talents. That is how he put it." <<

After Delft

As a girl, Marian Rijk wanted to become a detective. She devoured Agatha Christie novels because she loved solving puzzles. Now she creates them in her own thrillers. *Blauwdruk* (Blueprint), her second novel, published last year, was set in the faculty of Architecture and the Built Environment at TU Delft.

'He had not been at the faculty for thirteen years. The old building had since burned down, a new building was taken into use and the professor has been suspended. A new start.'


PHOTO: SAM RENTMEESTER

Name: Marian Rijk
Lives in: Leersum
Marital status: Married, three children
Education: Industrial design engineering
Association: None

When she was studying Industrial Design Engineering, Rijk had not yet started writing. That happened about six years ago, as a hobby. "I always had a tendency to make up stories and intrigues. Then someone said: What an imagination you have, you should write a book!" After a course in creative writing at Scriptplus in Amsterdam, she found herself a publisher for her first book, written under the pseudonym Marian Rijk.
She was labelled a 'literary thriller' writer and her publisher insisted on a new book each year. That proved difficult. So she decided to self-publish her second thriller, about the dangers faced by a girl in search of her biological father. Blauwdruk was published in October, after "a lot of stress and panic attacks," as she admits in her blog.
Professionally, Rijk has been developing products for online learning for around ten years, for the publishers ThiemeMeulenhoff, Bright Alley, Noordhoff and Vilans. User-friendliness is her byword. "I have always been preoccupied by buttons and screens. Do people know what they have to do? That was the main theme in my studies."
It should therefore come as no surprise that she graduated at Philips in 1998 after devising a system to enable parents to set their TV so that their children can only watch non-violent programmes. Rijk then started developing websites at Centric, for Neckermann, for example. They wanted to develop a user-friendly way of enabling people to book holidays on their website, with easy-to-use buttons. It was the perfect job for Rijk.
At Bright Alley, she became project manager, developing digital training courses. These included a simulation for flight attendants on how to use a new oven and a course for Hema staff on operating the checkout. In her current job at Vilans, which specialises in long-term care, she is developing e-learning solutions for healthcare professionals.
She still spends all her free time writing. She is currently working on her third book, an historical novel scheduled for completion in March. She is also collaborating on a script for a murder dinner: a return to her true love of puzzles.

In person

Female talent

Nine women researchers will be starting work at TU Delft as part of the Delft Technology Fellowship. This is expected to result in the further increase of the number of women at the university. The five-year fellowship will allow the researchers to develop their careers more quickly. Two were appointed as associate professors, and the rest were appointed as assistant professors. They will respectively receive starting grants amounting to €200 thousand and €100 thousand in order to set up their research. They will further be expected to devote 30% of their time to teaching. The scientists are: Darinka Czischke, Architecture and the Built Environment; Nancy Bocken, Industrial Design Engineering; Yuemei Lin, Applied Sciences; Liedewij Laan, Applied Sciences; Yaiza Gonzalez Garcia, 3mE; Queena Qian, Architecture and the Built Environment; Sofia Teixeira de Freitas, Aerospace Engineering; Helle Hansen, TPM; Caroline Katsman, Civil Engineering and Geosciences.

The DelftChemTech researcher Dr Ferdinand Grozema and the microscope expert Dr Bernd Rieger of the Quantitative Imaging department (Applied Sciences) have received € 1.9 million each from the European Research Council (ECR) to expand their research activities.

Prof Marcel Stive (CEG) has been named Hydraulic Engineer of the year for 2015. The American Society of Civil Engineers (ASCE) has presented him with the International Coastal Engineering award.

Alumnus Duco Drenth collected funds from other alumni in order to finance a part-time professor of Geothermal Energy. Professor David Bruhn will be at TU Delft for one week each month. The rest of the time, he is affiliated with the Geo Forschungs Zentrum in Potsdam.

The NYU researcher Anthony Townsend received an honorary doctorate from TU Delft for his pioneering research on Intelligent Cities. His Foundation Day address is available at tudelft.nl.

Biotechnologists Dr Pascale Daran-Lapujade and Dr Frank Hollmann have been awarded the ERC Consolidator Grant. For the next five years, each will be receiving about €2 million. Hollmann will also receive a Vici grant of €1.5 million from the Netherlands Organisation for Scientific Research (NWO).

Airborne Cowboys

Flying through clouds of ash, or flying on an damaged engine or a broken rudder; nothing fazes TU Delft pilots Hans Mulder and Alexander in 't Veld. These fearless pilots emulate aircraft incidents in the TU Delft Cessna Citation, thereby contributing to safer aviation.

AUTHOR: TOMAS VAN DIJK PHOTO: SAM RENTMEESTER

Everything was going smoothly on an October morning in 2013 when TU pilots Hans Mulder and Dr Alexander in 't Veld embarked on their landing manoeuvre. The contours of Woensdrecht military airbase loomed in the distance. The aircraft made a gradual descent, and soon recognised the signals emitted by the airfield's beacons. Normally, these radio signals (known as the Instrument Landing System or ILS) enable the autopilot to guide the aircraft along a safe glide path. But things did not go entirely according to plan. As the plane dropped below a hundred metres, the autopilot failed and the aircraft started to climb steeply. The pilots could no longer rely on the primary flight display, the most important screen for pilots during a landing. This console shows whether the aircraft is on the right course. The middle line, which indicates the correct vertical course, had totally disappeared from the screen. Mulder switched off the autopilot, let the aircraft dive and then accelerated, thereby creating lift. The pilots turned the plane around and made a smooth landing. The two were not particularly shaken by the incident.

But then, they had advance warning. In fact, they had been commissioned by the Dutch Safety Board to carry out this manoeuvre on purpose. It was a reconstruction of the landing of a Ryanair Boeing 737 (flight FR3531) on its journey from Palma de Mallorca to Eindhoven on 31 May 2013. The aircraft had been flying slightly too high when the autopilot made contact with the ILS, forcing it onto a false glide slope, a glide path that is too steep. The autopilot went completely haywire as soon as it locked onto this glide path. Mulder: "The pilots and passengers must have had a terrible fright."

