WHY WERE WOMEN MORE VIOLENT IN THE PAST?
HOLDING BACK WATER WITH LOWERED DYKES  DID LIFE ON EARTH ORIGINATE FROM THE COSMOS?
WANTING TO SLEEP BUT NOT BEING ABLE TO  HELP SCIENCE: BURY TWO TEABAGS  HOW VIRAL INFECTIONS IN THE SEA CAN BE A DRIVING FORCE IN NATURE
Last summer I was pleasantly surprised by the first hydrogen filling station in the Netherlands that was installed at a petrol station in Rotterdam. Just weeks before that, I had read about hydrogen cars and understood that it would be a long time before such emission-free vehicles would be found on the roads. In September, however, I read in de Volkskrant newspaper that both car producers and scientists think that not the electric car, but the hydrogen car will dominate our future car traffic. It is amazing how fast progress can be.

It once again illustrates the fantastic things that can happen when industry and science look for groundbreaking solutions to societal problems. Furthermore, I am always extremely enthusiastic if scientists manage to talk about these things in such a clear and inspiring manner that I can understand them as well.

I was gripped by the same enthusiasm when I thumbed through this special issue of Quest. There is not a single discipline in the world that brings us so much progress as science. We can see that in medicines that wipe out deadly viruses and in new technologies such as smart watches – increasingly smaller, faster and smarter. And we see that in how scientists devise solutions to counteract natural disasters, such as Neelie Doorn at Delft University of Technology is doing in the area of flood prevention.

All of the scientists who tell us about their research in Experiment NL show how they can make a jump forward in their research through the funds that NWO has made available to them. They describe how fascinating it is to contribute to the progress of our knowledge and our society through their work.

I hope that you are gripped by the same fascination when you read in this magazine what the top talents and scientists are managing to achieve. And just like you, I dream about what this will bring us next. Now the hydrogen car is within grasp, I am really curious to find out what the next world-changing discovery will be.

Sander Dekker
State Secretary for Education, Culture and Science
About NWO
The Netherlands Organisation for Scientific Research (NWO) funds more than 5600 research projects each year.

Dangerous women
Why were there more criminal women in previous centuries than there are now?

Migratory birds man
Spinoza laureate Theunis Piersma follows migratory birds from cradle to grave. ‘I want to know how they make choices.’

Don’t look!
Problem: By looking at quantum particles you change their state. Physicists from Delft have found a way around this.

Triple strength
Three organisations promote Dutch science behind the scenes.

Whether you want it or not
Free will? Your behaviour is easily steered in any direction.

Small world
Science is international. Six collaborations between Dutch researchers and their foreign colleagues.

Clean-up bacteria
Mark van Loosdrecht, Spinoza laureate, lets bacteria purify dirty water.

Living universe
At some point meteorites brought water to the earth. Did they also bring the first building blocks of life with them?

Shared blood
Twins sometimes steal each other’s blood. Researchers from Leiden improved the remedy which prevents that.

Living artificial cell
Plastic is dead. But in Nijmegen plastic cells appear very much alive.

Rotten tea
Tea rots if you bury it. How fast that happens says something about the climate.

SAFE DRINKING WATER
The groundwater in Bangladesh is full of poisons. The Bangladeshis are working with Dutch researchers on a solution: pumping up the water, aerating it, and then transporting it back into the ground.

Too awake
Sleeplessness is in your brain, says Eus van Someren.

Never in two places at once
Quantum particles can be in two places at once. We cannot. And that is very strange, thinks Spinoza laureate Dirk Bouwmeester.

Fashion myths
There is no such thing as Dutch fashion. Or is there?

Switchable medicine
Can you use an on/off switch in antibiotics to stop bacteria from becoming resistant to them?

Prince Swine
At the end of the eighteenth century, people in high positions were ridiculed far harder in the media than they are now.

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DOING A LOT? EAT A LOT!
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MICHELLE MOEREL
How does your brain process the sound that comes in through your ears?

100 ADMINISTRATION RIDICULED
How Stadtholder William V was ridiculed in the media in about 1790.
More than 5600 research projects

About NWO

The Netherlands Organisation for Scientific Research (NWO) is one of the most important science funding bodies in the Netherlands and has a budget of 650 million euros per year. Scientists can apply to NWO for funding for their research. NWO is made up of various organisational units spread throughout the Netherlands, each with their own working area. NWO encourages national and international collaboration, invests in large-scale research facilities, promotes knowledge utilisation and manages research institutes.

NWO manages research institutes, large-scale research facilities, promotes knowledge utilisation and encourages national and international collaboration, invests in funding for their research. NWO is made up of various organisational units with a budget of 650 million euros per year. Scientists can apply to NWO for funding for their research.

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Why were there more criminal women in previous centuries than there are now?

Women in jail

Judith beheads Holofernes by the Italian artist Caravaggio. The painting dates from 1598-1599. It is a scene from the Bible book Judith, in which she kills the head of the Assyrian army.

Now women commit about ten percent of all crimes. In the seventeenth and eighteenth centuries that figure was four times higher. Why? Historian Manon van der Heijden decided to find out.
Had a woman been raped? Then she was banished due to adultery!

A case of incest between a father and his daughter is what sticks in my mind the most. Everybody in the neighbourhood knew about it. I read no less than 38 witness statements. When the father also locked up the girl, he was reported by a member of the family. He received the death penalty. But that was not all. Incest was considered to be a deed so sinful that the perpetrator could never commit it without the consent of the victim. Consequently the daughter was banished forever. She could not count on any sympathy. It was only about the family’s honour. Horrendous.

Manon van der Heijden is Professor of Comparative Urban History at Leiden University. She read thousands of hearings, sentences and witness statements from the seventeenth and eighteenth centuries. Initially for her final-year dissertation about criminality among women in eighteenth-century Rotterdam and now with funding for a five-year follow-up study. She has already made some striking findings in the period investigated: women committed about forty percent of the crimes. That is a lot more than now when ‘only’ one in ten convicted criminals are women.

What sort of lives did the women in the case files live? ‘They were mostly women who had a hard life because they had to fend for themselves. Migrant women from Germany or France who had no support from their family, women whose husband was away for a long time at sea, servant girls, textile workers, and widows. Most of the women did work but could not earn enough. To make ends meet they often had temporary jobs besides their normal work and they often engaged in criminal activities as well.

They did not have many options. There were some provisions for the scammed wives they had relatively more rights. For example, they could arrange the finances if their husband was away and they were allowed to start their own company. That was not the case for the women I encountered in the case files. They often had affairs and they sometimes had children with different partners as well. It also struck me how mobile they were. If they were banished from Amsterdam due to a crime then they simply travelled to Rotterdam and re-started their lives there.’

Which crimes did they commit? ‘It mostly concerned theft, fraud and receiving stolen goods, but definitely violent crimes as well. In that period it was quite normal for people to carry weapons and to use these to settle disputes. The punishments given for this were relatively light. If you severely wounded somebody then at most you would be given several months in prison surviving on bread and water. We did not know up until now that women also used so much violence in their everyday lives. The women also committed sexual offences but other offences fell under this category than is now the case. It was not so much about sex with minors. Adultery, bagamy and prostitution could also be punished. For adultery you could expect to be banished for fifty years. And if a woman had been raped then she was also considered to have committed adultery. But even if you remove all the sex crimes from the statistics then the women back then committed more crimes than now. That is probably due to the moral standards that applied in that time and the difficult legal position that women were in. I saw an example of the latter in the cases of child murder I encountered. Nearly all of these were committed by unmarried servant girls or cleaners who had become pregnant. Sex outside marriage, or ‘shyxy conversations’ as it was called then, was punishable. Such a person was chased out of the town with a rod. Midwives were not allowed to help unmarried pregnant women unless the father of the child also presented himself. Otherwise there was the risk of the woman becoming a beggar because she would be dependent on alms. These women were completely trapped. Eventually out of despair they threw their new-born child in the river.’

What else did you find in the files? ‘I saw an enormous amount of gossip and backstabbing. Everybody knew everything about everybody else. In most cases, a whole host of people had something to say about the suspect: friends, family, the neighbours, and the innkeeper. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans side. People sat on the street drinking wine, and mother shelled the beans. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans. At that time everybody lived outside. People sat on the street drinking wine, and mother shelled the beans.

Youth centre was a centre? ‘It was only about the family’s honour. Horrendous.

Disappeared off the radar

For her PhD research at Leiden University Medical Center, psychologist Elisa van der Molen spoke to 229 young women who had been released from a youth detention centre five years previously. After that period in detention they were effectively left to find for themselves because they no longer fell under the help of youth care services. And that could clearly be seen. ‘The girls miss the skills to look after themselves. Two-thirds have no qualifications, most of them have no work and they are in debt. Some were homeless, were in institutions, or in adult prison. One-third had a child. On average they had become a mother when they were 20 years old. I did not have the feeling that these were criminal girls. Society only sees the crime they have committed and not the person behind this. The girls were found and foremost very vulnerable. They were not capable of living a stable life. Yet alone bringing up a child. One quarter of their children had therefore been placed in care. Many of the girls had psychiatric problems. About 40 percent had a personality disorder such as borderline syndrome. They were far more concerned about their own needs than those of the child. The young mothers had the feeling that the children cried to annoy them. ‘Then I just scream back’, they said. The ability of the girls to regulate their emotions left something to be desired. For example, they would hit a person simply because he or she looked at them in a certain way. Nearly all of them used alcohol and drugs, also during pregnancy. Many of the girls had partners who were in prison. Of them were involved in criminal activities with their partner. Together they sat and told me about how they stole cars. This is a category of girls that has disappeared off the radar. Young men commit crimes more often and in that sense they remain more in the picture with respect to getting help. But once these girls have reached the age of 18 and no longer fall under the youth care services they have nowhere to go. In effect they end up on the streets. There is no scientific evidence that a stay in a youth detention centre helps. I therefore call for young people not to be placed in one unless it is really necessary. But in particular I would like there to be a better safety net for the girls and their children. Because I have often thought that we also see these children in 16 years’ time in a youth detention center.’
be sentenced. A confession was needed. However extracting that with the aid of torture was quite acceptable. Then the torture was called on. He first of all showed the thumb and shin screws to scare the accused. If that was not enough then he used them as well. This is all stated in the trial documents. If the suspects confessed during the torture, they had to do that again but without ‘bands of pain and iron’. Then it looked like the confession had not been forced. Eventually Hendrikje confessed that she had poisoned everybody with arsenic. In 1847 she received the death sentence but that was commuted into a long correctional centre sentence. There she died after just 8 days.

MARIA SWANENBURG (1838-1915)

At the end of the nineteenth century she poisoned more than 100 people in the neighbourhood, 27 of them died. ‘Good Mie’, her nickname, looked after sick and poor people and concluded a funeral insurance for them, often more than one. She poisoned them and pocketed the insurance money that was left after the funeral. She preferred to work with arsenic, which she put in barley gruel. Good Mie also killed 16 members of her own family, including her parents. Four years after the start of the slaughter, in 1863, she was arrested. In 1915 she died in a correctional institute.

MATTHE HARI (1876-1917)

She came into the world as Margaretha Geertruida Zelle in Leeuwarden, but at the start of the twentieth century she became world famous as the ‘amourous dancer’ Mata Hari. Paris and London, in particular, fell at her feet. She led her life of a celebrity and came into contact (sometimes amorous) with many men in high positions. That was eventually her downfall. During the First World War she moved in high military circles in both France and Germany. Had she fetched sensitive information from these gentlemen? No direct evidence has ever been found for this. Nevertheless France accused her of being a double spy and executed her in 1917.

BONNIE PARKER (1910-1934)

Better known as Bonnie from Bonnie & Clyde (Clyde Barrow), the American gangster duo that roamed plundering and murdering through the United States at the start of the 1930s. Amazingly they always managed to escape capture by the police. As they mainly attacked banks the two enjoyed certain popularity among the people. It took several years before their criminal existence came to an end: in a police ambush both were riddled with more than 50 bullets.

MICHELLE MARTIN (1960)

Did nothing against the crimes of her husband. The Belgian child murderer Marc Dutroux. In the 1980s he raped live teenage girls with the help of Martin. Both were sentenced for this but were released early in 1992. In the following years Dutroux kidnapped a total of six girls who he locked up in the cellar of his house. When he was imprisoned for several months for another crime, Martin knew that there were two girls in the house but did nothing for them. She did, however, kill the dogs in the house. The girls died of starvation. Two other victims also died. In 2004, Martin was sentenced to 30 years in prison for her role in the crimes. In 2012, she was once again granted parole. Initially she went to a monastery but she has now indicated that she wants to live independently again.

Poison mixer ‘Good Mie’ at work. The victim on the right knew exactly what was going to happen.

For years Bonnie Parker and Clyde played a cat and mouse game with the police. While travelling the two made provocative photos, such as these.

Women were no pushovers as this fight in a sixteenth century brothel shows. The artist is not known.

that yet. I suspect it only occurred in the twentieth century when the welfare state was introduced and welfare increased. Then a wide range of facilities became available for the more disadvantaged in society. This alleviated some of the problems that had caused women to commit crimes in previous centuries. However we still need to find out if this hypothesis is true.

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CRIME

Famous criminal women

HENDRIJKJE BOELEN (1764-1847)

She lived together with her husband Aaldert in the mid-eighteenth century in an almshouse in the village of Wijk in Drenthe. At a certain point a wide range of people in her vicinity died: first her husband, then another woman in the house and a neighbour. Three children became ill and one of them died after eating her pancakes. Eventually Hendrikje confessed that she had poisoned everybody with arsenic. In 1847 she received the death sentence but that was commuted into a long correctional centre sentence. There she died after just 8 days.

Criminal women.

Manon van der Heijden, Uitgeverij Prometheus (2014): criminality and justice in Holland from 1660 to 1880 in Dutch.

bit.ly/womenincrime: Harsh existence of women in Holland led to criminality.

Prometheus (2014):

criminality and justice in Holland

EXPERIMENT NL

EXPERIMENT NL
How important are experiences for birds?

Theunis Piersma, Professor of Global Flyway Ecology at the University of Groningen, maps the lives of individual birds. He wants to know how their life experience influence their choices and the chances of offspring. In 2014 he received the NWO Spinoza Prize worth 2.5 million euros.

What does the prize mean for you?
‘I have organised my entire life around being a researcher and excelling in that. The prize is a great recognition of my work, although, to be honest, I did not feel I had anything to complain about in that area. It also allows me to do far more in my research area. We were already in a moving car, so to speak, and now we can really hit the accelerator.’

What exactly are you researching?
“We’re trying to find out everything about the demography of several species of waders. Where and when and how many born and where and when do they die? ’That is far from easy. As people we go to the town hall to register a birth. That is carefully recorded. However, in the case of wild birds you have to be something of a detective to find that out. We make part of the population recognisable as individuals by ringing them. We then put a lot of energy into finding the birds back again as often as possible. To make a good estimate of the survival you have to keep on doing that over a period of many years. Because if you do not see a particular individual for a while then you do not know whether you have simply not seen it or whether it is dead. However, if you see it again in the following year you know that you missed it last year. By understanding the demography you can investigate an awful lot of new questions. There are always more successful and less successful birds. There are so few insects there, little to eat. Then the question is why do they do that?’

And have you found the answer?
‘I think that the life experiences of a bird exert a considerable effect on its life course and the choices it makes. It could be a sort of imprinting. Perhaps the places where it grew up determine where it goes later in life. In biology the importance of the environment and life experience have largely been pushed into the background over the past fifty years. Most biologists try to explain certain behaviours and choices of animals from a genetic viewpoint. For example, the season of spring is becoming increasingly warmer. Some species are breeding earlier as a result of that. Even biologists interested in ecology first of all start from the genetic factor that determines the time of breeding. If birds with ‘genes for early breeding’ are more successful, then those animals are selected. With this approach we can explain a significant, but nevertheless small proportion, of the variation. I think that the effect of the environment is far more important still. Perhaps a parent bird translates a signal from the environment into a decision to go and breed earlier. In such a case the young will also be bred earlier. It could well be that there is a relationship between the moment a bird was born and the moment it wants to breed. Distinguishing such environmental factors from genetic influences is far from easy. To find out the extent to which the environment and life experiences played a role in the choices that a bird makes requires you to follow them from cradle to grave.’

How do you follow a bird?
‘Chicks are ringed with unique sets of colour rings around their helpfully long legs. Sometimes it can be several years before we see such an individual again and then you know nothing about its experiences during those intervening years. That is a problem because these are probably the years that shape its life. However, we do follow a number of adult birds using satellite transmitters that contain solar panels to enable them to function for years. The devices are fairly small and may now weigh as little as five grams. They transmit the bird’s location wherever that might be in the world. But even then, we still do not know what these individuals are doing throughout that entire period. We are on the point of equipping young birds with GPS loggers. Every five minutes these record the GPS position. And an even more exciting aspect is that we can also measure what a bird is doing because the log contains a movement sensor. That registers in three dimensions which movements the bird makes. If a bird is flying then its body always moves up and down a bit. If it walks the body always...’
Many biologists fail to take the environment seriously enough

Do you recognise individual birds?

‘I do not recognise each bird from our research. That would be impossible. The research I lead is following about 50,000 living and individually recognisable birds at this moment. However I often see a known bird. For example, I see red knots here on the mudflats and I see them again in a remote area in West Africa, places that take at least three days of flying to get there. So the distances always give me an awe-inspiring feeling.’

Why do you do this research with migratory birds?

‘There are several reasons for that. I do research on red knots, black-tailed godwits and spoonbills, all long-legged species that live in open landscape. That is practical because it is easy to see and read the coloured rings on their legs. Furthermore, these three species are easy to follow. They are specialists that are only found in certain areas. If a bird species is found in many different areas, and especially if such areas are covered in dense vegetation, then following them is more difficult. But even more important still we know the species very well because we have already investigated them for many years. That is the base on which we can build further. Because soon we will know how long a bird has flown, eaten or walked for but then we will also need to know in which context that has happened. Has the bird done that alone or in a group of one thousand? At a location with a lot or little food? Because we know these birds well then we will already know, for example, where they are found, where a lot or little food is present, and where areas which are successful. You need that knowledge to be able to take the next step. We know their patterns and routines. However, what we do not yet is how these patterns arise in their lives.’

What makes migratory birds so fascinating?

‘Migratory birds are a metaphor for the world’s ecology (and even the economy). They demonstrate that processes are connected with each other on a global scale. What happens here influences what happens in Africa and vice versa. The black-tailed godwit’s dependency on how farmers manage their land. That is the case here but also in West Africa. If something goes wrong with the black-tailed godwit here then they notice that there as well. It shows that on this planet we are joined lives. Furthermore, I see them as representatives of how important life conditions are lost as well. An awful thing. For us.’

Who is Theunis Piersma?

1980: gained his Bachelor of Science from the University of Groningen. 
1985: received the Herman Kliip Prize for the best student from many biologists living in the Wadden Sea.
1994: graduated cum laude from the University of Groningen.
1994: appointed as a researcher at NIOZ Royal Netherlands Institute for Sea Research.
1996: received the PIONIER grant from NWO to do five years of research on the wadden Sea.
2001: a subspecies of red knot migrating between Australia, China and High Arctic Russia was named after him. It bears the name Calidris canutus piersma.
2003: in addition to his work at NIOZ he received a part-time appointment as Professor of Animal Ecology at the University of Groningen.
2004: the Prime Bernard Cultuurlands Prijs for nature conservation and the Luc Hoffmann medal for excellence in science and conservation were added to his cabinet of prizes.
2009: appointed a member of the Royal Netherlands Academy of Arts and Sciences.
2012: with support from the World Wildlife Fund and Vogelbescherming Nederland he traded his professorship for a position for a professorship for a professorship for his professorship in global flyway ecology, a unique academic chair in the world.

SPINOZA PRIZE

SYDNEY GRANT

Who is Sydney Grant?

1904: born in the village of Hemelum in southeastern Friesland.
1920: gained his Master of Science from the University of Groningen.
1930: received the PIONIER grant from NWO to do five years of research on the Wadden Sea.
1936: received the Herman Kliip Prize for the best student from many biologists living in the Wadden Sea.
1949: graduated cum laude from the University of Groningen.
1954: appointed as a researcher at NIOZ Royal Netherlands Institute for Sea Research.
1963: received the PIONIER grant from NWO to do five years of research on the wadden Sea.
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Using quantum mechanics you can send a particle in all directions

Scientists from Delft University of Technology have learned how to steer a quantum particle just by looking at it. Does that sound unlikely? The trick is to measure smartly.

**Looks can kill**

Talk about strange. The world of quantum mechanics, which this article is about, is full of strange phenomena. It is the realm of quantum particles, small elementary particles such as atoms and electrons. Here nature does very different things than in our world of everyday life. For example, in our world you can measure where one electron is located at one moment in time: it is located in one position. In the quantum world that is not the case. There a particle at one moment in time can be in several places at once. For example, both up and down or left and right. That is the case as long as you do not look at the particle. If you do look at it then you permanently fix it in a certain position. Then it behaves in just the same way as all particles around us: all matter at one moment in time is located in one position only.

To demonstrate how strange the quantum world is, the Austrian physicist Erwin Schrödinger published a much discussed thought experiment in 1935. Place a cat in a closed box with a tube of deadly poison. A quantum particle, which is in two places at once, is the switch that does and does not smash the tube to pieces. As long as a quantum particle finds itself in two places at once, the tube of poison is both intact and broken, and so the cat is both dead and alive at the same time. But that changes as soon as you open the box to see if the cat is dead or alive. The first step is not to look at it completely but just a little bit.

**Peeking in the box**

And for many researchers that is an irritating fact: a research object always changes state as soon as you study it. But here at the lab in Delft they have found a way to benefit from that: they can influence the states 'up' or 'down'. An atomic nucleus has a so-called 'spin', explains Blok. 'A small magnetic field that points either up or down.' As long as this atomic nucleus finds itself in a quantum state, its direction is undetermined: it can point in several directions at once. But if you look at it then you fix it. The researchers tried to influence the spin of the atomic nucleus by looking at it a little bit.

**Electron turns**

At first glance it seems impossible to look 'a little bit'. You can either look or not look, but there is no in-between state. So to create this, the researchers attached the atomic nucleus to an electron. They became two entangled particles. In quantum physics that means that you have made the states of both particles dependent on each other. If you measure the state of the one particle then you also fix the state of the other particle. In the case of the electron and the atomic nucleus if the atomic spin points upwards, the electron rotates clockwise. If the atomic spin points downwards, the electron rotates anticlockwise.

The trick is that the two particles must not become completely entangled. The degree to which they are linked is dependent on the strength of the measurement. The longer you wait before measuring, the more the two particles have become entangled and the more information you can obtain. If you measure quite quickly, the electron only gives you a little bit of information about the state of the atomic nucleus. Then you only partly disrupt the quantum state. The researchers peek into the box beforehand and by doing this they slightly increase or decrease the chance that the cat is alive or dead. However you don't need to phone the animal protection service straightaway. Of course in Delft they do not use a cat. In this case its place is taken by an atomic nucleus in a diamond. And instead of the two states alive or dead the researchers try to influence the states 'up' or 'down'. An atomic nucleus has a so-called 'spin'.

Erwin Schrödinger's cat is neither dead nor alive. As you don't look at it the animal is both dead and alive as long as you don't look at it completely but just a little bit.

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A small magnetic field that points either up or down. As long as this atomic nucleus finds itself in a quantum state, its direction is undetermined: it can point in several directions at once. But if you look at it then you fix it. The researchers tried to influence the spin of the atomic nucleus by looking at it a little bit.
Quantum particles under construction

The steering of quantum particles can be done without actually looking at them sounds spectacular. But does it have any practical use as well? The usefulness of the research is mostly theoretical: it provides a better understanding of the role of measurements in quantum mechanics. Other researchers can benefit from this insights. Because these types of measurement with feedback are important for future quantum computers. These could solve certain calculations faster than the computers we have now. Normal computers work with bits (zeros and ones) as information units. Instead of these, quantum computers use so-called ‘qubits’. These are in a quantum state and can therefore be 0 and 1 at the same time. In theory, calculations that would not be possible on a standard computer could be performed rapidly on a quantum computer.

Quantum computer under construction

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Smart measuring

The coloured laser beams in the laboratory are used to read out the electron. Mirrors on the table ensure that the lasers are sent in the right direction. By reading out the electron instead of the atomic nucleus, the researchers can indirectly influence the atomic nucleus. But how can that action send the spin in the direction you want? Because in quantum mechanics you cannot determine in advance which state a quantum particle will end up after you have made a measurement. All you know for certain is that it will assume one state: up or down. Blok: ‘To stay with the example of the cat: by looking at him a bit you make him a bit more dead or alive. But you do not know which way it will go. The only thing you can influence is how much more dead or alive the cat becomes.’

So how can you nevertheless steer things in a certain direction? By allowing the measurement you perform to depend on what you measure previously. In other words: including a feedback loop in your measurements. Blok explains it using an example: ‘You could imagine the electron to be the needle of a compass that is sensitive for the spin (small magnet) of the atomic nucleus. If the nuclear spin points up then the needle will rotate slightly clockwise. If the nuclear spin points down then the needle will turn anticlockwise. We first of all set the compass to point North. Subsequently we let it spin for a while and we read out the electron. If we were to measure straight away then the result would not tell us anything about the nuclear spin: the chance of up or down is still 50%. But the longer the researchers wait with reading out the stronger the measurement and the greater the amount of information obtained. The state after the measurement is also slightly different as a result of this: the 50-50 state (up-down) at the start of the experiment has then, for example, changed into a 25-75 state.

Influencing the future

Imagine you want to allow the atomic nucleus to point slightly more upwards. Then you need to measure in a targeted manner. You read out the electron for the first time. Is the outcome the way you had hoped for? Then you let it be the case. You know that the state of the atomic nucleus has changed: its spin has now become ‘75 percent up - 25 percent down’. Is the outcome not what you want? Then you give the atomic nucleus another kick by making a stronger measurement by allowing the electron to rotate a bit further and therefore to create more entanglement. When you measure the electron again, you hope that this time the outcome is what you want. There is, however, no guarantee of this. Stronger still, this chance is actually smaller. Namely just as we had previously established about 25 percent. However by measuring the overall chance that the atomic nucleus has now achieved the state you want, you know the chance of this being the case is greater. Were you not to measure now then it is guaranteed that the atomic nucleus is in the opposite state: ‘25 percent downwards and 75 percent upwards’. However, if you do measure it then there is a small chance (25 percent) that the state has changed. By selectively measuring you can change the odds to your advantage. You give the atomic nucleus a ‘preference’ for a certain spin direction. It is just like playing a coin: you can influence the outcome by making one side slightly heavier. Just as for the coin, you can never say in advance with absolute certainty that the outcome will be what you want. But through smart measurements and adjusting the measurement strength on the basis of what you measured previously, you can nevertheless send the atomic nucleus a bit more towards the right direction. So can the researchers influence the future a bit in this manner? Blok: ‘Yes, in a way we can. You can ensure that the future works out as you had wanted it to be. Just by looking at it. Fantastic isn’t it?’

Diamond to order

Diamond is popular in quantum experiments. The rigid and exceptionally hard crystal structure makes it easy to protect the fragile quantum states of the entrapped electrons and atoms against external influences. At the same time the quantum states remain easy to read out with a laser. But how do you find a diamond with an electron and an atomic nucleus in it, as was needed for the experiment in Delft? You simply order it, says researcher Michiel Bliks. He draws one of the diamonds that they use from close up. It is a miniscule stone no more than half a millimeter in diameter. There is a company that makes artificial diamonds according to the desired specifications. In principle, a diamond consists of carbon. All diamonds also have contaminants: defects. If a diamond is yellow then it contains a lot of nitrogen for example. There are an awful lot of different defects. For the diamonds needed in Delft, a carbon atom has been replaced by a nitrogen atom nucleus. In the position next to this an atom is missing: a nitrogen cavity containing an electron.

FURTHER INFORMATION


tinyurl.com/Spinoza2013: Erik Verlinde, NWO Spinoza laureate in 2013, about quantum mechanics (in Dutch).
Paper book adapts itself

We read increasingly more on tablets, telephones and computer screens, but also increasingly less on paper. So is the paper book doomed to extinction? Koen Brillenburg Wurth, literary scientist from the Utrecht University thinks that the book will adapt itself because that always happens. Old and new media have strengthened each other for hundreds of years. Take, for example, the emergence of the phonograph in about 1880. It was thought that this would mean the demise of the paper book as people would no longer read books but listen to them. Now we all know that it was not that extreme. More books are being printed than ever. Will the book survive screens, tablets and telephones? According to Brillenburg Wurth the paper book will become less of a mass product and more of a work of art, something exclusive. The book will not die out but start a new life.

Something you cannot get so easily on a tablet or e-book: a signature from the author.

The book will not die out but start a new life.

Experiments by medium-sized black holes had never previously been observed. That might be because they do not suck up as much matter and are therefore less noticeable than their supermassive colleagues.

Spinach makes you alert and friendly

It is a myth that spinach makes you strong. The vegetable does, however, crank up your responsiveness. Research by cognitive psychologist Lorenza Colzato from Leiden University has revealed that this is due to the amino acid tyrosine that is found in spinach. Colzato and her colleagues let volunteers look at a screen. Every time a green arrow appeared on the screen they had to quickly press a button. If they saw a red arrow, however, they had to do nothing. The participants came to the test lab twice. On one occasion they were given orange juice to drink to which tyrosine had secretly been added. On the other occasion they received a placebo. The volunteers performed better after receiving juice with tyrosine than they did after juice without tyrosine.

In another study, Colzato demonstrated that spinach also makes volunteers friendly. On this occasion they were given juice with the amino acid tryptophan (also found in spinach) after which they had to play a game of trust. Volunteers who drank the juice containing tryptophan gave more money in the game to another person. "Nutrients influence how people think and how they perceive the physical and social world," concludes Colzato.

Blowing bubbles of iron

If we want to be less dependent on crude oil and natural gas then we need to obtain our energy from elsewhere, for example from the sun. But how do you store and transport that solar energy? Irem Tanyeli from FOM institute DIFFER (Dutch Institute for Fundamental Energy Research) has developed a technique for that. First she makes a foam from iron. A foam is less dense than the material we use to transport solar energy? Irem Tanyeli from FOM institute DIFFER (Dutch Institute for Fundamental Energy Research) has developed a technique for that. First she makes a foam from iron. A foam is less dense than the material we use to transport solar energy, for example from the sun.

After that Tanyeli can use the electricity generated by a solar cell to split water into oxygen and hydrogen. And hydrogen (a superb fuel) can be easily stored and transported. You can keep it in gas bottles or in enormous vessels and let it flow through gas pipes. So with this approach you can directly transport solar energy.

Digitally catching thieves

The police use computers, hard disks and telephones. In the new digital world reports about house searches it sounds so simple but for researchers at the Netherlands Forensic Institute (NFI) that is just the start. They must search through the gigabytes of data for digital evidence. Fortunately, they have special search programs for that. The problem is that these programs must be regularly adapted to new versions of Windows and new mobile phones. But that will not be the case for much longer. Jeroen van den Bos from NFI together with the Centrum Wiskunde & Informatica in Amsterdam has developed a tool that almost automatically adjusts the search program to new versions and devices. Van den Bos has now started to test and implement this tool.
Measuring airflows in fine detail

When invent the wheel yourself if nature has done it already? That is also what nanotechnologists from the University of Twente under the leadership of Sijtje Krijnen thought. They made a ‘camera’ that can observe flow patterns. However, this camera does not work with lenses but with tiny hairs. The source of inspiration? The cricket. This insect has extremely sensitive hairs on the rear of its body to measure air flows. Consequently the cricket follows an enemy is creeping up on it without having to look up or around. The technologists from Twente replicated the cricket hairs using epoxy resin. They connected the hairs to sensitive detectors on a chip. After that they followed the movement of each hair separately. Combining all of those separate movements provided an image of the total airflow. The researchers suggest that their invention can be used in advanced motion detectors, for example.

Interesting, a brain scan. It gives you a good idea of which area of the brain is active during certain tasks, such as reading. Researchers from Radboud University Nijmegen have now taken a step further. From brain scans they can see which letter you just read. They placed volunteers in a functional MRI scanner and let them read the letters B-R-A-I-N-S. The computer that analysed the scans chopped the images up into 1300 pixels of 2 x 2 millimetres. For each pinned down the computer learned what letters look like in general. Afterwards, the computer could clearly reconstruct the letters from the hazy image: B-R-A-I-N-S. Nijmegen researcher Sanne Schoenmakers now wants to reconstruct faces according to the same principle.

Strike together or do not strike

After a strike has ended the strikers and non-strikers have to work together again. And that is not always easy. The political scientists Agnes Akerkman and Kirsten Thommes from Radboud University Nijmegen posed questions to 715 employees from a range of different sectors. This revealed that a strike, especially if it lasts a long time, can cause considerable disruption to relationships. Even one year later, strikers and non-strikers still sometimes refuse to work together, lunch together or take coffee breaks together. And one third of the employees who took action or went on strike experienced negative consequences as a result of that. Striking can also have positive effects. Teams in which everybody went on strike tend to perform better afterwards. This was revealed by negotiation games and other experiments carried out by the researchers from Nijmegen. Akerkman: ‘Going on strike together makes it clear that you are willing to support each other. In the short term, at least, that has a favourable effect.’

Collapsing ice shelves

In 2002 an ice shelf in Antarctica the size of Utrecht province broke into pieces. Consequently, glaciers feeding the shelf were no longer buttressed and so more ice flowed into the sea than before. If this would have been an isolated incident there would have been little cause for worry. According to meteorologists, however, nearly all of the large ice shelves in the Antarctic Peninsula will probably give way during the next 250 years. Only the two largest appear to be safe,” says polar meteorologist Peter Kuipers Munneke. Together with his colleagues from Utrecht University, he has unravelled the mechanism behind breaking ice shelves. What did this reveal? The shelves break because the snow layer on top is disappearing. Therefore, the shelves below are no longer protected against meltwater from the surface. The meltwater seeps through the ice, widens cracks against meltwater from the surface. The shelves below are no longer protected against meltwater from the surface. Therefore, the ice shelves and causes the collapse of the ice shelves. Kuipers Munneke: ‘We have to limit global warming to 2 °C. Half of the threatened ice plains could be saved.’

StemBells repair heart muscle

Ultrasound pushes the StemBells in the right direction.

Blood vessel

StemBell

Tissue

Flow

100 µm

The StemBells have reached the tissue.

Using remarkable microbubbles to literally write a new chapter in cardiology. By making use of ultrasound, the research team at the University of Twente has succeeded in guiding special stem cells that have been damaged after a heart attack. The microbubbles, called StemBells, are literally guided by a special ultrasound method. The StemBells have to find their way through tiny blood vessels to arrive at the damaged heart tissue. The research team attached antibodies to the StemBells that ‘knew’ where they had to go because he had attached antibodies to them that target damaged heart muscles. Normally, however, these modified stem cells flow so fast through the arteries that they do not have time to stick. That is why the microbubbles are so useful. These ensured that he could push the StemBells to the heart tissue with the help of sound waves.
Three umbrella organisations look after Dutch science

Behind the scenes of Dutch science, three large umbrella organisations for knowledge work together: NWO, the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Association of universities in the Netherlands (VSNU). What do they perceive to be the biggest challenges for science in the coming years? A discussion with the three presidents.

TEXT: DAVID REDEKER / PHOTOGRAPHY: HARMEN DE JONG

Three umbrella organisations

Strong science

that works out well. The presidents of NWO, KNAW and VSNU have just come from a break at the Dutch House of Representatives. They did not have time to talk about it afterwards and so they take the opportunity now while drinking tea and coffee before the interview. VSNU president Karl Dittrich: ‘I was pleased to see that the defence specialists in the Dutch House of Representatives said that they would like to talk with scientists more often. We will definitely arrange that for them as then we can increase the impact of science in society.’ NWO chairman Jos Engelen backs up Dittrich. ‘Scientists have a lot to offer politicians. Scientists are independent and can offer new insights. At the same time politicians can inspire scientists to come up with new questions.’ KNAW president Hans Clevers nods in agreement. ‘Sciences are very important. One of our institutes (the Rathenau Institute, together with the Scientific Council for Government Policy, ed.) investigated this in 2013. If there is one thing that Dutch people have confidence in then it is science. More than in newspapers, the legal system or the Dutch House of Representatives, for example.’

Now we are talking about politics, what would you implement if you were the Minister of Education, Culture and Science? What major challenges does the science system face?

Engelen (NWO): ‘I don’t think I’m destined to be a government minister. Nevertheless, if can say the following. I recently spoke in Germany to a room full of young researchers and I concluded that if we take Germany as the standard then Dutch spending on research has a shortfall of 1 billion euros. That is way too high. Science is vital for tackling the grand societal challenges well.’

Clevers (KNAW): ‘Just look at what the government spends on healthcare. That has doubled over the past 10 years and without any real discussion. So twenty percent more for science is not such a strange idea.’

Dittrich (VSNU): ‘I would set up the top sector for Education. The Netherlands depends on knowledge. That is our essence. So it is strange we do not pay far more attention to education, from the nursery to university. We already have nine top sectors, but the basic, education, deserves more attention and support.’

Clevers (KNAW): ‘We do not have any mineral ores, gold or oil in the Netherlands. Knowledge is our capital. We should therefore view education and research as an investment and not as a cost. In Germany and the United States they are slowly realising that already, but that is not yet the case here.’

So money is important. But should we give researchers the freedom to choose what they want to research? Or may the funding body, in this case society and politicians, request certain research?

Engelen (NWO): ‘I sometimes say science does not always lead to predictable results but always leads predictably to useful results. However, you cannot always say which results will be useful and that is. And that is what makes it so hard to explain to politicians and the public. In some cases it simply takes a lot of time before a discovery yields something. Quantum mechanics was developed in the 1920s by researchers who had the opportunity to follow their curiosity. That led to an understanding of semiconductors and in 1948 to the invention of the transistor: a basic component of computers and countless other devices.’

Indeed that cannot be steered. So does society simply have to wait and see which problems science will solve in the coming years?

Engelen (NWO): ‘No. We must get rid of cancer and cardiovascular diseases, defend ourselves against climate change and do something about the dwindling supplies of oil and gas. In all of these areas Dutch scientists are working in a mixture of fundamental and applied research. Solutions will emerge from that but in science you can never exactly predict how that will happen. You must give scientists the freedom to investigate what they want and how they want to do that, but you can steer it a bit. For example, in the coming years NWO will invest more in several themes important for society such as the transition from a throwaway society to a circular economy, a longer healthy life, and a more resilient society.’

Quality first

What?

NWO, Netherlands Organisation for Scientific Research

Tasks?

With an annual budget of 650 million euros NWO is one of the most important science funding bodies in the Netherlands. NWO currently funds more than 5400 research projects at universities and knowledge institutions. Scientists can apply to NWO for research funding. Independent experts assess the proposals on behalf of NWO. The best proposals receive funding.

And further?

NWO manages eight research institutes with large, expensive equipment that is difficult to house at a university. Examples are the NWO Royal Netherlands Institute for Sea Research with the research vessel Pelagia and the ASTRON Netherlands Institute for Radio Astronomy with the LOFAR telescopes.

Further information www.nwo.nl
‘There’s a real buzz in Dutch science’

Representing interests

Forum and conscience

What? VSNL, The Association of universities in the Netherlands

Tasks? VSNL is the umbrella organization supporting the 14 Dutch universities. It lobbies for a strong knowledge-intensive society with top-quality education and research, VSNL represents universities’ interests to the government, politicians and public organizations. It also organizes debates and discussions, for example, about the need to make scientific publications freely accessible to everybody. VSNL also negotiates about salaries and employment conditions on behalf of the universities.

And further? VSNL’s strength was evident with the professors’ protest in 2011 when more than 500 professors walked in front of the Dutch parliament to protest against the intended government cuts.

Further information? www.vsnl.nl

Karl Dittrich, VSNU president

Kees Clevers, KNAW president

What? KNAW, Royal Netherlands Academy of Arts and Sciences

Tasks? The KNAW was founded in 1808 as an advisory body for the government and it still performs that task. In addition, the KNAW is responsible for sixteen research institutes. It is also a society of excellent scientists. The KNAW calls itself the forum and conscience of scientific research.

And further? Ten years ago the KNAW started an independent society for top talent: The Young Academy. Forty scientists aged 25 to 45 are selected every two years who, in the opinion of the committee, are very bright and ambitious enough to quickly take on responsibility in this respect.

Further information? www.knaw.nl

What do you investigate? ‘As a chemist I study macromolecules including plastics (synthetic macromolecules). I study their properties and try to develop new types that are useful for society. For instance, some commodity (everyday) plastics need to be biodegradable to prevent problems like ‘plastic soup’ in the oceans. Other plastics need to be extra resilient because they are used outdoors, for instance in window frames.’

How did you get this far? ‘I was born in Germany and grew up in Frankfurt, near one of the largest chemical companies: Hoechst. During my childhood we often played there and all those chemical substances fascinated me. Furthermore, many scientists lived in the neighbourhood and I soon realised I wanted to do something similar. I did a degree and PhD in chemistry and then I did a postdoc at Brooklyn Polytech in the United States. Subsequently the University of Groningen offered me a position to start my own research group. Groningen has a good reputation in polymer science and has superb facilities. It was a golden opportunity I could not refuse.’

What are your plans? ‘With the Vici grant I plan to investigate block copolymers, in which two different types of plastic are combined into a single molecule. This gives rise to interesting properties. For example, if you simply mix polyurethane and PEG (polyethylene glycol) they will separate into two distinct phases, like oil and water. However, if they are joined together as a block copolymer this no longer occurs at the macroscopic scale, but at the nanometric scale. This gives rise to fascinating structures such as lamellae, spheres and cylindrical phases that can spontaneously occur, which in turn lead to interesting physical properties not observed in the parent polymers.