Warning

Mulder and In 't Veld found the fault in the ILS. Thanks to the work carried out by these two pilots and the Dutch Safety Board, a worldwide warning was issued to aviation companies within just a few months. In a hangar at Schiphol airport, Mulder shows me the Cessna Citation in which he, In 't Veld and four other colleagues carry out countless experiments to help improve safety in our airspace. The six of them form a pool of pilots, who fly for both TU Delft and the

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Alexander in 't Veld

Hans Mulder

National Aerospace Laboratory (NLR). The NLR is co-owner of the aircraft.
Mulder, who also gives flying lessons in two- and four-person light aircraft, has been working as an engineer/pilot for seven years. In 't Veld has been on the team for ten years and is also a stunt pilot. Over the years, these two men have carried out numerous flights, some of which were just as spectacular as the aerobatic stunts that In 't Veld performs in his spare time. In 2011, for example, the pair intentionally flew into the airspace that had been closed to air traffic because of the ash clouds emitted by the Icelandic volcano Eyjafjallajökull (see item 'Through the ash cloud').

'You can't compare this plane with other aircraft'

The year after that, they were the first to fly an aircraft on an alternative fuel consisting of 95% synthetic kerosene to test the safety of the mixture. They also carry out regular flights emulating weightlessness, known as parabolic flights. These flights involve plummeting to earth from great altitudes. Scientists sit behind them in the aircraft, carrying out experiments that require weightlessness, such as tests on set-ups to be used in space at a later date.
"Is our research dangerous? No," says Mulder. "We make a complete safety analysis with the team before we embark on a special flight. We map the entire flight plan and think about everything that could go wrong."
"You can't compare this plane with other aircraft," continues Mulder, pointing to the colossus. "It is packed with built-in sensors; on the aileron, the trim tabs... We are aware of the configuration of the whole aircraft during the entire flight. When we take a bend, we know exactly how many degrees per second we are banking. Most pilots don't know things like this. They just make sure that the passengers feel comfortable when they turn the plane."

Flight model

Next year, the pilots are in for an exciting time. The aircraft has been fitted with fly by wire, which means that you can take a computer on board and allow it take over the controls. Tests that until recently were only possible in flight simulators can now be carried out in the air.
The Bijlmer disaster of 1992 is a good example. The El Al aircraft that crashed had just lost two engines. Researchers who emulated the flight in the Simona flight simulator belonging to Aerospace Engineering managed to land the plane safely. They will soon attempt the same manoeuvre in the Cessna. "The engines obviously won't actually fall off," says In 't Veld. "But the software that controls the aircraft will think that they have. An employee sitting behind us will programme it that way."

Through the ash cloud

Mulder and In 't Veld set out to brave Icelandic airspace immediately after the Eyjafjallajökull volcano erupted in 2012. They were the only ones. Flying through the clouds of ash was prohibited. "The Minister gave us special permission," says Mulder. "And we had to have a chat with our insurance..."
The aim of the exercise was to monitor the effect of ash particles on the engines, and to validate models relating to the dispersal of the ash cloud. The KNMI fitted the plane with a special 'sniffer pipe' to count the particles.
Ash is razor sharp. It can sandblast the engines, causing serious damage. The ash heats up and melts in the engines. When it cools down, it forms a glass-like layer on the turbines.
The pilots from Delft carried out several flights, venturing deeper into the ash cloud each time. In between flights, a boroscope (a special engine endoscope) was used to inspect the aircraft's engines. All in all, it was not as serious as had been expected as the concentrations were not high enough to cause damage to the engines.
"I can still see the pink/brown glow of the ash looming in the distance," says Mulder. "You edge deeper and deeper into the ash cloud. We were actually the only people mad enough to fly into the airspace. That certainly got me thinking."


PHOTO: NASA

Flying on synthetic kerosene

Airline companies are allowed to mix their fuel for fifty percent with synthetic kerosene made from natural gas. This produces fewer polluting, sulphurous hydrocarbons. They are not allowed to mix more than this amount because aircraft engines run more smoothly if the fuel contains a certain amount of dirt. At least this was the assumption. Tests carried out by researchers in Delft have shown that engines run perfectly well on 95 percent synthetic kerosene.
But is this mixture safe when flying at higher altitudes, where the pressure and temperature are low and the air is thin? This is what Mulder and In 't Veld wanted to find out. So one of the Cessna's engines was fitted with special fuel pumps and filters.
Mulder: "This fuel is more volatile than ordinary kerosene. The main question is whether you can restart an engine if it fails at a high altitude. So we turned off one of the engines at twelve kilometres and tried to restart it."
In 't Veld: "If one of your engines fails, you can normally continue flying on the other one. Fuel is transferred from one wing to the other so that the weight difference doesn't cause the aircraft to tilt. But in this case, we were unable to redistribute the fuel because we were flying on two different types. We had to make sure that the fuel levels in the wings were different before we took off to compensate for potential problems. Even then, we only had a maximum of one hour's flying time on one engine before the centre of gravity shifted too far. This experiment required a very detailed and well thought-out plan."

"One of the things we want to investigate is whether we can make the control system respond to a new situation so that it can land the aircraft safely, despite the technical defect," adds Mulder. "Imagine if a rudder stops working; you can still steer the aircraft by giving one engine more power than the other. So the software will have to adapt to a new type of flight model."
Another problem is that in situations like this, you do not know the limits of the new aircraft configuration. For example: what's the maximum banking angle for a plane in this condition? Mulder: "Predicting flight behaviour – envelope prediction in jargon – is a serious business."
Air France flight AF447, which crashed into the Atlantic Ocean off the coast of Brazil on 1 June 2009, is also on our list. The aircraft's speedometer was defective. The pilots had no idea that they were flying too slowly and stalled. The plane plunged into the sea from an altitude of ten kilometres.
Another area of flight research concerns providing information to the pilots. In both cases described above, the pilots were unaware that something had gone wrong with the aircraft. Aircraft are fitted with countless sensors, and so defects do not go unnoticed. The problem seems to be that pilots are not always given all the information.
In 't Veld: "That's how it works at the moment. The plane takes over from the pilot. Until something major goes wrong. Then the aircraft says, okay, you can take over now. But many pilots simply don't know how to respond in these situations. We must make sure that pilots are given a lot more information. About what's gone wrong, but more importantly, about how to resolve the problem." <<