I will synthesize and use block copolymers that contain polyurethane blocks. Plastics and electricity are produced in certain materials when these are placed under mechanical stress. So with the right materials you could harvest electrical energy from the vibrations of everyday tasks such as shutting a door. By combining these electrical properties with the structures formed in block copolymers, I will produce piezoelectric nanometre-sized foams that could be used in sensing devices. In a more advanced application this piezoelectric property could be used to create memory prototypes that are smaller, faster and have more storage capacity than the flash memory cells currently used in storage devices.’

What do you like most about your research? ‘My research projects range from working on the molecular level to the fabrication of real-life products. For example, we make biodegradable polymers for “green” plastic water bottles. This variation fascinates me and I really enjoy producing materials that can change the world. Without all of the necessary research tools and discoveries by the chemical industry or academia we would still be living according to the standards of the eighteenth century!’

Kelie Loos (43), chemist at the University of Groningen, received a Vici grant in 2013.

Mixing plastics

Karl Dittrich (VSNU): ‘There’s a real buzz among the universities. Salaries and employment conditions are a priority. VSNU also negotiates about making scientific publications freely accessible to everybody. VSNU represents universities’ interests to the government, politicians and the average person on the street.’

Clevers (KNAW): ‘We have our work cut out training scientists to be a specialising and a bit of chemistry. Good researchers need to be able to look further than their professional capabilities.’

‘But you will need new people for that. How will you ensure a new generation of scientists?’

Dittrich (VSNU): ‘You have raised an important issue here. I think we need younger researchers around too long. We always say that we train students and young researchers for a job in science. However, the figures show that three quarters of the PhD students do not continue in science. That is understandable because there are very few possibilities for career progression. But it is a shame as we throw so much knowledge away.’

Clevers (KNAW): ‘I find the situation alarming. Now occasionally we hear younger people say that they do not choose to study science because a career in science is too uncertain.’

Dittrich (VSNU): ‘The Veni, Vidi and Vici programme of NWO for scientific talent is a big success. However, I am shocked by the situation in some parts of some universities. They let all of their talented researchers apply for Veni, Vidi and Vici grants and those who get one can stay. But that blocks up your system. I think that every university needs to take their responsibility in this respect.’

Clevers (KNAW): ‘Something else I would like to mention is that young people and Dutch science is that Dutch science is of a high quality. We rank high in the synthesis of rankings. Dutch research always comes in the upper echelons regardless of how you count or measure it.’

Dittrich (VSNU): ‘I agree. And what I would add is that universities are still able to commit people to the talent for scientific excellence they need to have. That takes place at the level of research groups. An example is the Dutch research into nanotechnology. The collaboration there is really good. Companies are also closely involved in this.’

Clevers (KNAW): ‘Science is embedded in both society and companies. Science is also a forum and conscience. The KNAW was founded in 1808 as a forum and conscience of society. It is also a society of excellent scientists. The KNAW calls itself the forum and conscience of scientific research. And further? Ten years ago the KNAW started a new independent society for top talent: The Young Academy. Forty scientists aged 25 to 45 are selected every two years who, in the opinion of the committee, are very bright and ambitious enough to quickly take on responsibility in this respect.’

Dittrich (VSNU): ‘We are working with passion and have fantastic predecessors. How do you feel about your predecessors?’

Clevers (KNAW): ‘Yes, we must dare to dig deep. We simply won’t get there with a bit of physics, a bit of biology and a bit of chemistry. Good researchers need to be able to look further than their professional capabilities.’

But you will need new people for that. How will you ensure a new generation of scientists?

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Does seeing drinking make you want to drink?

How does alcohol in films influence viewers? To find out, psychology PhD student Renske Koordeman from Radboud University Nijmegen placed students in a laboratory setup that was very similar to a student room, including a fridge full of drinks of course. The volunteers could therefore watch a film while enjoying a beer at the same time. One of films they were shown was a shortened version of What happens in Vegas. Volunteers thought it only lasted for one hour because otherwise the experiment would cost too much time. That was not the real reason, however. Koordeman had made two different versions: one with scenes in which the actors drink alcohol and another without those scenes. And what did she discover? The men were sensitive for alcohol in the film. If they saw the version of the film in which the actors drank alcohol then they drank more of it themselves. The women did not drink more when watching that version either. It could be because in films it is mostly men who drink. And if women do that, it is portrayed more negatively. In What happens in Vegas, for example, actress Cameron Diaz falls drunk from the bar and walks around later with an enormous hangover. In the case of male actors, drinking is portrayed more as a tough thing. This does not mean, however, that women are not influenced at all by alcohol in the film. Koordeman also discovered that for both sexes a drinking actor or actress increases the chance that they take a sip themselves within 15 seconds (although the effect is stronger for men than for women).

Regular drinkers drink more

Alcohol in films therefore influences alcohol consumption. Does the same apply to commercials? To investigate that Koordeman also invited two groups of volunteers to a cinema. This time both groups saw the same film in which not a single drop of alcohol could be seen. The difference was in the block of commercials shown before the film: one group saw only ‘neutral’ commercials, such as for deodorant and telephone subscriptions. The other group also saw commercials for alcohol. As it was a service cinema drinks and snacks could be purchased during the film. Afterwards the orders were compared with each other. The commercials for alcohol only influenced regular drinkers: after seeing those they clearly ordered more alcohol. For the moderate drinkers it did not make any difference which block of commercials they saw. Clearly we allow ourselves to be more easily influenced by films than by commercials.

Our subconscious plays a considerable role in taking decisions

Our consciousness guides the decisions we take. Or doesn’t it? Psychological research consistently shows that we take a lot of decisions subconsciously. And our subconsciousness is influenced by many different things: from the films we watch to our opponents during a game.
Do what I do

O

ginally psychologist Marnix Naber, now at Leiden University, did not plan to study imitation behaviour when he started this research at Harvard University. What he actually wanted to know was how people move if they play a game against each other: in which directions do they go? And at what speed? It soon transpired, however, that players clearly imitated each other: they subconsciously adapted their speed to that of their opponent. Even if that meant that they became slower themselves: if their opponent was poor then their own performance became worse. The game concerned was Whack-a-mole, a favourite at fairgrounds and amusement arcades. On a board with holes a mole keeps popping up at a different hole each time and you have to give it a good whack with the hammer. Naber’s version was slightly different as the players played against each other. They stood at opposite ends of the table with a touchscreen on which moles appeared. The game was about who tapped away the mole first. Several moles could also appear at once and then the players had to think in which order they dealt the blows. The average response times of the winner and loser were always very close. And if several moles appeared at once then the order in which they were hit was suspiciously similar for both players. That seems illogical. Other research had shown that people imitate each other if they like each other. You would therefore expect little imitation in a competition in the heat of a game you are not meant to like your opponent. And if as a result of imitating you play slower then that is poor tactics. Brain imitates automatically

So why do we still do it? Naber sees imitating behaviour as an automatic process. Furthermore, it is a useful process as it allows us to learn quickly from each other. But what if the other person gives the wrong example? When we have the time to assess that correctly then we are quite capable of suppressing our imitation behaviour. But in the case of a quick and dynamic game like Whack-a-mole that is far more difficult: the game costs so much thinking power that it is far simpler for our brain to ‘brain imitates automatically’, says Naber. People have developed such a level of routine that during the game they have enough brain capacity left to suppress imitation tendencies. But what if the other person gives the wrong example? It could also be that it was cold during a match and the players moved large distances to keep warm. ‘In addition, Naber suspects that professional sports people have developed such a level of routine that during the game they have enough brain capacity left to suppress imitation tendencies. Do you automatically want to come home with a bag full of healthy food? Then all you need is a reminder at the top of your shopping list. Recipe for healthy shopping

If you give busy supermarket visitors a recipe with health and dieting words on it when they enter the supermarket then they spontaneously place fewer sweets and fatty foods in their shopping trolley, discovered a psychologist Esther Papies from Utrecht University. At a supermarket in the Veluwe region 99 visitors were given a recipe card at the entrance. In half of the cases they had texts like: ‘Recipe for a slim figure’ on them. Without any further instructions they went into the shop. Once they had paid for the shopping they were given a questionnaire to complete. Only then did they discover that the shopping played a leading role in the research. Based on the receipt the researcher examined whether the recipe had influenced the purchases. The answer was yes: people who were overweight purchased on average 34.2 percent less unhealthy snacks if they had received the recipe card that emphasised the slim figure. However, for participants who were not overweight it did not matter which recipe card they had received.

Overweight people are therefore more sensitive for messages about healthy eating. And it did not matter whether they thought about that while filling up their shopping trolley. Even if they said they had not thought about it they still came to the checkout with fewer unhealthy items. ‘This means that the people who did not consciously think about it were still influenced subconsciously,’ says Papies.

Myth debunked

How long the people who took part in the study spent in the supermarket had no effect on the impact of the recipe card. The researcher sees that as a good sign: clearly the message remains in the back of the mind throughout the entire supermarket visit, irrespective of whether somebody takes the time to shop or races past all of the shelves. Papies has also debunked a well-known myth. In her research it made no difference whether the people investigated were hungry when doing the shopping or had a full stomach. A lot of time or little time, and hungry or not hungry; it did not influence the purchasing behaviour. But what clearly did work was giving a message prior to shopping that matched somebody’s personal objectives. ‘In this case it was a healthy eating message’ that was important for people who are overweight, says Papies. ‘Perhaps they were already trying to snack less and this was a good reminder for them.’ According to the psychologist everybody can build such reminders into their lives, for example by scribbling an ‘eat healthy message’ at the top of each shopping list.

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Eating less healthily due to multitasking

Tucking into a bag of crisps while watching an exciting film? Perhaps that’s not a good idea if you have just decided to snack with moderation. As a result of multitasking we easily eat and drink too much. Not so much because we consume bars of chocolate or bottles of fizzy drink unknowingly but because we need to consume more of it before we notice the taste.

Psychologist Lotte van Dillen from Leiden University together with her colleague Reine van der Wal from Radboud University Nijmegen asked volunteers to memorise a series of numbers or letters. Sometimes they received a code of seven symbols that they had to memorise without the memory task. When Van Dillen and Van der Wal gave their volunteers salty crackers they saw something similar: those with a difficult memory task were least impressed by the salty taste. Meanwhile they had clearly snacked more than those without this task. Van Dillen: ‘Clearly we cannot taste and think at the same time.’

Furthermore, our tongue is not only distracted by memory tasks. Also our everyday environment can make tasting difficult. In a follow-up study, Van Dillen found that energetic music lead to a less intense taste experience than quiet songs. They have clearly known that for some time in foreign countries such as the United States, where a lot of marihuana is being grown. Van Dillen: ‘Energetic music reduces taste.‘

The last study revealed that volunteers who had the difficult memory task made their drink far sweeter. On average they added 50 percent more syrup to the glass. Meanwhile they found the drink just as sweet as the group without the memory task. When Van Dillen and Van der Wal gave their volunteers salty crackers they saw something similar: those with a difficult memory task were least impressed by the salty taste. Meanwhile they had clearly snacked more than those without this task. Van Dillen: ‘Clearly we cannot taste and think at the same time.’

Furthermore, our tongue is not only distracted by memory tasks. Also our everyday environment can make tasting difficult. In a follow-up study, Van Dillen found that energetic music lead to a less intense taste experience than quiet songs. They have clearly known that for some time in the catering trade. Van Dillen: ‘In chic restaurants there is usually no music or at most very quiet music, whereas in fast food chains loud, energetic music is played.‘

Besides making a mess of your desk, eating during your work is also not good for your figure.
OYSTER REEFS

Can the construction of oyster reefs counteract the erosion of sandbanks in the Oosterschelde? An experiment needs to test that. The oyster reefs break the waves and capture the sediment. Another advantage is that the oysters help to maintain the biodiversity of the area.

We should not view water as the enemy but as an ally. We would be wise to bear that in mind over the next fifty years say a team of Dutch and Flemish experts in the journal Nature. Raising the height of the dykes is a never-ending job. We have learnt that the hard way in the Netherlands and Belgium in recent years. Take the Schelde, for example. The high water level of the river has risen by 130 cm in the past 80 years, whereas the sea level has only risen by 25 cm. The surrounding land has also settled and sunk.

Dykes also have another disadvantage. A tidal wave, which comes inland on average once every few hundred years, rises even higher in a river narrowed by dykes and then reaches monstrous proportions. According to the experts we cannot carry on like this.

So what should we do then? Should we demolish the Delta Works and blow up the Afsluitdijk? No, such extreme measures are not necessary. But at locations where the water is too high we can give it more space. For example, by giving some polders back to the rivers. We can also ensure that waves cause less damage.

Tjeerd Bouma from the NIOZ Royal Netherlands Institute for Sea Research, who was part of the Dutch-Flemish team: ‘Many people think that only the Dutch Five can stop trying to hold water back and let nature do its work

Dykes away!

It seems ridiculous: protecting the land by breaking dykes. Yet Dutch and Flemish researchers say that this is the smartest way of protecting large parts of the world against rising water levels.

NOORDWAARD

At the end of 2015 the Noordwaard polder (on the Nieuwe Merwede near ’S-Gravendeel) must be returned to its natural state. The existing dykes will be lowered by three metres to create openings for the water to flow in and out. If the water levels are too high then the water can flow into the polder. That will protect places such as Gorinchem where the water level will then drop by up to 30 cm.

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Plants in front of dyke subdue power of pounding waves

Height of the water is a problem but that is not the case. Waves are also very dangerous. They pound against a dyke and by doing this can weaken a dyke so much that it breaches.

Waves can be subdued with what experts call ‘planted river margins’. These are, for example, marshes where cordgrass, reeds or willows grow. By planting those now you ensure that no more waves can pound against the dyke. Then the old dyke can simply remain where it is and it needs to be strengthened less. ‘We will never be able to manage without dykes’, says Bouma. ‘But with the help of nature we can ensure that we don’t need to strengthen the dykes as much as we previously thought.’

According to the water experts the Netherlands still has a long way to go. Bouma: ‘We were the pioneers with dykes, polders and coastal protection. Now we are the first to see the problems of these and to come up with new solutions.’

The photos on this page demonstrate how Dutch and Flemish knowledge has travelled around the world. New Orleans, for example, is restoring its marshes and near the English city of Hull the river is being allowed to meet the sea naturally.

MARRIES NEAR NEW ORLEANS
Near New Orleans (USA) drained marshes are being restored to their natural state including vegetation. Branches of the Mississippi River can in future flow through these muddy areas.

MANGROVES IN FLORIDA
If you plant mangrove forests off the coast of Florida (USA) then you can level a tidal wave by about 50 cm. That saves a lot of people from getting wet feet.

SAND ENGINE
In 2011 the ‘sand engine’ was constructed between Hook of Holland and Scheveningen. It is a peninsula of sand that is now being shaped by the wind and sea so that in 20 years time new beach and dunes will have been formed. ‘Always follow the walking route’, the signs say here. Walkers who ignored the signs have had to be rescued on several occasions.

HUMBER ESTUARY
Near Hull the British government wants to strengthen the Humber estuary. The funnel-shaped estuary of the Trent and Ouse rivers flooded hundreds of homes during a storm in December 2013. The new plan includes the construction of places where the excess water can flow to.

FURTHER INFORMATION
www.klimaatbuffers.nl: seven nature conservancy organisations give Dutch examples of new flood defence works based on nature.
www.ruimtevooroverijssel.nl: at thirty locations the Netherlands is giving more space to rivers.
tinyurl.com/DijkTest: this is how the Netherlands tests dykes in a large outdoors lab.
The Amerindian past of the Caribbean

Islands are not isolated entities

The history the Caribbean started long before the arrival of the first Europeans in 1492. That is apparent from the work of Corinne Hofman, Professor of Archaeology at Leiden University. In 2014 she received the NWO Spinoza Prize worth 2.5 million euros.

Imagine you are in the position of NWO. Why do you think they selected you to receive the Spinoza Prize?

'I have thought a lot about that since NWO chair Jos Engelen phoned me with this fantastic news. There are many excellent researchers in the world and in the Netherlands. But I honestly have no idea why I received the prize. However I am very proud of the fact. I see it as a crowning of my career also because over the past decades most of my research has been funded by NWO. They have therefore been the body that has funded almost my entire career. And then on top of that I have received this prize as well! I am very grateful for that.'

How did you end up working on the archaeology of the Caribbean region?

'It all started back in 1987 when I was studying for my graduation. I received the opportunity to go to Saba and to study the Amerindian archaeology of the island. While I was working I saw that many of the objects found actually came from other islands. This materials could not have come from Saba because it is a volcanic island. So at an early stage I developed an interest in the contacts and exchange between the Amerindian communities in all those islands in the Caribbean. And starting from Saba, an island of 13 km², that is the fact. I see it as a crowning of my career also because over the past decades most of my research has been funded by NWO. They have therefore been the body that has funded almost my entire career. And then on top of that I have received this prize as well! I am very grateful for that.'

All those contacts between all those islands form the principal part of your work?

'The loot’s share concerns the reconstruction of social relations and interactions between the original inhabitants of the Caribbean region. That is extremely interesting. And new things are always emerging. For example, on the islands of the Lesser Antilles in the eastern part of the Caribbean we recently found small axe heads made from jadeite. But that jadeite might have come all the way from the Dominican Republic or even from as far as Guatemala in the west. This clearly demonstrates that exchange networks must have existed. But how? Who exchanged with who? How exactly did those small axe heads end up here? Those are very interesting questions.

In a new research project we are also now investigating how diseases spread. That is another completely different line of work. We want to investigate how diseases were spread after the arrival of the Europeans. As the Amerindians never previously had contact with the Europeans, the Amerindians and Europeans were very vulnerable for each other’s diseases (such as the small-pox that many indigenous peoples died from, ed.). All we know up until now about these communities and these exchanges has come from historic sources. European sources. One unanswered question, for example, is whether syphilis came from the New World and was brought by Europeans to Europe or whether it was the other way around, namely that the disease already existed in Europe and that after 1492 it came to the Americas. Perhaps we can find out more about that.'

Your work must contribute to 'the historical awareness and self-awareness of the local population'. Is that really necessary?

'We need to see that from the following perspective: these islands have a very long history. It goes back some 6000 to 7000 years. But due to the arrival of Europeans that history has become tainted. In the overall picture of the history of the Caribbean the Amerindian past has been brushed aside. That part is not recognised and acknowledged even though that Amerindian elements are still found in the modern-day culture at a number of locations. An example? We are now working on the Dominican Republic together with a small community. They live in houses that are built in a traditional Amerindian manner. And they are scarcely aware of that. At school they have learnt that the history of their island started in 1492. On top of that the history we are studying is under threat. On the islands many hotels are being built and roads constructed. However, nothing is documented about what is found in the ground during these construction activities as there is often no legislation implemented to protect the heritage.

So it is not the same as in the Netherlands where somebody who has building plans is required to carry out an archaeological survey?

'Exactly. This history is therefore pushed to one side. We notice that this concern is also shared by the people we collaborate with on the islands. In a multicultural society such as the Caribbean region how can we give each piece of history a place and yet still construct a single story from it? We want to investigate that. Not because we think the local population must be more aware of the history but for the history itself.'

And what about us? Don’t we also think that the history they only started in 1492?

'Yes that is also really sad. Columbus discovered America. That is what people know. And that is crazy. Because since 2010 the Netherlands has had the

The Amerindian past of the Caribbean

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‘We want to show that history is not so black and white’

Caribbean Netherlands, with special municipalities (Bonaire, Sint Eustatius and Saba, ed.) but in the Netherlands almost nobody knows that the original inhabitants were Amerindians, how they lived, and what happened to them. Our research is exposing that history which has never been recorded.

And to reconstruct that history you are not only using archaeological fieldwork?

‘Sometimes I think: does the term archaeology actually cover what we are doing? What do people think when they hear the word archaeology?’

People looking in the ground for old pots and statues.

‘Spot on. And of course that is part of our work as well. But after two months in the field you spend another two years working out your results. And that requires different perspectives. One person specialises in archeozoology, the studying of animal bones that are found during excavations, and another studies plant remains, and so on and so on. The discipline of archaeology is in itself already highly multidisciplinary. And then we also work outside of the discipline with people from many other facilitators. For geochemical research, for example, or with network scientists. Their knowledge is of course very interesting for us in view of the networks between the islands. Last year I set up a multidisciplinary research project made possible through a grant from the European Research Council. The project covers the humanities, social sciences and natural sciences and ranges from historical sources to DNA research.

What can genetic research, for example, teach you about the links between the islands?

‘Up until now we have not managed to conduct a large-scale DNA study. That would, however, be an ideal way of finding out how homogenous or diverse the indigenous population is. Based on the maternal culture (similaritys and differences between objects found, ed.) certain ideas have developed. These state that the inhabitants of the Caribbean originally came from Venezuela and populated the entire Caribbean island by island. However that story is probably much more complex. A DNA study, for example, could confirm or refute such a story.’