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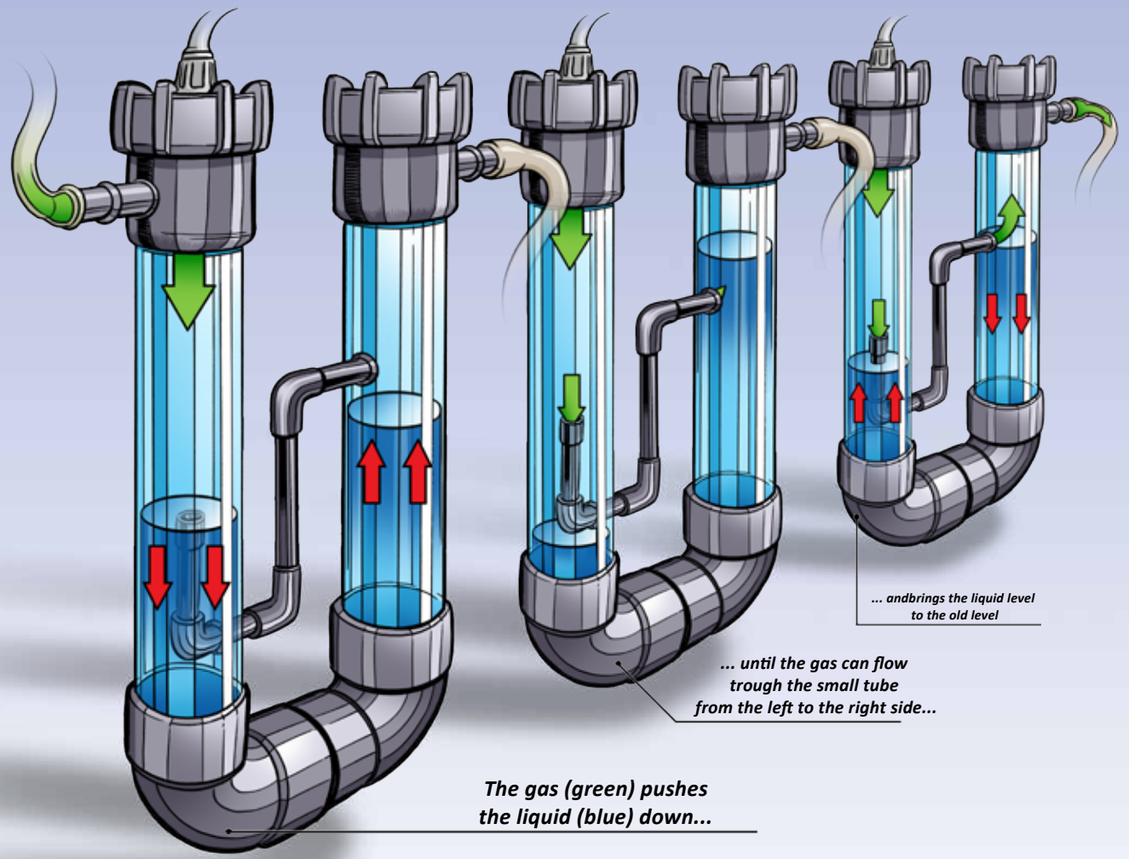
PATENT

Gas flow meter with pressure sensor

Inventor:
Ir. Guido Kooijman



"What a cool idea," thought Guido Kooijman when he came up with the idea of his ideal gas meter. Plenty of papers have been written on the subject and numerous types of gas meter invented over the years, but Kooijman, studying for a doctorate in the faculty of Civil Engineering and Geosciences, is convinced that his outshines the rest. The key advantage of his meter is that it contains no moving parts, which makes it less likely that it will fail.

Not only that, but Kooijman claims that his meter is more accurate and cheaper than the rest. "The range of flows it can measure is wider." Another advantage is that Kooijman's meter automatically corrects for air pressure and temperature, both of which have an impact on the volume of the gas.

With his company, Smart Process Instruments, he has already sold six prototypes for use in experimental research. His customers include universities and TNO and companies specialising in water purification. They want to find out how much gas bio-fermenters produce with different types of treatments and waste.

Kooijman is now working on an improved version of his gas flow meter. It will include a built-in screen, whereas the current version has to be hooked up to a computer. The new version will also feature a methane sensor so there is no longer any need to analyse the gas composition separately.

The doctoral candidate sees the work on his design as a 'great part-time job'. It is separate from his doctoral research, despite the connections between the two. Later in the year, Kooijman hopes to be awarded his doctorate for biogas production in water purification. SB

Groningen

Never start a column with an anecdote about your grandmother, my writing teacher once told me, but here goes... My grandmother (1914-2015) came from Groningen, where the people are as tough as nails.

One day a car stopped in her street, its deafening music echoing across the entire neighbourhood. At the traffic lights, the driver – with shaven head and a jogging suit –opened his window and emptied his ashtray onto the pavement.

My grandmother could simply have walked past and avoided it, but she didn't. She bent down and used one hand to wipe the ash into the other. She then knocked on the driver's window.

Knock-knock.

Taken aback, the man wound open his window, staring at the old dear.

"You forgot something," said my grandmother, tipping the ash into the man's lap.

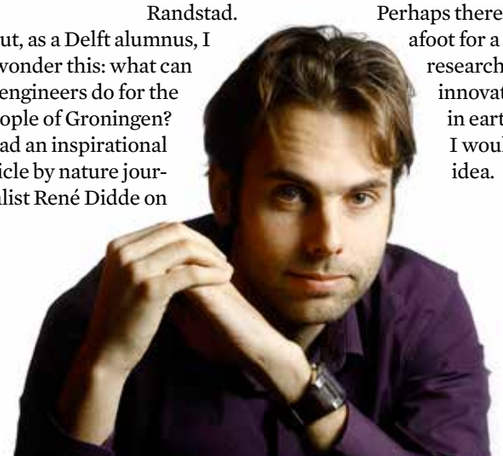
I inherited some of this Groningen pride from my grandmother, together with the Groningen pain. The land being pumped dry for our natural gas, the earthquakes and cracked buildings foisted on the Groningen people in return, the dismal economic prospects and exodus to the Randstad.