How easy or difficult is it to do research in the Caribbean?

‘We work a lot with local interested parties. Like local communi- ties and governments from whom we have to obtain permission of course. Whether that’s difficult? It isn’t for us. At least not more because over the past thirty years we have built up a network and we have an awful lot of local partners who work with us. We need those contacts, not least because the legislation on each island is different but because each one has its own colonial history.’

A bit later, but in that interview, the telephone rang. Hofman answered it. On the line the had the most important contact on Saba, Lucase. The two talked for a long time in detail, for exam- ple, about the beautiful plants for the future. After the conver- sation Hofman continued: ‘So just what I meant. You’ve been a witness to it. This was one of the persons with whom we have worked for many years. The man is 80 years old, and perhaps even older still, and yet he still runs the archaeology over there. For our work those contacts are incredi- bly important because they have the knowledge of the island, the political knowledge and experi- ence to get things arranged.’

What is the most beautiful finding that you have ever found?

‘That remains this one (Hofman takes a fish shaped object from a glass cabinet, ed.) This comes from Saba, from my third visit in 1989. It is a snuff inhaler in the shape of a fish, cut from a mana- tee (sea cow) bone. It is still intact. It is a symbol of our success. Why? Because it comes from Saba, of course, where I started my research in 1987. Yet it also sym- bolises the richness of the sea and the importance of the sea for the connections that existed between the islands.

Is there such a thing as a holy grail for you? Is there something that you would still very much like to discover or achieve?

‘What I would still like to achieve is that the picture we are trying to sketch becomes clear and that with that we make a contribution to the history of the world. We want to show that history is not as black and white as it sometimes appears to be and that is also needs to be examined from the other point of view. Take, for example, this research in the Caribbean area. Its conquest by the colonial powers changed everything there and in the rest of the world. But what happened between colonisers and the indige- nous people is still happening today in other parts of the world. You still have the powerful and the less powerful. And indigenous peoples are still being marginalised. I think that archaeology can make a contribution to the discussion about diversity in the world, the multicultural society and the importance of history and heritage.’

Finally: what will you do with the money?

‘I am in the fortunate position that I already had a very large research project with many people. But as a result of that I also know exactly what is still missing. That is one of the reasons why I am so happy about this prize. Because the money that you nor- mally receive for research is allocated. This means that you must state in advance very detailed how much money you will spend on each aspect. And now I can determine that myself. Which is a luxury. And a fantastic feeling. I also want to invest in my research group. I want to encourage and train the people here. Because, of course, the research cannot rest on my shoulders forever. I also want to find very good people in the Caribbean and bring them here to the Netherlands. That is one of the things I want to do, strengthen my research and my research group. But I also want to study encounters between different population groups in other parts of the world such as in the Pacific. How did that happen there? And what do we still notice about that today? And thirdly knowledge utilisation. I was already working on that but I want to strengthen our efforts in this area. I want our research to genuinely reach a wider public in both the Caribbean and the Netherlands.’

Who is Corinne Hofman?

1959: born on 10 July in Wassenaar.

1987: graduated from Leiden University in archaeology after a research project on Saba.

1990: gained her PhD in Leiden for research into the precolonial indigenous population of Saba and their pottery.

1993: was appointed assistant professor of archaeology and cultural history of Indian America in Leiden.

2002: received an NWO Apoasia grant and became an associate professor.

2003: received an NWO Vidi grant for

2007: became a Synergy Grant from the European Research Council (15 million euros) for research into the colonisation of the Americas (in collaboration with colleagues from Utrecht, KU Leuven, University of Amsterdam and the University of Konstanz).

2013: received a Vidi grant together with colleagues from KU Leuven and the University of Konstanz for research into the conquest of the Lesser Antilles after the European colonisation.

2014: appointed as a member of the Royal Dutch Society for Sciences and Humanities.

berry.overbeek@quest.nl
Using a laser, the doctors separate the connected blood supply of the twins

Two hearts beat as one

Identical twins can make each other’s lives difficult before birth. Sometimes one twin takes blood from the other. Gynaecologists from Leiden have found a solution for this.

It is a warning sign. All of a sudden the pregnant woman’s abdomen grows very rapidly in just a few days. Sometimes it even looks like it is about to burst. If you are expecting twins then you can count on a fairly uncomfortable period. But this is worse. Such a tight abdomen indicates a problem. You can experience it if you are carrying identical twins. Then the umbilical cords of both foetuses are usually connected to the same placenta, which means that the vascular systems of the two children are connected as well. If as a result of these connections one of the twins takes blood from the other then both become ill. Unless action is taken, there is a high chance that both will die. The expectant mother receives a warning sign with that rapidly expanding abdomen. That happens because the child that gets too much blood produces extra amniotic fluid. Each year, gynaecologists from Leiden University Medical Center (LUMC) treat 50 to 70 expectant mothers who experience this problem. The problem is called Twin-to-Twin Transfusion Syndrome (TTTS).

Recently the laser treatment for TTTS has been improved with the ‘Solomon technique’.

It's twins

Back to the start. If a woman becomes pregnant then her chance of having twins is about two percent. The chance of having non-identical twins is one and a half percent and the chance of identical twins is a half percent. If two eggs are each fertilised by a sperm then the woman will have non-identical twins, says Femke Slaghekke. She is training to be a gynaecologist at the LUMC. ‘These are two different foetuses that happen to be in the womb at the same time.’ Twins can also develop if only one egg is fertilised, these twins are identical. This fertilised egg divides and after a few divisions forms a clump of cells, an embryo. If during the first few days of pregnancy this embryo splits into two clumps of cells then these will develop into identical twins. ‘If the split occurs in the first 8 days of the pregnancy, each embryo makes its own placenta, like in non-identical twins’, says Slaghekke. But two-thirds of identical twins develop from a clump of cells that splits later. Then both embryos are attached to the same placenta via their umbilical cords and the distribution of oxygen and nutrients is not always fair. As a result of this, one child might grow better.
Unborn twins who share their placenta always exchange blood with each other

about 10 percent of the twins attached to the same placenta. The child that receives extra blood will try to get rid of the excess fluid. First of all by urinating a lot', says Slaghekke. In the urethra each of the twins has its own amniotic sac with amniotic fluid that is nothing other than the foetus’s urine. So the recipient of the blood will acquire more amniotic fluid around it. For the blood donor the exact opposite occurs. It suffers from a lack of fluid in its body and consumes its amniotic fluid. ‘The following step is that the heart of the receiving child becomes overworked’, says Slaghekke. ‘The heart must pump around so much blood that it can no longer cope.’ Consequently the foetus comes hydropic, which means it retains fluid outside of the circulatory system. It leaves the blood vessels and ends up in the empty spaces between the tissues in the child’s abdomen or limbs. ‘That is a sign the foetus is very ill’, says Slaghekke. Blood becomes lethal. Without treatment there is a 5% or more chance that the expectant mother will lose her twins. Often the child that receives blood from the other twin dies.

The Twin-to-Twin Transfusion Syndrome (TTTS): the child on the right draws blood and other fluids from its brother or sister and urinates extra amniotic fluid. Both are ill.

The white line is the result of the Solomon technique: the laser has coagulated the locations where the children’s blood vessels were connected. The TTTS has been cured.

TTTS: TWINS-TWINS TRANSFUSION SYNDROME

Extra amniotic fluid due to urination. This recipient has too much blood and right become hydropic. Increased urine production. Too little amniotic fluid. Too little urine production. This child has the little blood.

Thick blood. The foetus that acquires more blood can urinate excessively, even twice as much as both foetuses normally would. Their mother feels her abdomen becoming tense. If the pressure becomes too great then the membranes can break and premature birth can occur.

Sword or laser?

‘Sword or Laser? Of the entire equator in the case you coagulate the vessel on the artery is connected to a vein then that is exactly where the separation occurs. In that case we look at connections nearby, know where you need to coagulate this? We make a small incision in the abdomen wall. We place a thin tube just a few millimetres in diameter through that with a cathol for the camera and a canal for the laser’. The gynaecologist subsequently looks at the vessels on the surface of the placenta. Does such a vessel go from the umbilical cord of one twin to the umbilical cord of the other? Then there is connection. How do you know where you need to coagulate this? ‘Arteries are darker than veins. If an artery is connected to a vein then that is clear from the colour’, says Slaghekke. In that case you coagulate the vessel on the colour transition. ‘If two arteries or two veins are connected then we do not know exactly where the separation occurs. In that case we look at connections nearby and draw a line between these. If that line runs over the connected veins or arteries then it gives you an idea where you need to coagulate the connection’. During the treatment the gynaecologist can also drain a bit of amniotic fluid from the foetus that has produced too much. The foetus that retained too much amniotic fluid will automatically produce more fluid.

Joining the dots

But there is room for improvement, because about 20 percent of the treated women still lose one child and in 15 percent of cases neither child is saved. Slaghekke: ‘Occasionally we see that the TTTS comes back again and sometimes another disease develops: TAPS (Twin Anaemia Polycythaemia Sequence). It can occur if only very small blood vessels are connected with each other. For example, if vessels have been missed during the laser treatment for TTTS. In that case the two foetuses do not develop a large difference in amniotic fluid, as is the case for TTTS, but a large difference in the red blood cell count. These go from one foetus to the other. Consequently one of the foetuses develops anaemia, whereas the blood of the other becomes too thick. That is dangerous, knows Slaghekke: ‘Anaemia can lead to brain damage and blood that is too sticky can lead to blood clots. These can block a blood vessel as a result of which limbs or
The Solomon laser also coagulates the small blood vessels

- parts of the brain can die. The gynaecologists from the LUMC came up with a solution to both TTTS and TAPS. With laser they draw a line over the placenta from one placenta margin to the other by connecting the coagulated spots. There is a high chance that the small connections are also coagulated with this so-called ‘Solomon technique’.

Is it better?
The Solomon technique was introduced in 2008. From March 2008 till July 2012 patients were randomised for the Solomon technique or the standard technique. This international study was first performed in Leuven, Strasbourg, Birmingham and Milan. What were the results? In both groups the number of children saved by the treatment was the same. But with the Solomon technique, we saw fewer cases of TTTS occurring again and that TAPS developed less often. And that is an important benefit, says Slaghekke. ‘The Solomon children’ also experienced slightly fewer problems from other diseases even though the difference between the two groups was not big enough to be statistically significant. Slaghekke thinks that might be due to the small number of patients (274) in the study. ‘With a larger group we might see a difference between the two groups was not big enough to be statistically significant. Slaghekke thinks that might be due to the small number of patients (274) in the study. ‘With a larger group we might see a difference between the two groups was not big enough to be statistically significant.’

Womb says ‘no’

Some women experience a strikingly high number of miscarriages. Doctors from the University Medical Center Lübeck, including Nicholas Macklon, discovered that the endometrium of these patients does not work well. Or perhaps it actually works too well. According to the researchers the endometrium has two tasks. Each month the womb prepares itself for a fertilised egg. That fertilised egg can then reside there. However, the endometrium is not always of a good quality and the second task of the endometrium is to reject poor embryos. In this early stage of the pregnancy, several growth factors and other substances play an important role. If embryos do not develop well then less of these substances are produced. This is how the body normally rejects embryos that are not good. The researchers have yet to discover exactly how the mechanism works but in women who experience many miscarriages the endometrium is too receptive for an embryo. So although these women become pregnant more easily than normal, they also experience a miscarriage more often as there is no quality control on the embryos. That is painful for women who want a child but remain childless.

The camera projects the image on a screen. Laser. Placenta. Vein. Artery. Before the treatment of TTTS and TAPS blood vessels are connected. After the Solomon technique has been applied the blood vessels are separated.

What do you investigate?
‘With the Solomon technique it is more common to experience miscarriages. It takes a few minutes longer. After their second task of the endometrium is to reject poor embryos. In this early stage of the pregnancy, several growth factors and other substances play an important role. If embryos do not develop well then less of these substances are produced. This is how the body normally rejects embryos that are not good. The researchers have yet to discover exactly how the mechanism works but in women who experience many miscarriages the endometrium is too receptive for an embryo. So although these women become pregnant more easily than normal, they also experience a miscarriage more often as there is no quality control on the embryos. That is painful for women who want a child but remain childless.

What do you like most about your research?
‘My research proposal was my dream project and thanks to the Vidi grant I have received the opportunity to set up a research group around that topic. Now with a new affor-dance-based philosophical framework we are contrib-uting to the foundations of the cognitive sciences. We apply the knowledge that this yields in a collaborative project with psychiatrist Dumaan Denny from the Academic Medical Center Amsterdam. He and his team are treating people who suffer from an obsessive-compulsive disorder with deep brain stimulation. As a result of their disorder they experience the world differ-ently. We are trying to capture the experienced improvements as a result of operating on a patient or an architect and others as an example of the latter is a surgeon who want to develop a philosophical framework with which we can better frame and science.’

What are your plans?
‘I want to develop a philosophical framework with which we can better understand what skilled actions are. For this I mainly focus on affordances: the possibilities for action offered to us by our environment. A chair, for example, offers the possibility to sit on it but also to stand on it or to move it. I am trying to clarify what affordances are and which role they play in our behaviour. As via the studio I work intensively with architects, who are specialists in producing new affiances. I can see in practice how these experts deal with affordances.’

The Solomon laser also coagulates the small blood vessels
Biochemists pave the way for reactions at the nanoscale

Plastic gives signs of life

Scientists in Nijmegen are replicating components of the human cell using tiny pieces of plastic. These pieces get pretty close to what real cells do: carry out processes of life. Perhaps this near-living plastic will open up pathways to new medicines or materials that we currently cannot make.

TEXT DAVID REEDER

Some things are best kept separate. Your toilet is not in the kitchen and you do not watch television in the utility room if the centrifuge of your washing machine is running. Ruud Peters, biochemist at Radboud University Nijmegen, explains that the same principle applies to the cells in your body.

‘A cell is divided into organelles. These are small compartments. Each compartment has its own purpose. For example we have the nucleus that stores the genetic material. In other compartments, the mitochondria, energy is generated and peroxisomes get rid of toxic substances.’ If the cell did not have any compartments, it would be a mess. A wide range of chemical reactions would all go wrong. You can compare it to the conveyor belt at a chicken processing plant. The chickens are killed, plucked, cut into pieces and packed. If you change that sequence it will go wrong. It is exactly the same for cells. In a cell first one reaction has to take place before the next reaction may occur. Cells have solved the problem by dividing themselves into rooms. A molecule that must be broken down or built up by a series of chemical reactions goes from one room to the next in the right order, just like chickens in the chicken processing plant. What makes the compartments so fantastic is that substances which have to react with each other cannot miss each other. As a result of that, chemical reactions in a cell take place extremely quickly with hardly any waste being produced. The compartments therefore have three advantages: in series, fast and no waste.
After 15 minutes there was still nothing to show the experiment would work.

> Those are exactly the three issues chemists dream of when they design production processes.

**Building block is polymer**

It is therefore hardly surprising that Peters is interested in this type of compartments. What would happen, he wondered, if we could make same size replicas of these? And what if we could let a series of chemical reactions take place in these compartments? Next we could possibly construct something that could replicate itself. Or in the future we could treat people who have something wrong with their organs. Or we could allow reactions to take place that were previously not possible because the chemicals got in each other's way. Then we could produce new materials. Or... We'd better stop thinking about question number one, replicating these compartments. How did he do that? Randomly putting different substances in a test tube is not a good plan. Before you know it, the lot will result and then repeating everything 10 times. Real lab work: mixing in measuring beakers, pipetting into test tubes, centrifuging the tubes, rinsing away excesses, added drops of water and enzymes.

**Reaction in series successful**

Any reaction that the compartments alone are not enough. Compare it to the chicken processing plant. Peters only had empty rooms and no machines. Each compartment needed to have an active substance responsible part of the reaction. To test if the principle worked, Peters devised an experiment. He wanted to make two types of compartments in the ‘micro-beach ball’. And each compartment (let's say ‘nano-pea’) had to receive an enzyme that could carry out part of the test reaction. In total four reactions had to take place one after the other. If all of the chemical reactions were successful, the result should be the result: a fluorescent end product should appear after a few minutes. Even after 15 minutes there was hardly any red visible through the microscope. Had all the work been for nothing? Had something failed to take place? But look, after 45 minutes the screen became redder. And in the following hours the red shone more and more brightly from the screen. The experiment was a success.

**Fine-tuning later**

Why the reactions took place more slowly than had been predicted is still a mystery.

Peters suspects that it might be because in each compartment of his experiment, roughly the same conditions prevailed. In living cells that is not the case. There each organelle ensures its own conditions, such as an ideal acidity or the optimum salt level. Ah, it's a nipper who focuses on things like that at this stage. The fine-tuning can always happen in the future, if needs be. Now it was about proving the principle. A series of four successive reactions in a micro-beach ball with nano-peas that had never previously been demonstrated. The plastic gave clear signs of life. Peters made a lot of photos for the scientific publication of the experiment. You cannot miss the swelling of the red dots. Peters is interested in this type of compartments. What would happen, he wondered, if we could let a series of chemical reactions take place in these compartments? Next we could possibly construct something that could replicate itself. Or in the future we could treat people who have something wrong with their organs. Or we could allow reactions to take place that were previously not possible because the chemicals got in each other's way. Then we could produce new materials. Or... We'd better stop thinking about question number one, replicating these compartments. How did he do that? Randomly putting different substances in a test tube is not a good plan. Before you know it, the lot will result and then repeating everything 10 times. Real lab work: mixing in measuring beakers, pipetting into test tubes, centrifuging the tubes, rinsing away excesses, added drops of water and enzymes.

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**Nano-peas of fat**

And now? What is the use of this research? Peters: ‘On the face of it not a lot. We just made the fluorescent molecules to demonstrate our system works. And it gives an insight into how cells are constructed. The start of an answer to questions such as: Why are cells built like this? Why is it all so complex? Those are the questions I am working on.’ Now Peters wants to make artificial cells that are even more like real cells. He is already busy with the following step: producing nano-peas made from fat instead of plastic. Fat is more natural. It is less rapidly rejected by the body. That is vital if you want to treat people in the future. Furthermore, it is also interesting from a fundamental viewpoint. I want to know why nature has chosen this design. Other scientists are trying to make artificial cells that respond to their environment. Or cells that you can switch on and off remotely with the help of a light stimulus or a pulse of heat. Other colleagues of Peters, also from Radboud University Nijmegen, are building a replica immune system but bit by bit in the hope that the body can use it to attack cancer (see the box ‘Trio helps immune system’).

And then? Will we be able to make cells in a test tube that work just like human cells in 20, 30 or 50 years' time? And will we then be able to build a complete human being from cultured cells? For example? Peters does not think so. But that doesn't matter. With party we can also make a lot of progress and he hopes to demonstrate that as well.

**Trio helps immune system**

Addition of polymer PB-P-PEG encloses the compartments in a ‘plastic wall’ (orange).

The greater the number of red dots, the greater the amount of resorufin that has been produced and so the better the reactions in the plastic have taken place.
How teabags can improve climate models

They are burrowing with their hands in the damp soil. The soil researchers Bas Dingemans and Joost Keuskamp from Utrecht University are looking for two teabags that they buried three months ago on the university grounds. Together with a couple of colleagues they devised the so-called ‘Tea Bag Index’: a simple method for a worldwide comparison of how the soil is dealing with carbon. You can also take part. All you need for this is a bag of green tea, a bag of rooibos tea, a spade and three months of patience.

Mapping breakdown

With the help of the teabags researchers are determining how quickly the different soils break down plant material. Once they have been buried, a whole range of microorganisms benefits from the tea: they break it down. Three months later the researchers dig up the teabags again and weigh them. Then it is clear how much of the original tea is left. By doing this you can find out something about the capacity of a soil to retain the greenhouse gas carbon dioxide. ‘Plants take up carbon dioxide from the air’, explains Keuskamp. ‘They process the carbon into their leaves, branches and other parts. If the plants die that carbon enters the soil in the form of plant remains. Soil organisms break down the plant material. Part of the carbon is then released back into the air as carbon dioxide.’ The carbon supply in the soil is enormous. The soil contains three times as much carbon as the atmosphere. If more of this is released into the air that could have huge consequences for the climate.

By always using the same plant material, in this case rooibos and green tea of the same brand, the researchers can compare different types of soil throughout the world. The tea in these bags always has the same composition and weight. Previously such a comparison was not possible because soil researchers buried bags with plant material containing plant species that grew in in their research area. And of course the species differ per area.

Green decomposes fast

After just a few minutes of digging, Dingemans’ fingertips feel something nylon. Triumphantly he pulls a crumpled nylon bag of green tea up. It is creased and covered with mud. A little while later a second cry for joy: the other bag, containing rooibos tea, has also been found. We take our bounty inside. ‘ Normally we dry the bags first and then weigh the content’, says Keuskamp. But to show what is left of the two types of tea after three months he immediately pulls open the bags he has just dug up. From the green tea bag a smell like a really bad case of early morning breath emanates. Some brownish-grey mushy leaves are all that remains of the tea. ‘It is a mix of the green tea components that were difficult to break down and the remains of bacteria and fungi that lived from these and have died again’, says Keuskamp. The green tea gives a picture of the extent to which the soil stores carbon. This tea consists mainly of leaf matter. Initially that breaks down quickly. After a few weeks little more happens and after three months the breakdown has effectively stopped. Dingemans: ‘What is still left of the tea, and with that of the carbon, remains in the bag.’ How much that is differs per type of soil. So the green tea provides a picture of the carbon level in the soil.

The bag of rooibos tea is a different case. That smells a bit pleasanter. Here the microorganisms have clearly been working less hard. ‘Rooibos tea contains far more woody material and therefore this is what a bag looks like after 3 months.

In 2011 Bas Dingemans buried teabags in the Graendalur valley on Iceland.
Everyone can bury teabags in the ground and take part

In Austria, scouts buried the tea. These bags in Abisko (North Sweden) were easy to find again.

breaks down far more slowly’, says Keuskamp. And slower means that it can be followed more accurately. The rooibos tea is therefore used to determine the breakdown rate in the soil.

Tea predicts

The breakdown of plant material and storage of carbon in the soil depends on many different factors, such as the acidity, humidity and temperature of the soil. All of these soil characteristics have been really well mapped for soils throughout the world. The same is true for the amount of carbon soil in the soil Keuskamp: ‘The only thing we do not know yet is how quickly this carbon supply changes over time.’ and that is what the Tea Bag Index could reveal. By comparing the tea breakdown in different types of soil the researchers can see what happens to the carbon supply if the soil warms up due to climate change. The researchers have buried the teabags, for example, at a number of locations in Sweden and in Italy Keuskamp: ‘If you find differences in breakdown rate and carbon storage that correlate with the soil temperature, then you know what can happen to the carbon supply if due to rising temperatures the soil in Sweden becomes more like that of Italy.’ Researchers who are busy making climate models can use these data to sharpen their predictions about the quantity of carbon dioxide in the air.

It’s not difficult

Scientists are now making use of the Tea Bag Index. Keuskamp: ‘We published the method in 2013. Now all of a sudden we are receiving a lot of questions from other researchers about the method. For example, what should they do if sand ends up in the teabag?’ Then they must weigh the entire bag and subsequently burn everything. ‘What is left over is the sand. They must weigh that and then subtract the weight from the original measurement.’ Keuskamp: ‘All of those questions mean that many scientists are using the method. It would be fantastic if they would not only use their data for their own work but would be willing to share the data as well. Because a lot of help is needed to map the functioning of the soil throughout the world.’ Dingemans and Keuskamp have therefore made their method as easy as possible so that everybody can participate in this research. That includes you if you would like to make a contribution. Everybody can bury two teabags, dig them up again after three months, dry them and weigh them. You can enter your data on the researchers’ website (see ‘More information’). It will cost you are two unused teabags. Keuskamp: ‘We tried to do it with used teabags. But it transpired that people make tea in very different ways.’ Then the water-soluble substances and the substances that break down quickly already disappear in the water. People make tea using water of different temperatures and storage of carbon in the soil. Dingemans: ‘On Iceland, we also tested the method. ’ Then they must weigh the teabag. ’ ‘What do you like most about your job?’ ‘I like to talk with elderly people. They have a lifetime of experience and a wealth of stories to tell. I find that interesting. ’

What are your plans? ’ ‘I want to know how the loss of function arises in elderly people who have been admitted to hospital and how we can help them to rehabilitate better after they have returned home. ’ ‘I have a tip for anybody who would like to participate in this research?’ ‘Then make sure you can find your teabags again. For example, you can mark them with a sticker. ’ ‘My research is not too noticeable at places where lots of people come,’ warns researcher Bas Dingemans. ‘People are curious and sometimes tamper with what’s theirs.’ and that is there is a chance that you will never find your teabag again. It’s not just people who are curious. Dingemans: ‘On Iceland, where I also tested the teabag method, birds took off with my lab and sometimes the entire teabag.’ The researchers have a tip for anybody who has a metal detector. Buy a coin with the teabags. ’ Then it is easy to find them again. What do you like most about your research? ’ ‘I like to talk with elderly people. They have a lifetime of experience and a wealth of stories to tell. I find that interesting. ’

What do you investigate? ’ ‘I investigate the consequences of hospital admission among elderly people. ’

What is your next destination? ’ ‘I will benefit from a training programme at the Yale School of Medicine. ’

What do you think about the Tea Bag Index? ’ ‘It would be fantastic if people would not only use their data for their own work but would be willing to share the data as well. ’

More information


Bianca Buurman (36), Health Scientist and senior researcher at the Academic Medical Center (AMC) received a Rubicon Grant in 2013 for her research at the Yale School of Medicine (USA).

How did you get this far? ’ ‘I did a degree in nursing and then worked as a nurse for six years. ’

What do you like most about your job? ’ ‘I like to talk with elderly people. ’

What are your plans? ’ ‘I want to know how the loss of function arises in elderly people who have been admitted to hospital and how we can help them to rehabilitate better after they have returned home. ’

What do you think about the Tea Bag Index? ’ ‘It would be fantastic if people would not only use their data for their own work but would be willing to share the data as well. ’

More information

www.decolab.org/tbi: read more about how you can take part in this research.

Science is international. NWO is collaborating with many different countries to strengthen research in the Netherlands and to maintain the country’s top scientific position. Six examples of how talented researchers are doing research with foreign colleagues from Europe and beyond.

Together scientists can find solutions quicker

INTERNATIONAL COLLABORATION

A valuable raw material from rotting leaves

In a nutshell? What happens to the pile of stalks and leaves that are left after the maize and sugarcane have been harvested? For several years scientists have been trying to produce biodiesel from these leftovers. Now microbiologists from the University of Groningen are going a step further. Together with their Brazilian colleagues they want to convert the waste into biogas or bioethanol. Fungi and bacteria are doing the dirty work for them.

The research? The team from Groningen is working together with scientists from Brazil because of their knowledge on sugarcane production. Furthermore, the Brazilians have trial fields full of sugarcane that the Dutch researchers can benefit from. ‘And the maize remnants come from my allotment’, says microbiologist Joana Falcão Salles who works in Groningen. She is trying to get bacteria and fungi to convert the maize leaves and stalks into biodiesel. Other researchers are focusing on a single bacterial or fungal species. However, we are working with mixtures. We think that a community of bacteria and fungi is more efficient than a monoculture. The researchers are using a kitchen table technique to culture a microbial community. They throw maize remnants and soil into a flask, close it and wait. After three days the mixture goes mouldy and you have a microbial community that likes to grow on maize. The microbial community from the mouldy maize remnants is then put with clean maize in a new flask. Once again the microorganisms grow and they are probably even better at digesting maize than their counterparts in the old flask. The researchers repeat the procedure 10 to 15 times to obtain a stable community of fungi and bacteria. That goes into the freezer so that it can be used for further research at any desired moment.

Why together? The Brazilian scientists know a lot about sugarcane. And our country is the cradle of modern biotechnology.

Challenge? The exchange of experimental material. If the Brazilian scientists send vessels with sugarcane waste then a lot of paperwork needs to be completed in both the Netherlands and Brazil.

Future? Salles: ‘We want to see which enzymes the microorganisms produce. We suspect that the enzymes involved in the breakdown of maize waste are the same as those involved in the breakdown of the sugarcane waste. In the future we could isolate those enzymes. Then we could convert worthless waste into a valuable raw material.’
Working with Africans showed just how Western our research had been

The Sacred Heart of Jesus in the Ghanaian port city of Elmina.

Parents in Holland, kids in Africa

In a nutshell? Many Africans who emigrate to Europe leave their children behind. For years, researchers thought that this was bad for both the children and the parents. Scientists, including researchers from Maastricht, have discovered that in some cases things are not that bad after all.

The research? Researchers from Europe worked together with African scientists. A Dutch – Ghanaian team studied families between the Netherlands and Ghana because there are many Ghanaians living in the Netherlands. An Irish – Nigerian team focused on Nigerian families because many Nigerians have emigrated to Ireland. And Portuguese and Angolan researchers worked together to study the large number of Angolan families living between Angola and Portugal. The researchers carried out surveys among thousands of migrants and those they left behind. For a period of two years they also followed a small number (between 10 and 20) of families in each of the countries by following the migrant parent in Europe and the children and caregivers left behind in Africa. What did this reveal? The distance between parent and child did not always impact families negatively. Children whose parents live in Europe were not more depressed or had not shown worse behaviours than children who were living with both their parents in Africa. In all three African countries it is quite normal that parents entrust the upbringing of their child to a grandma, aunt or pastor, even if they live in the neighbourhood. So what is important for migrants? The parents must earn enough money in Europe to be able to send some back to Africa for their children. And it really helps if the parents and children can occasionally meet face to face.

Why together? ‘Local scientists knew the country and its customs far better than we did,’ says Valentina Mazzucato. She works at Maastricht University and is the project leader for the research. ‘Thanks to local researchers in Africa we realised that previous research had been done from a perspective that was far too Western.’

Challenge? Building contacts costs time. Mazzucato: ‘I started attending conferences where Ghanaians presented their research back in 2000. I also visited the University of Ghana on several occasions. Only a few years later, once we had built up a relationship of trust with each other, did we start doing research together.’

Future? People migrate and they often maintain close contact with their home country. This sort of scientific research aims to provide insights into how you can facilitate integration, says Mazzucato. ‘For example, our research could be a reason for the Netherlands and Ghana to give Ghanian children a short-term visa so that they can visit their parents in the Netherlands during the long summer holiday.’

Sacred Heart

In a nutshell? There are thousands of statues and paintings of Jesus in which his heart lies on his chest and radiates light and warmth. The image is important in the Catholic Church. But non-Catholics are also fascinated by the Sacred Heart of Jesus. How do different ethnic groups in the world view the Sacred Heart? In the end the project was too short. We wanted to work with far more cases as possible. But researchers cost money. Fortunately, the project has already yielded a basis for a series of books that go far beyond this follow-up study. This project has also formed the future of the Netherlands and Ghana to give Ghanian children a short-term visa so that they can visit their parents in the Netherlands during the long summer holiday.

The research? Scientists from Utrecht University are working with colleagues from the United Kingdom, Norway, Austria, India and Brazil. They are investigating how different ethnic groups view the Sacred Heart image. Professor of religious studies Birgit Meyer from Utrecht University is focusing on Ghana. Throughout Ghana you can see paintings or statues of the Sacred Heart of Jesus. Fishermen paint a picture in their tree trunk canoes. Street artists make paintings of it and from China life-size Jesus posters are imported to hang at work and in the home. Why is the image so cherished? Meyer: ‘We see that people are not only moved by the image but that it also has a normative function. It gives the Ghanaians protection, consoles and comforts them, and keeps them on the right path.’

Why together? ‘By working together we could study the images and the cultures with different specialisms and in a global perspective,’ says Meyer. ‘For example, I strongly focussed on observation: how do people look at the images? The researcher from the United Kingdom mainly focussed on the emotions that the images can elicit. The Norwegian scientist looked at the political impact. Together we could explain why the images have such a strong and powerful effect. We showed how a single image is adapted, embedded and interpreted in each culture. As a result of that we learned a lot about the creativity and innovation of cultural patterns.’

Challenge? Meyer: ‘In the end the project was too short. We wanted to work with far more researchers to investigate as many different cases as possible. But researchers cost money. Fortunately, the project has already yielded a follow-up study. This project has also formed the basis for a series of books that go far beyond this project alone.’

Future? The scientists are continuing to work together. Meyer: ‘Through this project I have realized that the global circulation of items such as religious images is a superb perspective for gaining a better understanding of the cultural dynamics of societies.’

Strongest magnet in the world

In a nutshell? Radboud University Nijmegen has the HFML, the High Field Magnet Laboratory where the strongest magnets in the world are located. Scientists from around the globe come and do research here.

The research? Physicists, chemists, biologists and astronomers: In an average year about 70 researchers from 20 countries visit the laboratory for several days or weeks. The HFML also has its own researchers. Physicist and Nobel Prize winner Andre Geim was one of them. In the mid-1990s he let a frog levitate in one of the magnets. That received so much media attention that the lab became famous for good. The blog also demonstrated that not all magnets can be made magnetic if you have extremely strong magnets. That opened up new research possibilities for cells, polymers and other so-called soft materials. Now chemists are manipulating microscopically small plastic vesicles that they want to use to deliver drugs in the body. The HFML is also helping companies for a Nijmegen company that wants to make new sensors for electronic equipment.

Why together? ‘A magnetic field lab costs millions of euros per year. A single university cannot afford that. Consequently there are no such labs in the world. Our scientific community, says Mazzucato, ‘has one of those. A large part of the funding comes from NWO.’

Challenge? The magnets in the HFML cannot be purchased in the world. A single university cannot afford that. Consequently they are doing research on the strongest magnets in the world, and the parents send their children to school in Africa, even if they live in the neighbourhood. So what is important for migrants? The parents must earn enough money in Europe to be able to send some back to Africa for their children. And it really helps if the parents and children can occasionally meet face to face.

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Future? People migrate and they often maintain close contact with their home country. This sort of scientific research aims to provide insights into how you can facilitate integration, says Mazzucato. ‘For example, our research could be a reason for the Netherlands and Ghana to give Ghanian children a short-term visa so that they can visit their parents in the Netherlands during the long summer holiday. Future? The funding for the coming years has been secured. Nijmegen can even expand. Director Nigel Hussey: ‘We can carry out more experiments and welcome users from an even greater range of scientific backgrounds. We are becoming the world leader in the area of research with high magnetic fields.’
In a nutshell? Independent peace negotiators, such as the United Nations, often think that they should not bring up the subject of human rights violations with warring parties. Researchers, such as the United Nations, often think that they should not bring up the subject of human rights violations with warring parties. Researchers, such as the United Nations, often think that they should not bring up the subject of human rights violations with warring parties. However, that is not the case. Researchers, including some from the University of Amsterdam, have discovered that bringing up the subject of human rights can help to end a conflict sooner.

The research? The researchers looked, for example, at the last series of peace talks in Northern Ireland. After 2005 those proceeded with difficulty. On the one side the negotiators held the view that talking about war crimes during the negotiations was definitely not a good idea. On the other side human rights organisations were shouting from the rooftops about cases of human rights violations, also in the press, and consequently thwarted the negotiations. Both the negotiators and the human rights organisations legitimised their position with examples. Political scientist Brian Burgoon (University of Amsterdam) and the Sri Lankan negotiator Ram Manikkalingam (adviser to the Peace Process in Sri Lanka) argued that it is a good idea. On the other side human rights organisations were shouting from the rooftops about cases of human rights violations, also in the press, and consequently thwarted the negotiations. Both the negotiators and the human rights organisations legitimised their position with examples. Political scientist Brian Burgoon (University of Amsterdam) and the Sri Lankan negotiator Ram Manikkalingam (adviser to the Peace Process in Sri Lanka) argued that it is a good idea.

Why together? Through the collaboration with negotiators and human rights organisations the researchers could make an inventory of all the stories from the parties. And because at the same time they carried out a large scale study into statements from human rights organisations in the media, they could also provide evidence for those stories. Researchers from the universities of Delft, Wageningen and VU Amsterdam worked together with scientists from universities in Bangladesh. They produced a pump setup that purifies the water indirectly. First the aerated water goes back into the ground. Iron in the ground reacts with the arsenic and oxygen to produce a compound. If you then pump up the water again, the compound, which includes the arsenic, remains in the ground. Researchers from the universities of Delft, Wageningen and VU Amsterdam worked together with scientists from universities in Bangladesh. They produced a pump setup that purifies the water indirectly. First the aerated water goes back into the ground. Iron in the ground reacts with the arsenic and oxygen to produce a compound. If you then pump up the water again, the compound, which includes the arsenic, remains in the ground.

Challenge? The research was more fraught than other sociological research. Another difficult aspect was that much of the information had to remain secret. For example, information about the Irish negotiations of 2005 to 2010 was only released in 2014. Researchers from the universities of Delft, Wageningen and VU Amsterdam worked together with scientists from universities in Bangladesh. They produced a pump setup that purifies the water indirectly. First the aerated water goes back into the ground. Iron in the ground reacts with the arsenic and oxygen to produce a compound. If you then pump up the water again, the compound, which includes the arsenic, remains in the ground. Researchers from the universities of Delft, Wageningen and VU Amsterdam worked together with scientists from universities in Bangladesh. They produced a pump setup that purifies the water indirectly. First the aerated water goes back into the ground. Iron in the ground reacts with the arsenic and oxygen to produce a compound. If you then pump up the water again, the compound, which includes the arsenic, remains in the ground.

Future? The Bengalese are still somewhat cautious. That is hardly surprising as they have been bombarded with ideas from well-intended development workers over the past 30 years. The researchers want to adapt the pump to remove any last doubts the people have. Savenije: ‘And we want to make our water pumps suitable for India. People there are open to new technology. A pleasant side effect is that they are willing to pay more for clean water. Earning money is not our goal though.’
How do you get the most out of microbes?

Bacteria do the dirty work

Mark van Loosdrecht, Professor of Environmental Engineering at Delft University of Technology, lets bacteria treat dirty water and produce valuable raw materials. In 2014 he received the NWO Spinoza Prize worth 2.5 million euros. ‘I am a nature manager. Only I don’t grow forests but bacteria.’

The Spinoza Prize is definitely not your first prize. Is there still room in the prizes cabinet?

‘The bank account of Dutch University of Technology is in any case large enough to handle the prize money, haha. And the Spinoza Prize is certainly special. I work at the interface of scientific research and engineering. As a scientist I pose the question ‘why?’ and as an engineer the question ‘how?’; how do you develop new technologies? I try to combine these two questions. I recently received the Simon Stevin Meester title for my work as an engineer. Now that I have received the Spinoza Prize it means that my scientific work has been recognised as well. I was not particularly looking for the recognition but it is nevertheless nice to receive it.’

Why have you received this prize?

‘I have not yet got a clue. There are so many scientists who do important research.’

Come on now, don’t be so modest.

‘Well I think it is a combination of factors. Our department produces good work. And in other countries they know that there is an important club in Delft in the area of water and microbiology. And although we publish a lot about our research we also focus on the application.

An important invention from your department is the method for treating wastewater with bacteria. Do the bacteria eat up the waste?

‘They do. And once they have taken their fill these bacteria, just like you and I, grow. We have discovered a way of allowing the bacteria to grow in a specific manner, namely in the form of granules. We do that by allowing the bacteria to feed on specific substances for certain periods of time and not in other periods.

These bacterial granules form a sludge that is also made up of granules. It is a granular sludge that is easy to separate from the water leaving clean water behind.’

That invention is becoming a worldwide success.

‘Yes. Together with companies and water boards we have developed two types of granular sludge wastewater treatment plants. One type is the Anammox plant, which efficiently removes nitrogen, especially in industrial wastewater. The other is the Nereda plant, which treats household wastewater. There are now five such Nereda plants in the Netherlands, two in South Africa, one in Portugal, several in the United Kingdom and twelve in Brazil.

Why is it such a success?

‘Because such a plant is far more compact than a traditional wastewater treatment plant. It requires less mechanical equipment because the bacteria do the work. For example, fewer pumps are needed. Consequently it uses about forty percent less energy. The granular sludge installation also requires less maintenance and ultimately it is also easier to run than a traditional plant. This means that a wastewater treatment plant is also more feasible for countries that are economically less well off. Furthermore, because the plant is so simple you do not need to import expensive parts for it.’

So the new water treatment method is not only accessible to rich western countries?

‘No, to the contrary. The construction of the Nereda plants is taking place extra fast in Brazil because they are busy investing in environmental technology. Up until now they have done little in this area and so they had few wastewater treatment plants. Nereda plants are therefore being introduced faster there than here in the Netherlands, for example, where traditional plants are already present. You can see the same trend with the Anammox wastewater treatment, which is now being exported to China, for example.

China is not a poor country but recently companies have come under closer scrutiny. They now have to clean up their wastewater. In the Netherlands, companies have had to do that for far longer. They are not suddenly going to get rid of their existing wastewater treatment plants even if a better method is now available. So that is why the construction of granular sludge plants is taking place less quickly here.’

How long did it take before the bacteria could treat water?

‘It took quite some time. We started in the mid-1990s. (The first Nereda plant was opened in 2012 in Epe, the Netherlands, ed.) We first of all had to investigate why those bacteria granules arose. For the technical development and application we subsequently formed a consortium with the engineering consultancy DHV, the Dutch water boards and Delft University of Technology. But that also took quite a bit of time. From an economic viewpoint it had to happen as favourably as possible. With a pilot plant we learned how to make use of the technology. Such a granular sludge wastewater treatment plant must work under all conditions: when it freezes in the winter but also in July if it is 25° C and after a shower of rain when the composition of the water has changed. It took a while before the plant, including the bacteria, could cope with that well enough. And the operators had to learn to work with the plant as well.’