But, as a Delft alumnus, I wonder this: what can engineers do for the people of Groningen? I read an inspirational article by nature journalist René Didde on this very subject: the dikes between Eemshaven and Delfzijl are located in the earthquake risk zone and are being given a makeover. Local government and engineers from Alterra, Wageningen UR, are seizing this opportunity to innovate. They are testing what is known as a sludge engine ('slibmotor'). Between a double dike, the tides are given free rein and deposit sludge that can be used to raise the land level. It is a much better idea than buying in clay from Lithuania and Estonia, as the Netherlands currently does to reinforce its dikes.

Lightened of its load, the water then flows to brackish agricultural land, where algae and samphire grow. Nature has also been taken into account, with special pools for fish and foraging areas for birds. Cycle lanes and paths for nature lovers complete the picture.

A map of the area shows that this pilot project is taking place literally a stone's throw away from a gas exploration site. It is easy to be cynical about these things. But let us look at it positively for a change: maybe it is actually possible to successfully bring together all of these opposing interests.

Perhaps there are already plans afoot for a Delft/Groningen research group to explore innovative construction in earthquake zones? I would welcome the idea.



Tonie Mudde is the Chief Science Correspondent at De Volkskrant. He studied Aerospace Engineering at TU Delft from 1996 to 2003.

LDE centres: sprint or marathon?

The aim of the Strategic Leiden-Delft-Erasmus Alliance, established by the three universities in 2012, was to improve research and education and competitiveness. Projects are intended to develop from the ground up, which led to the establishment of eight joint centres in 2013. A quick look around reveals that lack of time is proving to be their key obstacle.

AUTHOR SASKIA BONGER, ERIK VAN REIN PHOTOGRAPHS SAM RENTMEESTER

Take a social issue, find researchers to explore it from different areas of expertise, put them together and voilà: the research projects will mushroom, with Dutch and national grants following rapidly in their wake. That, in a nutshell, is the idea behind the eight research centres set up by the universities of Leiden, Delft and Rotterdam in 2013. They are 'Education and Learning', 'Metropolis and Mainport', 'Global Heritage and Development', 'European Research Centre for Economic and Financial Governance', 'Governance', 'Sustainability', 'Safety and Security' and 'Frugal Innovations'. Behind these centres, there are hundreds of researchers, supported by 'initiators' with minimal administration staff and several hundred thousands of euros in seed money from the three universities. So how are things progressing and what lessons have been learned so far?

Enthusiasm and inspiration

The researchers in most of the centres have already discovered how inspirational it is to look at the same subject with several colleagues from different fields. Take Global Heritage, as an example. It took nearly fifty discussions with researchers of all different kinds, but it is now clear how wide-ranging the centre actually is. Historians, economists, construction and civil engineers and many others have spread themselves across five research themes. The people involved seem to complement each other, which is a motivating factor.
Or take Education and Learning. This centre brought together people who hardly knew each other at all. The focus of government and universities on study success and online education has given new impetus to research into university education, but the mutual contact also appears to have a beneficial effect.
Another example is the 'European Research Centre for Economic and Financial Governance'. In it, everyone is convinced of the fact that structural solutions for the economic and financial crisis cannot come from individual areas of research. Integrated solutions will be the winning formula.

Making progress

The centres each have their own strategy and pace. As one initiator says: while one centre will achieve numerous sprints, another will run a marathon. Almost all of the centres have already achieved their fair share of major and minor successes. Most of them have a relatively new website, have built up networks, formulated subthemes, appointed support staff, held workshops and events, organised congresses, developed curricula and submitted research proposals.

> The differences in the structure of the academic year create problems

For example, 'Safety and Security' has had two NWO research proposals approved, on cybersecurity and flood security. A conference was also held on the subject of cybercrime on 6 November. Within 'Metropolis and Mainport', proposals are also being submitted to the NWO and the European Union. Subthemes have been selected, such as accessibility and synergy between port and city. For each theme, detailed road-maps are being developed to provide direction for the years ahead. The centre is also working to improve its name recognition by sponsoring a poster prize and organising workshops.
After a shaky start, the Centre for Sustainability has now set itself a course within what is a very broad field. It is focusing on a relatively new area, the management of resource streams. On 4 November, it even had the honour of organising an event to accompany the meeting of the prestigious UNEP International Resource Panel in Rotterdam. Although cooperation of this kind is inspirational, it is not always easy.
Occasionally, researchers literally do not even speak the same language. There may also be differences of opinion on what defines success. Whereas one person may want to publish in a leading international journal as soon as possible, another may see a Dutch journal as a more appropriate platform. Collaboration with businesses may be second nature to one, but completely uncharted territory for another.
As one of the interviewees joked, a manual for dealing with Leiden academics is not necessary. However, researchers need to respect each other's differences and their successes. That is the only way of making further progress. Experience has shown that the fact that the researchers come from different fields is a benefit. If there is overlap, it can often cause disagreement about who should do what.
The university marketing departments have already begun to become protective of their institutions' images. As a result, it is no longer permitted to use the acronym LDE (for Leiden, Delft, Erasmus). Although everyone may not strictly abide by the rule, it can make it difficult for centres to sell themselves. Every time, they have to give the name of the alliance, including the full names of the universities. There is no joint corporate image as such, although the websites all share the same look and feel. This is deliberately different from that of the three individual institutions.

Obstacles

There are also various organisational obstacles. Each of the centres faces some of these: different support systems, differences in terms of rules and procedures. The differences in the structure of the academic year also create problems. These make many researchers reluctant to establish a joint >>

minor, for example.
There are also some obstacles that do not affect everyone. Governance would like to introduce a joint Master. The aim is for it to be a state-of-the-art two-year multidisciplinary programme featuring the best researchers from the three institutions, entrance requirements for students, its own location and internships abroad. However, Leiden and Rotterdam are currently prohibited by law from offering a two-year Master's programme. A solution is now being sought, but in the meantime the centre does not actually exist. Joint research has already been around for a while, argue the researchers, so a centre is not necessary for the time being. There is enough work to do.

Lack o ftime

Almost everyone suffers from a lack of time. Even if there is a lot of enthusiasm at the outset and numerous ideas for research and education, it is not easy to find the time. Of course, the research for the centre can be accommodated within the work an academic is already doing, but there are always additional duties in practice while the employment contract stays the same.
The innovators are on hand to make sure people stay the course. They keep the administrative work, such as building websites, organising events and writing future visions, separate from the people focusing on the substance. This is because the latter need to be able to do their work as smoothly as possible with minimum fuss to worry about. Otherwise, as has already happened, they will abandon the venture. That can leave the future of a centre, which is heavily dependent on the ideas of researchers, in the lurch.

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Centre for Frugal Innovation in Africa

Iva Peša is exploring Zambia in search of initiatives for the Centre for Frugal Innovation in Africa (CFIA). The post-doc is the first researcher attached to the centre full-time. Peša is investigating which sustainable developments could be beneficial for African societies. "These new products not only need to be cheap, but also accepted by the population."
That is the aim of frugal innovation, a brand-new area of research. The idea is for the academic sector to make it possible for businesses to develop smart devices and services that make money and genuinely help inhabitants of developing countries to make progress in such areas as combating poverty or promoting healthcare. Peter Knorringa, Professor of Private Sector & Development (Erasmus University) is one of the founders.
Together with TU Delft's Professor of Management of Technological Innovations Cees van Beers and André Leliveld (African Studies Centre in Leiden), he has been working on frugal innovations for quite some time. "When we heard about the strategic alliance, the penny dropped and so we decided to discuss the options. Looking back, I wonder why we did not do it sooner."
The fact that there is chemistry between the approximately fifteen researchers involved is often cited as an important factor in their successful cooperation. This is because interdisciplinary research calls for a tolerant attitude towards other disciplines. Several times a year, they have brainstorming sessions to share ideas. They have already achieved concrete results. For example, a frugal thermometer has been developed by medical anthropologists at LUMC and industrial designers from Delft that enables people who cannot read to tell if someone has a fever. A student has already been able to visit Ghana to explore the options for selling a frugal weather station designed in Delft.
These kinds of subprojects are working successfully, but the centre will only survive if it receives grants. The CFIA has enough seed money from the steering group to last until late 2015, after which it will need to look after itself. There are already two concrete research proposals waiting for approval, one with the science-funding body NWO. That grant application already revealed the formal difficulties of operating as a centre, since NWO expects to have one main applicant. That means that the subsidy is awarded to a single university, even though the research actually depends on three.
It is not only in the Netherlands that people need time to become accustomed to this new alliance; in Europe as a whole, there is a lot of work to be done to improve the centre's name recognition and that of frugal innovation in general. If that fails, the chance of major funding from the Horizon 2020 project will be minimal. The first round of applications is already complete, but the centre missed it. Leliveld: "It was simply too early. You can increase your chances of success in Europe by demonstrating success elsewhere, which was why we are opting to apply for grants in the Netherlands first. We will then build on that later." EVR

THE FIRM

For his graduation project, Stefan Roest developed a solar panel. When he wanted to test it, the sun was nowhere to be found. There was no artificial sun available for sale, so he built his own. He had identified a gap in the market, as the success of Roest's company Eternal Sun demonstrates.

Roest can well remember walking around the car park behind the faculty of Electrical Engineering, Mathematics and Computer Science in 2010. He was in search of sunlight, pulling a cart with his self-designed solar panel and measuring equipment.
He knew he had a success on his hands: a solar panel that can generate electricity and hot water. All he needed to do was prove it. But it was the start of autumn and the sky was overcast. "On the only sunny day there was, a crane was blocking out the sunlight. How can I ever get any good test results?"
"I need an artificial sun," replied Roest to his own question. Now, over four years later, he tells his story, standing by just that kind of simulator. It is a three-by-two metre colossus that mimics sunlight with 98 percent accuracy. In 2014, Eternal Sun achieved an annual turnover in the region of a million euros and he has big ambitions. With good reason: the solar energy market is booming and new products need to be tested.
Before Roest had even graduated, it was already clear that his artificial sun would fill a gap in the market. As he was working on it, he was contacted by someone from TNO, asking if he could have a simulator like that.

PHOTO: SAM RENTMEESTER

With a friend from the Virgiel student association, SEPAM student Chokri Mousaoui, he drew up a quotation and quickly set up his own company.
It was the right move. "We had two more customers in no time. We joined up with YesDelft (the TU Delft incubator for start-ups) and hired two people." Things continued to move fast. "We received an order for three units from South Korea. It took nine of us eight months to build them."
Business then started to go quiet. "We had not focused enough on marketing. It was touch-and-go for a while. Fortunately, new projects quickly emerged in Turkey, India and the Netherlands." Last year, the company struggled to deal with the sheer number of requests. That was why Roest and Mousaoui decided to look for an investor.
The resulting two million euros have enabled Eternal Sun to hire staff, move to a bigger location and update the product. "Every unit we build is slightly better. I would recommend that to everyone: do not wait until your product is fully developed. Always try to deliver something, even if it is just a prototype. Often that is already enough for the customer. And always discuss with customers what they need. They are what keeps you in business." SB

Name:	Stefan Roest (30)
Studied:	Sstainable energy technology
Company:	Eternal Sun
Established in:	2011
Product:	Solar simulator
Mission:	Contribute towards renewable energy/sustainable products
Sales:	Around a million euros in 2014
And in five years?	"Eternal Sun will be at least ten times the size it is now."

Weird and wonderful worms

In the WaterLab, biotechnologist Steef de Valk is carrying out experiments with tubifex worms. These threadlike creatures are capable of reducing by half the quantity of sewage sludge from water treatment. No-one really understands how this works.