MARK VAN LOOSDRECHT, Professor of Environmental Engineering at Delft University of Technology, has received the NWO Spinoza Prize 2014.
‘Wastewater is a great system to discover bacteria in’

What else can the bacteria do? ‘They can produce energy, for example methane gas. Organic carbon is usually needed for nitrogen removal. In the Anammox process no organic carbon is needed, allowing energy production. The bacteria in the Nereda plants can produce a sort of glue, a natural polymer called alginate. That is normally found in algae and hence the name. Alginate is a valuable raw material. You can make a whole host of things with it such as burns bandages or synthetic caviar.’

Synthetic caviar from wastewater? ‘Yes, it is possible from both the technical and health and safety viewpoint. But in order to use the alginate from bacteria you can also brighten up colours in clothes. At present that only happens with expensive clothes because you can only extract the alginate from algae and you have to go to sea to do that. But if you can simply obtain it from wastewater treatment then you could also use alginate for cheaper clothes. I think it will be another year or two before that is possible. The raw material is already there but now it needs to be fine-tuned for a specific use.’

Why is wastewater so interesting? ‘The bacteria it contains fascinate me. The wastewater is an interesting system to discover all sorts of bacteria in. The Anammox bacterium was found because we were investigating wastewater treatment. Wastewater is easier to oversee than the open sea and you also know exactly how much nutrients are present for the bacteria to consume. You can play around with that to discover new macroorganisms. Another fine aspect is that with research into wastewater treatment you are working in the public sector because water treatment is run by a water board. That is a very open field. When you work with companies they tend to want to keep the knowledge for themselves.’

Aren’t you afraid that others will run off with the invention? ‘Oh, that is happening already. And that’s fine. A handful of variants are already available for the Anammox process and other variants are also working on the Nereda process. But we have the advantage that we are collaborating well with both the government and industry. In other places companies or universities are trying to start pilots on their own. That is difficult because you need each other. Therefore others do not always succeed in developing a technology that is successful. But if they do, then great. The market for wastewater treatment is large enough. In the Netherlands alone there are about 300 wastewater treatment plants.’

What are you actually going to use the 2.5 million euros for the Spinoza Prize for? ‘I want to use it to discover how bacteria exploit changing conditions. Then we can discover new microorganisms that can do fascinating things. Did you know that ninety-nine percent of microorganisms are still unknown? That is because bacteria are carefully fed and looked after under laboratory conditions. Microorganisms in nature are used to variable conditions such as periods of hunger. You cannot discover those in the laboratory using traditional techniques. Their discovery requires the creation of special conditions and that is what we do here. For example, we have discovered a microorganism that produces hydroylasanaktoze, a sort of bioplasic. We are examining another bacterium to see whether we can use it to make lipids (oil) that can be used as biodiesel.’

Could those bacteria replace a plastics factory? That would be quite environmentally friendly. ‘Yes it would be. If the bacteria can do the work then ultimately you only need the sun. There are so many microorganisms that we could make use of. Not only for wastewater treatment but also for converting waste into useful raw materials, for example. Now when we grow new microorganisms that harvest the fruits and then the plants away. The same is true for potatoes. But such plants contain a lot of organic material. You could convert that into alginate, bioplastic or biodiesel with the help of microorganisms then you could make society more sustainable. You would close the cycles. Then you would be less dependent on a range of material flows throughout the world. Then as long as you have agriculture you could be produce a significant proportion of the materials you need yourself.’

You let the bacteria work for you? ‘Yes, in effect. I am a sort of nature manager. I create a nature area in which I only grow things I want. But then not forests or heathland but populations of bacteria.’

You go to loads of congresses from Singapore to Saudi Arabia. When you get a break soon? ‘I travel a lot because I want to spread the message about granular sludge technology as much as possible so that people know the technology exists and what the underlying principles are. But in August I am taking time off and then I’ll walk around Mont Blanc with my partner. She does not go with me on all of my work trips but each year we spend two months together on holiday. I admit to being something of a workaholic but this time off is a good compensation.’

Aren’t you tempted to glance at your smartphone while on holiday? ‘At Mount Blanc there is usually no network. We mostly go to places without internet. Not particularly to be offline but mainly because those are beautiful places. We like to travel to mountainous regions such as the Himalayas or the Andes but not to climb as high as possible. I don’t see the point of climbing just to reach the top. If by chance I have an internet connection then I do occasionally look. But then only to quickly answer some emails. Otherwise I can let go and leave my bacteria to do the work.’

Who is Mark van Loosdrecht?

1959: born in Loon op Zand, Noord-Brabant.
1973: gained his high school diploma.
1983: gained his PhD in microbiology and physical and catalytic chemistry at Wageningen University.
1991-1993: assistant professor at Delft University of Technology.
2002: awarded a Visiting Professor from NWO for his research into the conversion of agricultural waste into raw materials, such as biopolastics.
2004: was appointed a member of the Royal Netherlands Academy of Arts and Sciences.
2006: water treatment process Nereda won the Process Innovator Prize.
2007: won the Dow Energy Award, the prize of the American chemical concern Dow.
2008: won the International Water Association (IWA) Grand Award.
2011: was appointed Knight in the Order of the Netherlands Lion for his research into wastewater treatment plants.
2012: won the Singaporean Lee Kuan Yew Water Prize.
2013: was appointed Simon Steven Meester by Technology Foundation STW.

The Spinoza Prize has not been presented yet. Do you plan to celebrate it soon with a glass of clean water? ‘No, definitely with champagne because I never drink water. I only drink polluted water such as coffee or beer. I think I will first of all raise a glass with my Delft colleague from two days further up, Sef Hoek. He is very much like me, a down-to-earth practical type.’
When the earth was still very young, many pieces of rock from space collided with it. These brought water with them that now flows in the earth’s oceans and seas. Could they also have brought molecules with them that form the basis for life?

**Space rain**

Dutch astronomers and geologists are simulating comets and planetoids on earth. That is helping in the search for the origin of water and building blocks of life in space.

**TEXT: DAVID REDDEUX**

This story started about 25 years ago. Geologists could not explain where the water on earth came from. When our planet was formed, about 4.5 billion years ago, it was so hot that any drop of water that might have been present would have evaporated instantly. At this stage the earth did not have a thick atmosphere yet and so this evaporating water would have immediately disappeared into space. There was some water stored in minerals but no liquid water on the surface. So how were the oceans on earth formed?

Astronomers had already discovered that comets largely consist of water ice and they suggested that the water on earth possibly came from projectiles in space. When the earth was cooling down during the first few million years after its formation, many meteoroids and other small solar system bodies (see the box ‘Types of debris’) landed on earth. If water was in or on these objects then that could explain the origin of water on earth. How can you prove that it literally did rain with rocks full of water? Geologists hastened to museums to borrow meteorite samples and to investigate whether these contained water. However, they could not find any liquid water. If the meteorites had ever contained liquid water then it had evaporated by now. Several scientists placed their hopes on Antarctica. The meteorites that are preserved there are more pristine, unaffected by earthly influences. But the meteorites from Antarctica did not contain liquid water either. They did, however, contain ‘mineral water’: water trapped in the minerals from which the meteorites are made. Would that be enough water to fill the oceans with? The chances of finding the origin of water seemed to be evaporating.

**Light betrays water**

Meanwhile astronomers had refined their techniques. For years they have analysed the radiation (such as light and UV radiation) that originates from stars, dust and gas in space. A series of peaks...
Each year hundreds of tonnes of space debris fall on earth

observed for certain colours (spectrum) is characteristic for a given molecule. Nowadays that spectrum is known for thousands of molecules, including water. As the astronomers acquired increasing-ly better telescopes, they could investigate the cosmos more accurately. What did they find? The enormous gas and dust clouds in our Milky Way are full of ice and water vapour. And those enor-mous clouds are the very place where stars and planets are formed and they are teeming with space debris. At the same time geologists were developing increas-ingly better measuring instruments and experiments. Several years ago they discovered that a significant part of the water in our oceans probably comes from the mineral water in asteroids and meteors. This discovery got people excited. All life on earth is not only depen-dent on water but, for example, on proteins as well. Or to be more accurate, on amino acids, the molecules from which proteins are built. Could those amino acids, just like the water, also originate from space? And it is yes, how could they have ended up on earth?

Those really are questions to which geologists and astronomers cannot give an answer without each other’s help. In 2013, NWO and SRON Netherlands Institute for Space Research made 1.75 million euros available for PEPSci, an interdisciplinary research pro-gramme for planetary and exoplanetary research within which astronomers and geologists are being given the chance to solve questions like this together (see the box ‘Short day’).

Recipe for amino acids

The search for extraterrestrial biomole-cules, including amino acids, is one of the main themes within PEPSci. Harald Linnartz, an astrochemist at Leiden Observatory, is heading an experimental research group that is investigating how amino acids can evolve under conditions typical in space. In his laboratory, the physical and chemical processes govern-ning molecule formation are simulated. For this, molecules as found in space are studied in a ‘chamber’ as big as a shoe-box. The experiments are performed in a vacuum and at temperatures that are typical for space, roughly minus 260 degrees Celsius. Subsequently the mole-cules are irradiated with high ultraviolet light, radiation that the molecules also encounter in space, or bombarded with hydrogen atoms that are omnipresent in space.

Linnartz explains: ‘In the laboratory we want to find the recipe that shows us how water and amino acids form under inter-stellar conditions. What are the ingre-dients needed, what are the optimum conditions? With this information at hand observational studies can be guided to search for the right spots in space, looking for the correct ingredients and the best conditions. This is the way to systematically investigate whether amino acids are also present at such locations in space.’

Dwarf planets

De Kok explain it in two minutes on YouTube (see bit.ly/2k3wJnk). Their research is part of the PEPSci programme. Scientists from various disciplines are investigating planets and exoplanets. For example, they are examining how life on other planets inside and outside our solar system has evolved. PEPSci is a national and interdisciplinary research programme in which astronomers, geologists, chemists, atmospheric scientists and mathematicians are working together, each with his own specialism, bringing the scientific disciplines together increases the chances of crucial insights being gained.

Dwarf planets

What? Dwarf planets are bodies that orbit the sun. They are smaller than planets and have not absorbed the dust or other small debris in their orbit all the way through.

Size? A dwarf planet is more than 1000 km in diameter. Pluto (more than 2000 km in diameter) is the best known. In 2006 it was degraded from the status of a real planet to a dwarf planet. Where? One dwarf planet, Ceres, lies in an orbit between Mars and Jupiter. The rest resides beyond the orbit of Neptune. Small solar system bodies (planetoids and comets)

What? Dust particles, pieces of rock or ice swerving in space. Size? Maximum one metre (otherwise it is a planetoid) and at least half a centimetre otherwise it refer to it as space dust. Where? Our solar system is riddled with meteoroids. If one of them comes into the earth’s atmosphere and burns up it is called a meteor or shooting star. Meteoroids do not have to be large pieces of rock or ice, otherwise it is a meteorite.

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The universe is full of organic molecules

Small rock, big impact

17 metres. That was the diameter of the rock that caused the earth to shake on 15 February 2013. At about 09.15 local time the meteorite exploded near the Russian city of Chelyabinsk. More than 12000 people were wounded, mostly by falling glass. Space organisation NASA, which monitors thousands of planets, missed it. ‘Why simple the rock was too small. Nevertheless the explosion was 30 times heavier than that of the atomic bomb which fell on Hiroshima in 1945 and it produced a shockwave that went around the earth twice. Not bad for such a little one. We can now get ready for Apophis, a block of rock about 300 metres in diameter that will whizz between the earth and the moon in 2029. According to calculations the chances of Apophis colliding with earth is zero. So we have nothing to worry about in the coming years.

Inga Loes ten Kate next to her experimental ‘safe’. Earth scientist Inga Loes ten Kate from Utrecht University is not waiting for the measurements from new telescopes. She is investigating the reactions between biomolecules and minerals. Ten Kate is replicating a piece of a planetoid on earth, in a stainless steel chamber of 50 x 50 x 50 cm. It looks somewhat like a safe. ‘Ten Kate: I cannot make it as cold as Linnartz’s small compartment in Leiden. But in my safe it is easier to do experiments with pieces of rock or dust particles.’ Stone and dust mostly form the basis of planetoids. Ten Kate places a teaspoon of finely crushed stone in her tray and radiates the heap with UV light. ‘We suspect that within clumps of ice and tray and radiates the heap with UV light. It would be fantastic if we could simulate the reactions that occur in space. Furthermore, we have an increasingly better understanding of how such molecules can evolve. Now it is just a matter of waiting for the first identifications.’

How did you get this far?

During my psychology degree I focused on biological psychology, including brain research. This fascinated to me, and so after my degree I did my PhD at Maastricht University investigating the processing of sounds by the brain. While we made progress, some research questions remained unanswered. These questions could only be answered with stronger scanners and at that time they did not have those in Maastricht. MRI scanners use magnetic fields. The strongest scanner I could use at the time operated at 3 Tesla (the magnetic measurement unit, T). Now they also have a scanner with a strength of 7 Tesla and one at 9.4 Tesla. At the University of Minnesota, where I am doing my Rubicon research, they have the strongest human scanner in the world I will soon be able to measure with 9.5 Tesla and that will make it possible to study the brain at a better resolution.

What are you investigating?

‘One of the questions that I could not yet answer during my PhD research concerned the combinations of sound properties that are processed in a very small part of the cerebral cortex. Examples are the sounds’ frequency content, and changes of that frequency content over time. Research on animals has revealed that this is organised at a very small scale. If you want to study how the human brain combines these sound properties, you need to zoom into the brain such that only a small piece of cerebral cortex (which is approximately 3 to 4 millimetres thick) can be detected independently of each other. In Maastricht, I could only zoom into a level of several millimetres, whereas in Minnesota we can measure separate signals at a resolution of 0.8 millimetres. I hope that as a result we will soon be able to discover exactly how the cerebral cortex organises the different properties of sound.

What do you investigate?

‘I study human audition, so how we hear sounds. Every sound that we hear enters at the outer ear. But before you hear that sound, a lot of things must happen in your brain. The brain ‘dissects’ the sound, analyses its pieces, and puts it back together again. We still know very little about the exact process by which that happens. I study this by putting volunteers in an MRI scanner and letting them listen to natural sounds such as voices, music and animal cries. With the MRI scanner we can see which part of the brain is active for hearing each of these sounds. In this way, we are trying to analyse the process leading to sound perception.’
Trillions of virus infections are the driving force in nature

If you could take all of the organisms out of the ocean and place them on a massive weighing scale then 98% of the weight would be made up of microscopically small living organisms. The influence of viruses on these microorganisms is enormous. Corina Brussaard can see that with her own eyes.

TEXT: FRANK BEIJEN
Take a dip in the sea and you expose yourself to billions of viruses

Most of us already know that viruses are very small. And we are willing to accept the fact that the sea is teeming with life. But did you know that if you take a dip in the sea at Scheveningen you will be exposed to billions of viruses? In just one millilitre of seawater there are already 1 million viruses. Now to be honest that is a rule of thumb, says viral ecologist Corina Brussaard. Sometimes you have 10 million viruses per millimetre. And sometimes even 100 million.

Brussaard works at the NIOZ Royal Netherlands Institute for Sea Research on Texel, where she also lives, and is professor by special appointment at the University of Amsterdam. She investigates different aspects of viruses in the sea. ‘Viruses conjure up images of diseases. And if you are the person who is infected then that is also the reality,’ she says. However most viruses in sea do not harm people, as otherwise nobody would survive a day on the beach. ‘Viruses play a gigantic role at the basis of almost every food chain in the sea. And on a world scale they have an enormous influence on the energy cycle and the cycles of substances such as carbon, nitrogen and phosphorus.’

**Virus cannot survive alone**

A sea virus is not even aware of it. What does it actually do all day long? Seemingly not a lot. Without legs, swimming membranes or other organs of propulsion it cannot move itself. It does not consume and metabolise food either. ‘A virus is nothing more than genetic material (DNA or RNA, ed.) with a protein coat around it,’ says Brussaard. It is a parasite, which is entirely dependent on other organisms for its reproduction. Therefore viruses are not considered to be organisms they are not living beings. So how can a virus make new viruses then? It can only do that if it first of all manages to penetrate a host. In the sea that is often a single-celled microorganism, such as an alga. If a virus penetrates a living being then that is called an infection. ‘If that happens with us then we cough or we develop a fever,’ says Brussaard. But for a single-celled microorganism an infection, in principle means death. After all it only has one cell.

**Alga bursts open**

Broadly speaking there are two cycles that viruses can follow after they have infected a host. In the ‘lytic cycle’ the virus immediately takes over the host cell. Inside the alga the virus replicates itself with the help of the host’s biochemical machinery, says Brussaard. With her hands she illustrates how the viruses make more and more spheres that fill the infected host. Within a few hours to one day the alga contains so many new viruses that it bursts open and dies. The new viruses that have been released infect other algae of the same species that also become filled and burst. Things are very different in the lysogenic cycle. Then the virus does not kill its host but incorporates its genetic material into the host’s DNA. If the host cell later reproduces itself then it copies not just its own genes but also those of the virus. That happens a lot in the sea, says Brussaard, for example if quickly making a lot of new viruses with the help of the lysogenic cycle is not advantageous. That could be because the host has too little food and it is not in a good physiological condition. Or it might be because the concentration of hosts is too low. Then many of the viruses released from an infected cell during the lytic cycle would not find another host to penetrate. However, once circumstances improve, the virus will switch from the lysogenic cycle to the lytic cycle and kills its host after replicating itself.

**Away with food chains**

The death of all those hosts has major consequences for all the models science has of food chains say Brussaard: ‘You have those sums: start with one thousand kilos of algae that are consumed by zooplankton (such as krill and copepods, ed.). The zooplankton then become 100 kilograms heavier in total. One tenth of that extra mass subsequently ends up in small fish. The small fish disappear into the stomachs of large fish. Perhaps those end up on people’s plates.’ But because viruses kill many algae, those food chain sums are incorrect. These sums assume that all of the food goes directly from the one organism to the other. Yet that is an oversimplification of the reality. So Brussaard does not use the term ‘food chains’ but instead ‘food webs’ in which everything is recycled. An example is the remnants of algae that have been killed by viruses. If bacteria consume those remnants they release nutrients such as phosphate and ammonium. Living algae can use those for their growth. Brussaard: ‘Paradoxically you need death to maintain the production of new algae.’

**Virologists**

**Water is warming up**

One of the questions that all of these samples will help to answer is: What is the impact of different species of viruses on other bacteria? “We have collected at sea lie in our freezer and need to be investigated in the lab!” One difficult aspect of her research is the tiny size of the viruses. ‘Try to identify them and count them. At the end of the 1990s Brussaard worked in Norway at the University of Bergen and she examined viruses with a special type of microscope. ‘We stained the viruses with a green dye and looked for green fluorescent points: green, greener and greenest. But you could not see with certainty which virus had which shade of fluorescent green.’

However, better detection and counting methods became available about 10 years ago. Brussaard helped to realise these with her articles about the use of the flow cytometer, a piece of equipment that can distinguish and count various life forms and other particles. ‘With the flow cytometer you can process 100 to 150 samples per day once you go getting it. It has vastly increased our capacity. We come back home with far more samples, sometimes 10,000 to 20,000. In the past we had only 50 samples. ’

**2 CYCLES IN WHICH VIRUSES REPLIQUE THEMSELVES**

Some viruses are so large that scientists initially thought they were bacteria. These ‘megaviruses’ officially reinvented were discovered by French researchers in 2003. The giants contain far more genes than the ‘normal’ viruses. Some of their genes had previously only been found in higher life forms. ‘Why do they need all of that genetic material?’ Science has not found the answer to that yet. Interestingly some of these mega-viruses, such as Megavirus chilensis, have a thick outer mantle. That is a bit like a hairy Persian cat: it looks very large but if you make it wet it is actually half the size. Researchers speculate that these megaviruses can penetrate organisms more easily thanks to their size. For example, amoebas might mistake the viruses for bacteria they like eating. That is an expensive mistake for the amoeba: if it consumes the ‘bacterium’ it then finds out it has eaten a sort of Trojan horse: the megavirus kills the amoeba by replicating itself.

**Virologists**

**Megavirus chilensis**

Young and broad discipline

Even second hundreds of billions of viruses infect the human immune system. That is 5 with 32 zeros or 100,000 million million. However we only discover a portion of them, we are only discovering a fraction of what we are dealing with. The first publications about viruses appeared in 1973. But even the early 1990s did scientists say: ‘Hey, we should do some serious research into that,’ says Corina Brussaard. She was one of the first postdocs in the discipline. A growing number of groups are investigating viruses in the sea, but only a few are examining algae viruses like Brussaard. So they are studying a lot of subjects at once: infections, reproductive rate and mortality, measurement techniques, etc. It is very hectic! But interesting. There is still so much to discover.