AUTHOR JOS WASSINK ILLUSTRATION GENEVIEVE RIETVELD PHOTOS SAM RENTMEESTER

When Steef de Valk removes the worms from their container, it looks like he's holding a ball of dark-coloured slime. "They always do that when they're stressed", he says. "They all clump together in a ball." Changes in temperature, movement, being picked up - these are all things that upset tubifex worms. But there is one thing that these threadlike creatures can handle very well: chemical pollution. Insecticides and heavy metals leave them completely unfazed, within certain limits of course. These particular worms come from river sludge in Poland, because our rivers are too clean for tubifex; they are forced out by other creatures.
PhD candidate De Valk puts the clump of worms in a glass jar and stirs the water carefully. "From a chemical point of view they are very strong, but they have a fragile body." And indeed - the worms emerging from the clump are no more than a millimetre thick and a centimetre long. They are red in colour because, just like humans, their blood contains a sort of haemoglobin. They extract oxygen from the water by waving their tails, while ingesting sewer sludge at the other end. Yum. After a few minutes the worms begin to clump together again, forming three balls. "I don't know why, but they just seem to like being together."
De Valk isn't the only person with a fascination for worms; he is following the example of Charles Darwin. In the book on worms that Darwin wrote in 1881, he asked himself: 'It may be doubted whether there are many other animals which have played so important a part in the history of the world as have these lowly organised creatures.'

Scale model

The rectangular glass tank in which De Valk conducts his experiments is a scale model of a 125 m3 tank that was situated at the sewage treatment plant in Wolvega from 2007 to 2013. TU Delft alumnus Jelmer Tamis was involved in this as a biotechnologist. In his final report for STOWA, the Foundation for Applied Water Research, in 2010, he reported that in two years' time, worms had broken down 193 tonnes of sewage sludge (measured as dry product) of the 303 tonnes offered. Breaking down the sludge is of great economic importance - transporting sludge to incineration plants accounts for around half of the operating costs of wastewater treatment companies.
Tamis summarised the results of this practical experiment: a worm reactor can easily be added to the treatment process (see chart) and can achieve breakdown rates of 60 to 70 percent. Thanks to improved anaerobic digestion and biogas production, the process produces more energy than it uses. This all sounds very positive, but the fact that no-one really understands how the worms can break down so much material continues to nag us. Because if you don't precisely understand the process, it is hard to optimise it.

Collapse

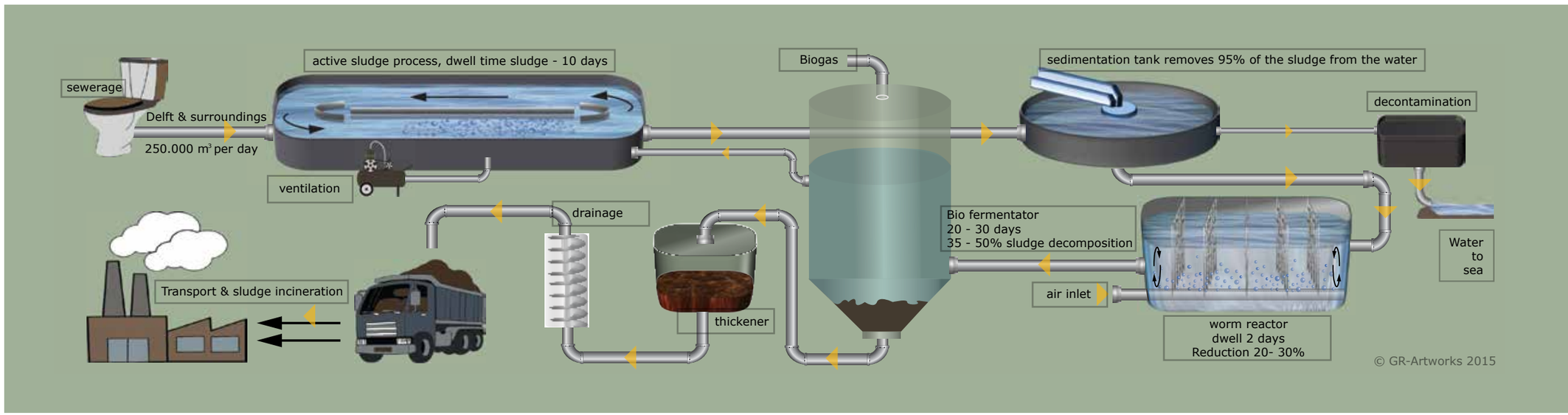
Research into sludge breakdown by worms was prompted over thirty years ago by a chance observation during a graduation research project at Wageningen University. This research began with free-swimming worms and later included sessile worms that behave in the same way as tubifex. The researchers reported a huge rate of sludge breakdown, up to 75 percent, but the stability of the population was a recurrent problem. During the last ten years a great deal of research has been carried out by Professor Yuang-song Wei (Research Center for Eco-Environmental Science) who became familiar with the technology in 2001/2002 while working as a postdoc at TNO.

> The Chinese don't have to think twice about it. They'll soon be the ones doing it

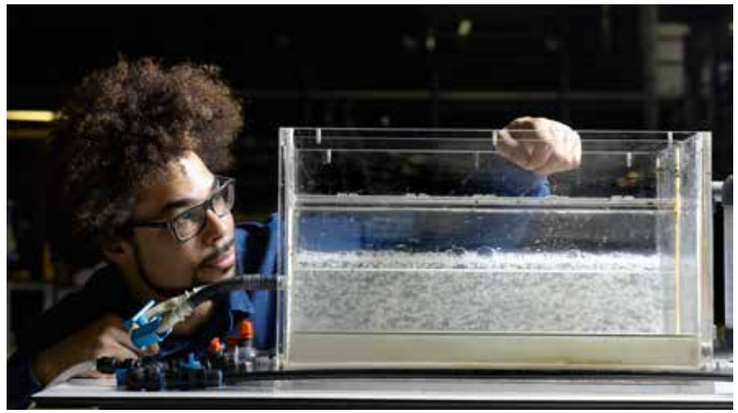
In Wolvega the researchers also experienced problems with the worm populations initially. In the first weeks of 2007 the colony (Aulophorus) grew rapidly and successfully, only to collapse in week 7. The Aulophorus was also supplanted by another worm species (Lumbriculus).
It took some time for the researchers to work out how to manage the worm populations in order to reverse the cycle of growth and collapse and to achieve a stable population. For this the population must be managed in terms of density, age and the worm/sludge ratio. And to make things even more difficult: sudden changes in temperature, nutrients and current can also upset the worms.
The researchers were finally able to create a stable worm reactor for the Wetterskip (water board) that remained operational until 2013. In 2007 the sludge breakdown rate was 66 percent, and in 2008 61 percent. After 2013 the reactor was dismantled to make way for an expansion of the plant at Wolvega.

Influence

Back at the Delft WaterLab, Steef de Valk is very familiar with the Wolvega reactor – as he did an internship at Tamis. The worms used in Delft (tubifex) live on grids suspended in the wastewater on one side of the test reactor. De Valk gets their 'food' from the Harnaschpolder wastewater treatment plant. The blackwater is kept in a tightly closed jerrycan. A dividing panel separates the test reactor into two halves which are completely identical, apart from the worms. This enables him to precisely measure the worms' influence on their environment, because the experiment in Wolvega had already >>



led to a number of questions, such as: were the worms responsible for the unexplained breakdown, was it the bacteria in their gut or was it an enzyme produced by one of the parties? De Valk: “We know that worms accelerate the breakdown process and that during the digestion process they raise the production of biogas as they themselves disintegrate in the digester. But what is the explanation in terms of enzymes? If we knew that, we would be able to create the enzyme using a modified bacteria. If you then added the enzyme during the digestion process, you would achieve the desired results”
It is not yet clear who or what is producing the enzyme in question. It may be produced by the worm, or possibly bacteria in the worm’s gut. And it could be that a whole series of enzymes is responsible for the breakdown process. “The whole research is a puzzle”, says De Valk, who wants to spend the coming time carrying out genetic tests in order to gain more insight into the bacteria involved. He hopes that comparing RNA fragments from the wastewater with a database will enable him to find out which bacteria are characteristic of the worm reactor.



STEEF DE VALK: “FROM A CHEMICAL POINT OF VIEW THEY ARE VERY STRONG.”

Catalyst

“That sounds pretty desperate”, says Jelmer Tamis, who is currently also a doctoral candidate at TU Delft and is in the process of completing his dissertation on bioplastics. “I don’t see much point in it. Just compare the result with and without worms and you can see the breakdown with worms is ten times as fast. The worms are the catalyst for the breakdown. And even if the mechanism for this is not known, you can see something is happening. If you want to achieve something useful, you need to build a large reactor. If you want to carry out fundamental research, you can investigate how it all works, but for myself, I’m more interested in using it in practice.”
His report for STOWA includes a new design for a full scale worm reactor (600 m3) in the form of a ring around the sedimentation tank. This would require an estimated investment of 700,000 euros as well as the installation of a digester. When questioned, spokesman for the Wetterskip, Michiel Zijlstra said that this was a bridge too far for the water board. “All in all it was just an experiment. If some other businesses had also been willing to invest, we might have considered it. But this didn’t work out, and we thought it was just too big an investment to be paid for by public money.”
Tamis still thinks it is a pity that things turned out the way they did. “We’re just too penny-pinching here in the Netherlands. Our calculations showed that the investment would repay itself within three years through the savings made on sludge transport, and energy production. The Chinese don’t have to think twice about it. They’ll soon be the ones doing it.” <<

Read the STOWA report (in Dutch): *Slibafbraak door Oligochaeten*, 2010. Freely available on internet.

Eating worms

Worms are a rich source of protein, but if they have been raised on sewage sludge they are not allowed to enter the food chain. This is not the case for the worm species (Lumbriculus) raised on products from the food industry. These worms form an excellent alternative to the relatively unsustainable fish meal presently used as fish and livestock feed. Dr Hellen Elissen used worm-breeding technology to launch her startup company TailTec from Wetsus. She develops customised breeding reactors that provide optimum conditions for breeding worms using organic waste from the food industry. This could be an alternative to insect breeding. Hellen Elissen (environmental technology WUR, 2007) is presently in discussion with customers to realise a first production plant.

HORA EST

‘Humanity should create a system for establishing life on other planets (panspermia) using extremophiles, as insurance against the possibility of an event that could result in our complete extinction’.

Calin Plesa, bio-scientist

‘There are many cosmic events that could conceivably bring life on Earth to an end. That is why, ideally, humans ought to start inhabiting other planets. The technology we need for this has not yet been developed to a sufficient level, however. In the meantime, it might be wise to send simple life forms that can live in extreme conditions (e.g. bacteria found on the ocean floor). In this way, we could increase the chance that life will continue to exist. It would be a relatively small investment. And who knows? Over the course of millions of years, perhaps those organisms will develop into intelligent life forms’. TvD

Native speakers of the English language get their papers accepted by journals more easily than others.

Ruihua Lu, engineer infrastructures

A good researcher follows the research plan only until a better idea comes along.

Lu Zhang, computer science engineer

A time horizon of more than a hundred years goes beyond our imagination

Maria Johanna Ruijter, mathematical engineer

One is better of being happy than being right

Giselle de Moraes Ramos, transport engineer

Technological progress of the human race is driven by the advances in materials science and almost nothing else.

Venkata Girish Kotner, materials engineer

Science enhances human capabilities, religion gives guidance about the way how to use these.

Pieter Cornelis Jenze Jan Coumou, physics engineer

Development aid is ineffective unless we halt neo-colonialism.