**The single cell alga Phaeocystis globosa can be found in all of the world’s seas.**

**In the lytic cycle a virus makes new viruses. In the lysogenic cycle, the viral DNA becomes part of the algal DNA. If the alga copies itself, it copies the viral DNA as well.**
The warming up of the sea will cause major changes to the food web

Food web changes to the ocean will cause major changes to the ecology of the sea. The warming up of the sea will become strongly layered because the warm surface water does not easily mix with the cooler water below. The nutrients in the deeper parts of the sea will become unreachable for organisms that live closer to the surface. The consequence for viruses, algae and with that the entire food chain, is that food web, can be nothing other than major. Brussaard gained an idea of that by collecting samples from different coastal seas and oceans. She made a trip from the Canary Islands to Iceland. Around the Canary Islands the seawater is relatively warm and strongly layered throughout the year. The cooler more northern waters are less strongly layered in the summer. Due to global warming, the northern waters are less strongly layered in the summer. Due to global warming, the northern waters are less strongly layered in the summer. Due to global warming, the northern waters are less strongly layered in the summer. Due to global warming, the northern waters are less strongly layered in the summer.

What is happening in the sea. Just how superficially people can think about the ocean was noticeable following the oil disaster in the Gulf of Mexico in 2010. We are shocked if seabirds wash up on the shore with oil on their wings. But as soon as the fishermen start working again, we act as if everything is okay. Yet deeper in the sea, the oil is still floating around and it is only breaking down very slowly. There the impact on the small sea life and viruses can also be considerable. ‘You cannot study the world without understanding the oceans’, says Brussaard. And you cannot understand life without studying microorganisms. That automatically leads you to the seas full of viruses.’ When asked what all those viruses bobbing around in the sea want to achieve her answer is short. ‘The aim of life is to multiply your genes’, she says. ‘Why?’ That is yet another question, haha.

Boundaries of technology

What do you investigate?
I study the relationship between people and technology. And especially the role that technology plays in society. We intuitively place people and technology at opposite poles. People are living and make conscious choices, whereas technology is dead and empty so to speak. Nowadays, however, people and technology are increasingly intertwined with each other. Technology influences decisions and choices that we make. For example, are you only allowed to heal people or can you improve them as well? Is it alright to give somebody a leg prosthesis with which he can do more than with his own leg? I investigate whether we need to revise our existing approach towards the relationship between people and technology.

How do you get this far?
‘At high school I struggled to choose between the humanities and the natural sciences. I was interested in physics and astronomy as I was in the classical languages and psychology. So when I discovered that you could study a combination of the two at the University of Twente, namely philosophy of technology, I immediately realised that I had found the perfect study. My heart lies at the boundary between the two. In 2000, I gained my PhD for research into philosophy and technical design. After that I received a Veni and then a Vidi grant for follow-up research in the same area. Now I have my own line of research within philosophy of technology. What are your plans?
‘As a philosopher of technology I study the ethical frameworks that we draw up for the relationship between people and technology. I want to investigate whether our frameworks are shifting. For this I work together with other scientists who develop technologies that elicit ethical questions. For example, I am investigating the lab-on-a-chip technology. You can use this to divide the sperm from men into sperm that produces boys and sperm that produces girls. Such a chip does not exist yet but the law forbids the price selection of the baby’s gender. However, such a device will probably become available in the future. Therefore I want to investigate now what the influence of such a technology will be on society so that we can embed those societal aspects as well as possible into the technology.’

What do you like most about your research?
I like working together with other scientists on studying new technologies that are useful for society. What I like most is pushing back intellectual boundaries. For my research I am trying to look at science in a new way and to approach the existing frameworks of philosophy from a different perspective. I find that both challenging and exciting.

Labs in ship containers

It is 66 metres long, the hull is blue and it is highly versatile. The Pelagia is the flagship of NIOZ, the institute where Corina Brussaard works. She does most of her research with it. The Pelagia is not only suitable for collecting samples but also for analysing it. The Pelagia has three permanent laboratories onboard and space for nine mobile labs in containers. These can be lifted on and off. That is because different situations require different lab kits to imitate the situation in the sea. For example, the light intensity and pressure vary with each depth. The lab in which you can investigate the situation at a depth of 40 metres has less light and greater pressure than the lab in which the situation at a depth of 10 metres is simulated. If you want to know what viruses and algae do to each other then you need to stay from water conditions that are as natural as possible, says Brussaard. ‘Without the Pelagia, I would not be able to do my research in this way. You can also him yourself in containers another vessel but then someone else determines the programme.’ A film that shows some of the research onboard another vessel can be seen at tinyurl.com/PelagiaNIOZ.


Insomnia comes in many forms

Why does one person sleep like a log while another person spends half the night staring at the ceiling? According to brain researcher Eus van Someren the answer lies in our brain. The question is where.

The representation of different subtypes in the sample. How can one test if there are indeed different types of night owls? Van Someren and his colleagues initiated the sleep register. Via www.sleepregistry.org anybody (with or without sleeping problems) can complete questionnaires about characteristics, habits and sleeping behaviour. Analyses of the data are already in place. Van Someren: ‘The brain of these insomniacs is hyperalert, always monitoring the environment, always ready to respond.’

Grey matter fails

A possible explanation for this extreme alertness starts with an area of the brain above the orbits of the eyes. Brain scans revealed that some insomniacs have less grey matter in this so-called orbitofrontal cortical area. Grey matter in outermost part of our brain consists of layers of neurons that process information and pass this on to other parts of the brain. Parts of the grey matter above the eye sockets has a specific function: assessing how you feel one feels. Am I too warm or too cold? Have I eaten enough? Am I sitting or lying comfortably? In other words, is the general internal situation pleasant and comfortable? If the answer is yes, these brain cells become more active. Van Someren: ‘They send a signal to other areas of the brain that it is a bit less important to monitor the environment for opportunities and dangers and to be prepared for action if they occur. Nothing needs to happen for a while.’ These are therefore the ideal conditions to fall asleep. Unless you have the misfortune of having less grey matter in this area, thus lowering the sensitivity to sense comfort.

Towards a therapy

Recently Van Someren and his team managed to demonstrate this for at least one brain connection, that of the brain cells above the eye sockets to the deeply situated head of the caudate nucleus. One of the many functions of that area is that it works as a sort of brake to the sensitivity of the cerebral cortex. The researchers gave volunteers in the brain scanner a task that normally activates the caudate nucleus. The results indicated that people with less grey matter above the eye sockets, had more difficulty activating the head of the caudate nucleus. This discovery will not immediately solve the problem but it is important for understanding the hyper-aroused state people suffering from insomnia often show. And help developing better treatments. Because cognitive behavioural therapy, the best treatment currently available, doesn’t work perfect and for all, according to Van Someren. ‘It would be great if we could completely target the treatments to the specific brain areas where things goes wrong.’

To do so, requires far more volunteers to complete questionnaires on www.sleepregistry.org, as well as to participate in sleep and MRI scans.

FURTHER INFORMATION

www.sleepregistry.org: help the research by completing questionnaires.

rodatie@quest.nl
**SPINOZA PRIZE**

**Why do we live in just one place?**

**Quantum effects are not weird**

Why can a quantum particle be in two places at once, whereas a person cannot? Dirk Bouwmeester, Professor of Experimental Quantum Physics at Leiden University, is trying to answer that question. In 2014 he received the NWO Spinoza Prize worth 2.5 million euros.

You are receiving 2.5 million euros! Have you already got over the initial surprise?

‘It was indeed an enormous surprise. For a researcher it is a godsend: the possibility to go further with your research knowing that you already have the money for it. If you do experimental research, you are constantly busy trying to obtain funding for it. This prize will give me lots more space to focus even more on research.’

And quantum research is not cheap for sure?

‘That's correct. I think that in the last fifteen years I have certainly needed a budget of one million euros per year for my experiments. It seems like a lot of money but in this type of research this is spent. One of my experiments makes use of very low temperatures and it is incredibly expensive to keep it running.

I am therefore very grateful to NWO. And it is not for the first time that an NWO grant has supported my research. Thanks to a grant from NWO I could go to Oxford in 1996 and work with Roger Penrose, a physicist who has been an enormous source of inspiration to me.

As a PhD researcher in the quantum optics group at Leiden University, is trying to understand how our classical world arose from this. Why does a particle at one location, which from a physics point of view is far weirder than the underlying quantum world.

Current physics textbooks still often assume that we have to take the quantum descriptions as a starting point and then ask yourself how our classical world arose from this. Why does a particle proceed along a single pathway in space? You should, however, do it the other way round. You should take the quantum descriptions as a starting point and then ask yourself how our classical world arose from this. Why does a particle proceed along a single pathway in space?’

Sorry but that is simply weird.

‘If you have studied quantum mechanics for long enough then it is actually logical. Objects which we know from our everyday lives have a speed and a position. They follow a path and are therefore not in two places at once. In quantum mechanics, however, this does not apply to very small particles. Instead a wave description is needed. A particle does not move in a line but as a wave through space-time. And does quantum mechanics have an answer to that? That is still being discussed. As soon as we measure a particle we make a jump from the quantum world, where waves play a role, to that of classical mechanics. There we have positions and speeds, but we cannot predict them if they take part in the research in Leiden.’

With your experiments you want to extend the boundaries of quantum mechanics. What does that involve?

‘Quantum mechanics is about the behaviour of matter and energy at the atomic level. At this scale you see weird things. For example: a quantum particle (a very small particle, ed.) can be at two different places at once. We cannot do that. People cannot be on this chair and at the same time on the chair in the room next door. An important question in quantum mechanics is why do we not observe these quantum effects in everyday life. Why can a quantum particle be in two places at once, whereas we cannot? By bringing large objects into quantum states we can observe these quantum phenomena.’

What does that experiment look like?

‘We observe a quantum particle that can move in two directions. It is a photon, the particle light is made up of. That photon is in quantum superposition, a quantum state in which it can move in both directions at once. We transfer this superposition to a larger object, which is a still very small mirror. How do we do that? At the end of both directions of movement there is a cavity. In one of those cavities a mirror is placed on a spring. If a photon collides with the mirror then the mirror vibrates. The displacement caused by this vibration is very small, far less than the size of the mirror itself but nevertheless large enough to notice. As the photon is in superposition then the same is true for the mirror, which is in a state of vibration and non-vibration at the same time.

So in effect, the mirror is in two places at once and the largest distance between these two positions is the maximum amplitude of the vibration.’

And does quantum mechanics have an answer to that?

‘The research needs those two places. The experiments need to come about? You are now doing those experiments in both the Netherlands and the United States. How did that come about? The research needs those two places. The experiments need to be carried out at extremely low temperatures. For more than one-hundred years, the Kamerlingh Onnes Laboratory in Leiden has specialised in this area. The nanostructures that are brought to those extremely low temperatures must be produced using advanced techniques. And they are very good at that at the University of California in Santa Barbara. My students in Santa Barbara work on producing and testing the materials. If these are good then they are sent to Leiden or I bring them over myself. And sometimes the students bring these materials with them if they take part in the research in Leiden.’
role, to the classical world, where a particle can find itself at a certain position in space. That moment is called ‘the collapse of the wave function’. An important question currently under discussion is: what is the mechanism behind this? In principle, quantum theory has a good answer to that. You have linked the particle you want to detect to a large measuring device that we can describe in classical terms. And that means that the particle becomes entangled with a whole range of particles in the measurement device. This entanglement is so complex that from that moment onwards we can no longer experimentally demonstrate that there is a superposition. From the quantum mechanical viewpoint that superposition is still there. However, from that moment on the system behaves largely as a classical system without wave-like properties.

But that is not the only possible answer. It could be the case that another effect also plays a role which we do not yet know about and which insures that the quantum laws do not apply to large objects. That is what Penrose suspects. He thinks that every superposition ultimately collapses even if you do not cause that by measuring it. According to him, gravitation plays a large role in that. He suspects that the heavier a particle is, the sooner a superposition will collapse. In the case of very small particles, such as electrons and atoms, the collapse takes too long to observe in the current generation of experiments. However you might well be able to detect a collapse in large objects.

What we want to test with our experiments is whether quantum mechanics also works so well for large objects and whether the collapse of the wave function can be fully understood in quantum mechanical terms or not.

What do you expect the outcome to be?

‘I honestly do not know what I expect. And that is what makes the experiment so worthwhile for me. I know very few experiments where it is not clear beforehand what the outcome should be. It is more usually the case that an experiment is successful if the outcome is what you expected. And if that is not the case then you try again. But that does not apply to this experiment. If it actually proves possible to make the superpositions of those tiny mirrors then I cannot predict what will happen next.

On the one hand, I lean towards the ideas of Penrose. Gravitation plays an incredibly important role in physics but I do not think it is particularly well understood yet. There is still plenty of room for surprises there. On the other hand I have some doubts that quantum mechanics works so perfectly while at the same time being so simple. It gives such fantastically clear descriptions of how the microscopic world fits together that I have no difficulty in believing that large objects can also be in superposition.

I expect that the first experiments with relatively small particles will demonstrate that the quantum mechanics still works really well. We will have to wait and see whether abnormalities will be measured in the case of larger objects. And if that proves to be the case then we will have to take a serious look at the proposals of Penrose and other theoreticians with similar ideas. However if quantum mechanics also works with larger objects then we would have another considerable adjustment to our view of the world. Then it is really possible that everything including people exist in incredibly complex superpositions.

What would be the consequences of that?

‘In that case you can imagine the craziest of experiments. For example, I could make a device in which I bring a photon into superposition. That photon could then move both left and right at the same time. On both sides I could place a detector. Before the experiment begins I could take a decision. For example: if one detector were to go off I would say farewell to my job in Leiden and work just in Santa Barbara. If the other detector were to go off I would say farewell to my job in Santa Barbara and work just in Leiden. If the other detector were to go off I would say farewell to my job in Leiden and work just in Santa Barbara. At the moment the photon is detected I will be in a superposition from a quantum mechanical viewpoint. This contains the reality that I will only work in Leiden at the same time the reality that I will only work in Santa Barbara.

A race against the clock to get their first?

‘I do not want to see science as a race. Rather I am happy that this type of research has attracted considerable interest and that a lot of people find it worthwhile to work on. This means that the question will most certainly be answered in the end. Of course I hope that our research will play a leading role in that. And with this new funding through the NWO Spinoza Prize there is a high chance of that. But that is not what motivates me. It is phenomenally inspiring to be involved in laying the foundations of a new line of research. It never ceases to amaze me how much has been discovered and developed in the past one-hundred years. Thanks to this knowledge the scientific world is currently exploding. Much of our current knowledge about pharmaceuticals and biology has been made possible thanks to quantum theory. Fantastic research is being done into new medical treatments that are only possible thanks to our precise knowledge of the DNA structure and other structures within living cells. And all of that is thanks to the quantum mechanical description of these structures. How molecules form can be calculated using quantum mechanics. Why do some molecules bind to each other, whereas others do not? Those are pure quantum mechanical calculations. And we can use that knowledge to make a considerable number of advances in the future.’

Who is Dirk Bouwmeester?

Who is Dirk Bouwmeester?

1991: graduated from Leiden University.
1995: obtained his PhD under the supervision of Han Wóortman for experimental and theoretical research on quantum optical systems.
1996: received a Talent Grant from NWO to carry out research on special solutions for Maxwell’s equations that describe electromagnetic fields.
1997: received an NWO Vici grant of 1.5 million euros for his research into the possible boundaries of quantum mechanics.
2000: became professor at the University of California in Santa Barbara.
2001: received the Descartes Prize for his experiments with quantum teleportation, three-particle entanglement and quantum cloning.
2007: returned part-time to Leiden to set up a Dutch-American research group to do research into the quantum world at extremely low temperatures.
2011: received a Vici grant of 1.5 million euros from NWO for his research into the possible boundaries of quantum mechanics.
Secretly, we’re quite fashion sensitive

Typical Dutch

The Dutch are often regarded as oblivious to fashion. What we wear is simply functional. Nevertheless, we still have a clear fashion identity.

TEXT: FLORINE WIERS

Does typically Dutch fashion exist? In the 1950s and 1960s there were various ideas about that. The basis was formed by the fashion from Paris, discovered Maaike Feitsma when she analysed issues of three Dutch women’s magazines in the 1950s and 1960s. ‘Those were Margriet, Elegance and Avenue. These three magazines approached Parisian fashion in different ways. Margriet and Elegance translated the fashion to the Dutch woman. They wrote, for example, what was not acceptable. Too frivolous, too vain and not practical enough because in the Netherlands you must be able to cycle through the rain in your clothes.’ That idea had already stuck to Dutch fashion: the clothing had to be sober and affordable. Avenue did not follow that line says Feitsma. That magazine viewed practical fashion as something negative. In 1965 it presented itself as ‘a clear “no” to the boring living and thinking patterns of the past. Dutch youth did not want practical clothes you could do the housework in, said Avenue. Instead they wanted something artful. Fashion in which you could show your talents and express your identity.

But what does characterise Dutch fashion then? Sobriety? Self-development? Practicality? Feitsma calls each of these views ‘fashion myths’. Not in the strict sense of fables or untruths but to make it clear that they are fabricated and incomplete views. Each myth says something about fashion in the Netherlands but not everything. They are movements that can happily coexist even if they conflict with each other. Feitsma writes that in her PhD thesis Nederlandse mode? Een verkenning van mythe-vorming en betekenissen [Dutch fashion? An exploration of myth forming and meanings] (Radboud University Nijmegen) in which she describes the fashion myths ‘to gain an insight into the function and position of fashion in the cultural dynamics of the Dutch identity.

Any more fashion myths? At the end of the 1980s a new movement arose in the Dutch fashion

Old and New Dutch, circa 1960: on a dyke in traditional Dutch costume and a sober knee-length skirt.

EXPERIMENT NL EXPERIMENT NL

Viktor & Rolf gave items of traditional Dutch costumes (such as the scarf around the neck, the decoration at the breast and on clogs) a modern design.

The chic Elegance conveyed luxury in a modest manner. The avant-garde Avenue (1985-1994) presented fashion as art and Margriet mainly showed how clothing could be practical for doing the housework.

D Vader en dochter, 1958: een typisch volkskostuum.

EXPERIMENT NL EXPERIMENT NL

FASHION
Nowadays the Netherlands is known as the country of jeans

world, Dutch Modernism, which the designers Viktor & Rolf were also part of. This movement ties in with the myth that Dutch fashion is sober: it introduced austere lines in primary colours inspired by De Stijl, an art movement from the 1920s that included artists such as Piet Mondrian. And the current myth is that the Netherlands is the number-one jeans country. Besides coexisting, fashion myths can also change. The idea that the Dutch produce sober fashion does not apply to Oililly. That Dutch brand is inspired by the colourful elements in traditional Dutch costumes. You can also view that as a new Dutch fashion identity. So the Dutch might not be known as fashion conscious but secretly we are, says Feitsma. ‘There is a clear relationship between Dutch fashion and Dutch identity. However, that relationship is more about the ideology behind the designs and less about the aesthetic aspects of these.

Due to the crisis and the cuts’, said Viktor & Rolf in response to the question why they had cut holes in the tulle ball gown. But you can also picture a Dutch ‘gatenkaas’ (cheese with holes) in it.

Oililly’s fashion, initially meant just for children, is colourful and expressive and based on traditional Dutch costumes.

The Dutch company G-Star sells the jeans clothing it designs (plus accessories) in more than 60 countries.
Photo of sun reduces pupil size

Everyone knows that if you look at the sun your pupils become smaller. It was always thought that your brain stem does that automatically without needing to make use of the smarter cerebral cortex. Cognitive psychologists Nabi and his American colleague from Harvard Ken Nakayama have now discovered that pupils also become smaller if you only look at a picture of the sun. This is remarkable because a picture is not bright at all. Yet, the appearance of the sun on a computer screen was enough to constrict an observer’s pupils. Furthermore, and that was perhaps an even bigger surprise still, the pupils responded for less strongly if the photo was presented upside down. Naber therefore suspects that the more intelligent parts of the brain, such as the cerebral cortex, are also responsible for pupillary responses. If that is true, that opens up new possibilities for research. For example, Naber wants to investigate if he can detect people with Alzheimer’s or other brain diseases using the human pupillary light reflex. In people with such a disease, the less strongly if the photo was presented upside down.

Old spy plane finds new ozone gases

It shouldn’t have been possible. Nevertheless, researchers have discovered four unknown substances in the atmosphere that damage the ozone layer. These must be substances that have recently been produced by humans. That is because they are found in air bubbles that have been isolated for centuries in ice and snow on Greenland as well as in a series of air samples that were collected between 1978 and 2012 about Tasmania (Australia). The scientists discovered the culprit when they took air samples at an altitude of 21 kilometres in a discarded Russian spy plane. Interestingly, three of the four new substances are chlorofluorocarbons (CFCs) substances that have been banned since 2010. They could be raw materials or by-products of insecticides or cleaning solvents for computer chips. The researchers are now searching for the underlying mechanism and contact with them. The entire unit fits on a so-called uniboard, a special motherboard of which there are hundreds in a supercomputer. Why is ASTRON interested in this? That’s simple. The institute is building new telescopes that will collect such vast quantities of data that they also need new supercomputers to process that. Cooling those supercomputers with air, which is the common practice, costs far too much energy and space.