Pieter Cornelis Jenze Jan Coumou, physics engineer

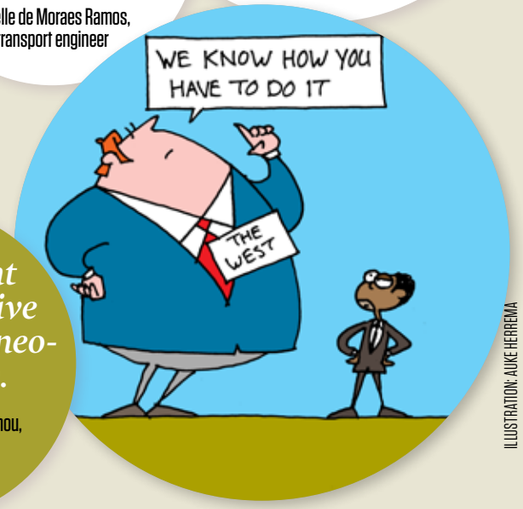


ILLUSTRATION: AUKE HERREMA

Alumni World

‘After 50 years, I wanted to do something in return’

In 1960, ir. Bob de Lange received a grant from what was then the Hoogeschoolfonds to take his degree in crystallography. Fifty years later, he decided to do something in return.
De Lange made a one-off donation to the University Fund, enough to support another graduating student in the final phase of his or her degree programme. ‘I don’t envy the students and the study climate they are faced with today’, he states. De Lange was only 16 when he completed secondary school. In 1950, he decided to study chemical technology at the Technische Hogeschool (Institute of Technology) in Delft.
For 10 years, he cycled back and forth be-tween Delft and The Hague. He referred to himself as a ‘bicycle student’ – one of many at that time. In 1960, he completed his graduation requirements with Professor W.G. Burgers. ‘I took my degree with distinction in crystallography, a subject that I had failed five times during my propedeuse’, laughs de Lange. ‘Professor Burgers applied for the grant from the Hoogeschoolfonds for me, as a source of personal financial support. I had never heard of it. He must have noticed that I was not particularly well of at that time. The grant allowed me to work less and devote more time to my studies’.
De Lange worked for TNO his entire adult life; there, he conducted research and held various management functions. He is now retired. ‘I wanted to do

> ‘It wasn’t easy in my day either but there was more freedom’

something in return, put something back into the Fund.
The gift is a major expenditure for me, but at that time, the grant was very much needed, and I am still grateful for it’. De Lange also does not envy the current generation of students and the study climate in which they work. ‘It wasn’t easy in my day either – to make ends meet, for example – but there was more freedom. There was no particular time pressure’. In de Lange’s opinion, a fund does not have to limit itself to enabling poor people to pursue a degree. ‘It’s a good thing that the current University Fund offers support to students in a variety of ways. They did that for me in my day, and I am happy to help them continue to do so’.

Would you like to do something in return too? Become a Friend of TU Delft at universiteitsfondsdelft.nl.

Alumni activities

26 March
Young Alumni Career Week – How to apply to land the job

22–23 April
IDE Masterclass – Context mapping

16–20 May
Dutch Engineers tour ‘The Nordics’ (Oslo, Trondheim, Copenhagen, Stockholm and Helsinki)

19 May
Conference ‘I am innovation’ – Technological Society

20–21 May
IDE Masterclass – New Product Marketing

28 and 29 May
Open Orientation Days for TU Delft Bachelor’s degree programmes

24–25 June
IDE Masterclass – Design for Healthcare

IDE Master Classes

Are you ready for a new inspiring episode in your career or longing for a dedicated update of your design knowledge? A new series of IDE master classes offers a broad range of intensive two day master classes for design professionals led by top lecturers from the faculty of Industrial Design Engineering (IDE), TU Delft.
In small groups of 12 to 16 participants, you gain insights in the latest developments, and you work on methods and tools currently being taught to the new generations of designers. The first edition was well attended by representatives of over 80 companies. The 2015 edition builds on this success and contains three new master classes:

22-23 April	Contextmapping, by Pieter Jan Stappers
20-21 Mei	New Product Marketing, by Erik Jan Hultink
24-25 June	Design for Healthcare, by Richard Goossens (new)
23-24 September	Service Design, by Froukje Sleeswijk Visser
14-15 October	Managing User-centred Design, by Jasper van Kuijk
25-26 November	Strategic Value of Design, by Giulia Calabretta (new)
27-28 Januari ’16	Persuasive Game Design, by Valentijn Visch (new)

Each master class combines theory with interactive assignments and group cases: you can directly apply what you learn. This is a great way of meeting and working with other experienced designers, expanding your network, and creating new opportunities. The programme is aimed at those of you interested in personal or professional development, whether that be refining your skills, focusing your ambition, or simply broadening your mind and gaining inspiration.
ide.tudelft.nl/masterclasses

Dutch Engineers Alumni tour ‘The Nordics’

After a successful pilot in the USA, the three universities of technology are planning another alumni tour. This time, we will be visiting Dutch engineering alumni in the Nordic countries.
Approximately 2100 Dutch engineers live and work in these countries. If you are one of then, we would like to invite you to attend a lecture and network at an event in Copenhagen, Trondheim, Oslo, Stockholm or Helsinki. The alumni officers of TU Delft, Twente University and TU Eindhoven will also be visiting several companies and talking with colleagues at Nordic universities. If you are working at a company or entity along with several other Dutch engineers, please contact us. It might be possible to schedule a visit or a small event.

Want to attend?
Alumni will be invited to these events based on the data included in the alumni database. If you would like to edit your information, please visit alumniportal.tudelft.nl. You can e-mail us at alumnibureau@tudelft.nl

CONTACT
Do you have tips, ideas, questions or comments for the alumni office? Send an e-mail to: alumnibureau@tudelft.nl or call +31 (0)15-2789111

ALUMNIPORTAL
Do you want to change (alumni) information, communication preferences or sign up for alumni events? You can do that through the alumni portal www.alumniportal.tudelft.nl

LINKEDIN
Do you want to contact other alumni? Join the ‘Delft University of Technology –Alumni LinkedIn’ group.

FRIENDS OF UFD FUND:
Become a ‘Friend of TU Delft’ and support Talent, Technique and TU Delft with your contribution. Bank account IBAN number NL19FVLB0226850471, account name ‘stichting UfD’, description ‘friends’. universiteitsfonds.tudelft.nl

Lab of...

Organic Materials and Interfaces

The OMI lab focuses on organic chemistry and nano-biosensors. "We don't manufacture the nanowires. Ph.D. candidate Anping Cao uses silicon nanowires as gas sensors in her research. Each wire can detect a different gas or vapour. When bunched together, it can work like a real nose.

"The engineers around us make stuff and we use it," says Ph.D. candidate Aldo Brinkman. His research on silicon nanowires in liquid could potentially be put to use in lifelike prosthetics, where the nanowires would work as bioelectric interfaces between the body part and the prosthetic. KD

PHOTO: SAM RENTMEESTER