Beer beaker turns out to be cooking pot

Research is a tough job at times. Archaeologist Sandra Beckerman from the University of Groningen knows all about that. She thought she had discovered a beautiful beaker that warriors once drunk beer from. Further chemical and microscopic research, however, revealed that the beer beaker was actually a cooking pot. Beckerman studied about 180 ceramics mugs, pots and fragments excavated in the Netherlands that were about 4500 years old. She wanted a definitive answer to an old archaeological question: were there first groups of people who only completely decorated their ceramics and then later tribes who only partly decorated their beaker and pots or did these two cultures develop independently from each other at the same time? Beckerman has yet to come up with an answer. Using the ceramics has proved to be more complicated than expected. But for the time being it is a good story down the pub.

Water cools computer

A glass of water over his keyboard knows, computers and water do not go well together. Nevertheless Gijs Schoonderbeek, instrument designer at ASTRON Netherlands Institute for Radio Astronomy, is working on a supercomputer that cannot exist without water: the water will cool the chips. From a reservoir he allows a tube to meander over the motherboard. The water flows closely past the chips but does not come into contact with them. The entire unit fits on a so-called uniboard, a special motherboard of which there are hundreds in a supercomputer. Why is ASTRON interested in this? That’s simple. The institute is building new telescopes that will collect such vast quantities of data that they also need new supercomputers to process that. Cooling those supercomputers with air, which is the common practice, costs far too much energy and space.

Dormancy makes seeds weak

Plant seed suppliers have always wrestled with one problem. They want to store the seeds as long as possible without it becoming old. That is because old seed germinates poorly. Many seeds are in a state of dormancy when they come from the plant. It had always been thought this dormancy ensures that the seed does not age too quickly. However, plant physiologist Leoni Bentsink from Wageningen UR has now discovered that dormancy causes the seed to weaken. Bentsink is now working with the seed industry on improving seed vitality by means of smart breeding and selection.
Lugworm inhibits greenhouse effect

It seems incredible, but the lugworm could help reduce the greenhouse effect. At least, if Francesc Montserrat (NIOZ, Royal Netherlands Institute for Sea Research) has a say in it. Lugworms eat sand, remove small organic particles from this and then poop that sand back out again in spaghetti-like strings. That is what interests Montserrat. The sand travels through the acidic stomach of the lugworm. In that acid the mineral that make up sand grains are partly dissolved. And now the key to the story: if that sand contains olivine, a common naturally occurring mineral on earth, then dissolved. And now the key to the story: if that sand contains olivine, a common naturally occurring mineral on earth, then as the olivine dissolves, the greenhouse gas carbon dioxide is effectively neutralised. Montserrat is calculating how much olivine and lugworms you need to help reduce the greenhouse effect. He wants to investigate whether the olivine and lugworms can be used in large-scale projects, such as dredging activities and the construction of artificial island and piers.

These lugworms will not save the world anymore by reducing the greenhouse effect. Instead they have been captured to serve as fish bait.

Material yields three surprises

The chemists Paul Kouwer and Matthieu Koepf from Radboud University Nijmegen found one material to another which they call PIC. PIC does not dissolve a polymer and can be used to form a gel. PIC is a polymer polyisocyanopeptide abbreviated PIC in Water. Surprise number one is that when the substance had spent the night in the fridge it could form a gel. Normally you need to heat a substance up to achieve that. Surprise number two came with that heating up. A gel formed. Usually you need to cool a substance to achieve that. The researchers want to make plasters with the material. If the substance is applied to the wound then a gel layer is created due to the warmth of the skin.

Surprise number three? That was the enormous quantity of water that PIC can absorb. A teaspoon of PIC can change a whole bucket of water into gel. If it is heated up, the gel changes it back to a liquid. PIC is a material for biopastics and not a waste product.

Supervisory board’s advice is welcome

Head teachers or management teams of high schools sometimes complain that the supervisory board interferes with their work too much. A supervisory board keeps its distance, looks back and checks, but should not involve itself too much in the strategy for the future is what you often hear. But that is not true, established political scientist Elke Heemskerk from the University of Amsterdam and teacher Klaas Heemskerk. They sent a questionnaire to all 342 high school boards in the Netherlands about their own role and the supervisory board’s. Their findings? Many head teachers do not need if the supervisory board looks to the future and gives good advice about the school’s courses. Of course checking and looking back remain the board’s most important tasks but if it does these well then managers are quite happy to listen to their advice. Klaas Heemskerk will now continue the research.

Many head teachers are happy if the supervisory board makes well-intended recommendations.

Solution for the paper industry

Thanks to an invention from separation technologist Maaike Kroon from Eindhoven University of Technology, the paper industry will no longer need to throw away half trees in about 10 years time. Up until now woodchips have been placed in a sort of pressure cooker. At high temperature these are separated into lignin and cellulose. The lignin is burned and the cellulose is allowed through to the paper factory. It is a time-consuming and expensive process. Kroon has discovered an environmentally friendly solvent that can dissolve wood fibres. Once the fibres have been dissolved, the lignin can easily be removed. It is still only the cellulose that can go to the paper factory. However, Kroon’s lignin is so pure that you can make biodegradable plastic from it. Kroon recently concluded an agreement with fourteen European paper manufacturers to market her solvent.

Frozen with fear

People who have witnessed a drowning and stood paralyzed on the waterfront. A woman who stills while being raped. According to psychologist Merel Hagenaars from Radboud University Nijmegen about 10 percent of people freeze from anxiety each year due to danger or trauma. And for sexual violence that figure is even more than 30 percent. Hagenaars investigated which people are more likely to stiffen and who is more likely to flee or fight. What did that reveal?

People who freeze are more likely to develop post-traumatic stress disorders. If you have previously experienced something very serious in the past then you are more likely to freeze. Hagenaars is one of the few researchers who elicits freezing symptoms in the laboratory. She does that, for example, by first showing a neutral photo of a sports person in action and then suddenly the head of a bloodthirsty dog. Useful, because with questionnaires you don’t get very far investigating traumas. People’s memories fail them when it comes to traumas.
Switching antibiotics on and off reduces the chance of pathogenic bacteria becoming resistant to drugs

Remnants of antibiotics that end up in the environment increase the chances of resistance developing. To prevent that Ben Feringa has developed a switchable antibiotic that only works if it finds itself in the body.
In experiments the antibiotics could be switched on using ultraviolet light

Together with the PhD student Willem Velema he ventured into the field of microbiology. Feringa: ‘We have a lot of expertise in the area of miniscule on and off switches, which we use to control our tiny motors. We thought that we might be able to use them to switch antibiotics on and off as well.’ With this endeavour Feringa hopes to be able to make a contribution to limiting antibiotic resistance. ‘The problem with antibiotics is that when you urinate, antibiotic remnants end up in the environment. Then bacteria in the soil or water come into contact with the antibiotic and develop resistance that they spread as well. It would be fantastic if we could administer antibiotics that switch on in the body and work, but switch off as soon as they enter the environment later,’ says Feringa. ‘Bacteria would then have less opportunities to become resistant.’ One of the switches that Feringa and his group use are so-called ‘azobenzenes’. These molecules change shape if you shine light of a certain wavelength on them. This ensures the substance attached to the azobenzene becomes active or inactive. Based on this science of Feringa’s PhD students attached the azobenzene to an important group of antibiotics, the quinolones in various ways. The method worked: if he shone an ultraviolet light on the antibiotic, its shape changed and it was able to kill bacteria.

Against side effects

That change was only temporary, however. Under the influence of visible light the antibiotic gradually resumed its old shape and lost its activity. Before you took the pill you could first of all activate it by placing it under an ultraviolet lamp. The medicine subsequently combats infection but slowly loses its effect. A few hours later when you excrete the remnants via your urine no active molecule is left and so no working antibiotic ends up in the environment,’ says Feringa. He and his group could even change the duration of the antibiotic’s activity. ‘By making some small molecular adaptations to the azobenzene, they could change how long it takes for the antibiotic to resume its original form. That can vary from 2 to 7 hours and then you can time it so that the antibiotic only remains ‘on’ while circulating in the blood. The control of antibiotic resistance is not the only application Feringa foresees for his switchable antibiotics. He hopes other targeted treatments will become possible as well. The problem with antibiotics is that they kill not just the harmful bacteria but the beneficial ones as well. Our intestines in particular, contain billions of beneficial bacteria. These help us to digest our food and maintain our immune system,’ he explains. So it is hardly surprising that antibiotic use is often associated with side effects like diarrhoea. ‘The beneficial bacteria also receive a jolly good pounding. With a switchable antibiotic it should be possible to only switch the medicine on when it reaches the infection site, thereby leaving the rest of the body alone. You could then take the antibiotic in an inactive form and only allow it to become active in the wound by specifically illuminating the wound with ultraviolet light.’ Infrared reaches deep

Feringa warns that you will not be able to obtain the switchable antibiotic from the pharmacist in the near future. His research mainly demonstrates that antibiotics with on and off switches are a possibility and have potential. Now it is time to optimise the process. ‘For example, we are busy investigating whether we can modify the azobenzene in such a way that it does not respond to ultraviolet light, but infrared light instead,’ he says. The main advantage of this is that infrared light can penetrate far deeper in the body. ‘Antibiotics that are switched on with ultraviolet light are really only suitable for skin infections, as ultraviolet light only reaches the upper skin layers. In contrast, infrared light can penetrate up to a depth of several centimetres. This means you can also use it to treat internal wounds.’ Feringa would also like to know if other antibiotics respond just as well to the incorporation of a switch. ‘You never know exactly what will happen if you start to tinker with medicines. Perhaps the activity will change and the effectiveness will disappear. In this case, incorporating azobenzene worked very well but perhaps we were just lucky. Nevertheless, each new molecule that you make will once again have to be tested for safety. That is another reason why switchable antibiotics will not become available on the market in the near future.’

Targeted chemo

If the on and off switch can be far more widely used then Feringa foresees many more applications. ‘Take switchable antibiotics that are used resistance develops less quickly. But antibiotics are often prescribed unnecessarily for acute cough caused by respiratory tract infections. Usually such an infection is caused by a virus and then antibiotics have no effect,’ explains Jochen Cals. He is a researcher at Maastricht University and a general practitioner. ‘As it is very difficult to distinguish a bacterial respiratory tract infection from a viral one, and because general practitioners think that patients generally like to receive medication, an antibiotic is often incorrectly prescribed.’ For both problems Cals developed a solution. He introduced a point of care test with which the inflammatory protein CRP can be simply measured in one drop of blood by using a finger prick. ‘If the concentration increases from about 2 milligrams per millilitre of blood to more than 100 milligrams per millilitre with such a point of care test, a bacterial infection can now rapidly be excluded. In the case of a low CRP concentration, the cough must be caused by a self-limiting infection. Cals also trained general practitioners to communicate better with patients about the use of antibiotics. With this approach, Cals has managed to significantly reduce the prescription of antibiotics. While in the past a patient with an acute cough went home with a prescription for antibiotics in 67% of cases, now that is only 33%. About 50% of all Dutch general practitioners currently use the point of care test. After my research, the implementation went incredibly,’ he says. As acute cough is one of the most frequently occurring symptoms with which patients go to their general practitioner, the research of Cals has led to a considerable reduction in unnecessary antibiotic use.

Talking or testing?

The Netherlands actually does quite well. ‘Whereas in some countries antibiotics are too easily prescribed, doctors in the Netherlands are mostly far more cautious prescribers. This is great, because if fewer antibiotics are used resistance develops less quickly. But antibiotics are often prescribed unnecessarily for acute cough caused by respiratory tract infections. Usually such an infection is caused by a virus and then antibiotics have no effect,’ explains Jochen Cals. He is a researcher at Maastricht University and a general practitioner. ‘As it is very difficult to distinguish a bacterial respiratory tract infection from a viral one, and because general practitioners think that patients generally like to receive medication, an antibiotic is often incorrectly prescribed.’ For both problems Cals developed a solution. He introduced a point of care test with which the inflammatory protein CRP can be simply measured in one drop of blood by using a finger prick. ‘If the concentration increases from about 2 milligrams per millilitre of blood to more than 100 milligrams per millilitre with such a point of care test, a bacterial infection can now rapidly be excluded. In the case of a low CRP concentration, the cough must be caused by a self-limiting infection. Cals also trained general practitioners to communicate better with patients about the use of antibiotics. With this approach, Cals has managed to significantly reduce the prescription of antibiotics. While in the past a patient with an acute cough went home with a prescription for antibiotics in 67% of cases, now that is only 33%. About 50% of all Dutch general practitioners currently use the point of care test. After my research, the implementation went incredibly,’ he says. As acute cough is one of the most frequently occurring symptoms with which patients go to their general practitioner, the research of Cals has led to a considerable reduction in unnecessary antibiotic use.

Unnecessary antibiotics use for a cough can now be prevented with a simple test.
We might be able to make anticancer drugs switchable as well

Chickens on both large and small farms in Asia are full of antibiotics.

Incubator of resistance

Constance Schultsz, medical microbiologist at the Amsterdam Institute for Global Health and Development and at the Department of Microbiology, Academic Medical Center, occasionally travels to Vietnam. There she visits dozens of chicken farmers. Together with the local research partners, she talks with them, looks in their medicine cabinets, and takes samples of chicken droppings and faeces from farmers and other healthy people. With this she gains an insight into how broad the use of antibiotics is in chickens and humans in rural Vietnam and how antibiotic resistance has spread. ‘It is one of the few studies that is looking at the use in animals and people at the same time within a region, and into how these uses influence each other’, says Schultsz. Her findings are alarming. ‘For a long time we thought that the smallest farmers, with just a few chickens, did not use antibiotics. They fed the animals on yesterday’s rice and housed them differently than on big farms. However that was not true: the chickens of small farmers were full of antibiotics. The fact that antibiotics for use in humans and animals can be obtained without prescription at the pharmacist means that farmers in Vietnam, and probably throughout Asia, are incubators for resistance. Schultsz: ‘Up to 40 percent of the people who end up in hospital in Vietnam carry bacteria that are resistant to almost all antibiotics. In the Netherlands that is not more than 5 to 10 percent.’ Schultsz also found indications that an exchange of resistant bacteria took place between chickens and humans. ‘Some chickens carried bacteria that were resistant to the antibiotics only used by people. In this way resistance can spread very quickly,’ Schultsz would like to do something about the unrestricted use of antibiotics but that will be difficult. The companies that produce the medicines and the sellers of antibiotics would rather not see an enforcement of the legislation.

What do you investigate?

‘In our universe there are extreme astronomical sources that produce short flashes of radio waves. I observe these radio flashes using the world’s largest radio telescopes in order to understand the physics of the objects that produce them. Often these are signals from neutron stars: stars that are only the size of Amsterdam, but which contain more mass than the sun. These are therefore very dense stars. The conditions in and around neutron stars are very different than on earth. As such, we use neutron stars as natural laboratories to study the extremes of gravity, electrodynamics and particle physics. Neutron stars also rotate exceedingly rapidly and this produces radio pulsations that we observe on earth. You can compare them to a lighthouse whose beam of light sweeps past one line of sight. From the measurements and calculations we perform we can derive the properties of these stars and use them to test fundamental physics theories, such as that of gravity.

How did you get this far?

‘My parents are originally Dutch but they emigrated to Canada in 1975. I was also born there. As a teenager I once saw the film Contactor, in which the gigantic Arecibo radio telescope plays a pivotal role. The movie made such an impression on me that from that moment forward I thought: wow, I want to be an astronomer! So, I studied physics and astrophysics at the University of Alberta, and later obtained a PhD position at McGill University where I worked with the same telescope as in the film Contactor. During my PhD I found the most rapidly rotating neutron star ever discovered. The Netherlands is very strong in radio astronomy and also has a long and proud tradition in astronomy in general. I still have a lot of extended family who live in the Netherlands and so for the next stage in my research I decided to move here in 2006!’

What are your plans?

‘I will work with LOFAR, which is a new radio telescope built by ASTRON, Netherlands Institute for Radio Astronomy. LOFAR became operational in 2012, and is made up of a vast number of radio antennas, which can capture the signals from faint astronomical radio flashes. The Netherlands has 30,000 of these antennas, and in the rest of Europe there are a further 10,000. Using LOFAR we can make measurements in several directions at once and thus detect far rarer phenomena than have been observed before.’

What do you like most about your research?

‘In my field of research you can still discover completely new phenomena. For example, in recent years we have identified a new type of signal that we suspect comes from far outside our Milky Way, and perhaps has nothing do with neutron stars. If such signals come from so far away, then they must be intrinsically very bright. The source of these signals remains a big mystery and that is a puzzle I would love to solve during my Vidi project.’

NWO funds talented scientists with an innovative research plan. The VEN grant is for researchers who have recently gained their PhD and is worth up to 250,000 euros. The VIDI grant is for more experienced scientists and is worth 800,000 euros.

Chickens on both large and small farms in Asia are full of antibiotics.
Around 1800 dignitaries were probably lampooned far more savagely than now

From swine to Willy

Modern-day satire is sometimes harsh but in the period of the patriots and orangists (1781-1787) comedians were just as savage, if not more. Noblemen were portrayed as whoremongers, the stadtholder a pissing swine: it was all up for grabs.

TEXT BERRY OVERVELDE
The first Dutch victim of a media hate campaign stems from the patriot era

often make comments about a certain subject. For example, in 2011 they produced The Care of Holland, a parody of The Voice of Holland. In that parody they also made comments about the state of the ‘healthcare sector’. In a nutshell: a combination of a recognizable form and specific criticism. Savage criticism.

Ad hominem attacks

People sometimes complain about the media becoming coarser. Van Woensel tried to show that doubts about that. ‘He made ironic packing. Some people viewed that as a serious threat.’ The literary historian thinks that the second option is more likely in the case of Willem-Alexander. In the case of William V, the opposite was true. In 1786 he had lost nearly all of his authority. Yet even though the satirical magic lanterns and raseekh had such a great impact on the public image and power of the stadtholder and the regents, eventually the patriot period was brought to an end with military force. In 1787, Frederick Willem II, King of Prussia and brother-in-law of William V, sent his troops in the Netherlands to help the stadtholder out of his predicament. The patriots received a right beating from the Prussians. And then it was William V who had the last laugh.

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The rareekh had been a fairground attraction since the Middle Ages. In the eighteenth century this rareekh also became a tool for spreading satire.

The Gelderland Swine, alias Stadtholder William V who had fled to Gelderland.

How serious is satire?

When is something satire? According to Ivo Nieuwenhuis it lies in the combination of an attractive laugh-eliciting form and serious content. It often make comments about a certain subject. For example, in 2011 they produced The Care of Holland, a parody of The Voice of Holland. In that parody they also made comments about the state of the healthcare sector. In a nutshell: a combination of a recognizable form and specific criticism. Savage criticism.

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I investigated flood risks. Floods are a major problem worldwide. In the spring of 2014 we witnessed the heavy flooding in Eastern Europe. And due to climate change this problem is set to increase in the coming years. We all too easily turn to the possibilities offered by technology. But technology is not always the solution, it is also a question of distribution. For example, if lots of floods occur in Germany then that is favorable for the Netherlands because for us downstream, the river discharge is lower. Technically such solutions as dams and dykes can provide extra protection but these often make it less safe elsewhere. They literally displace the problem. Floods are therefore an ethical problem as well. How do we consider to be a fair distribution? Where do we provide protection?

How did you get this far?

At high school I was fascinated by the news. That planted a seed in my mind. As I was good in maths and physics, I went to study civil engineering in Leiden. After my graduation I wanted to do something about the fact that major heavy flooding in Eastern Europe. As I was good in maths and physics, I went to study civil engineering in Leiden. After my graduation I wanted to do something about the fact that many lives lost as a result of heavy flooding in Bangladesh were often in the spring of 2014 we witnessed the heavy flooding in Eastern Europe. And due to climate change this problem is set to increase in the coming years. We all too easily turn to the possibilities offered by technology. But technology is not always the solution.

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The cat is simultaneously dead and alive.
Steering by peeping, page 18

DIY coastal protection: wind and sea change the dredged up sand into new beach and dune.
Oyles away!, page 36

Why not give antibiotics a switch?
On/off antibiotics, page 84

Write ‘eat healthy’ on your shopping list and then you will buy less fatty snacks.
Decisively unaware, page 30

Child murders were nearly all committed by girls in service or pregnant cleaners.
Women in jail, page 8

The National Roadmap Large-Scale Research Facilities aims to strengthen the scientific position of the Netherlands by encouraging the development and construction of large-scale research facilities. This may involve telescopes, particle accelerators, magnetic fields or databases, for example. With this programme, the Netherlands Organisation for Scientific Research (NWO) and the Ministry of Education, Culture and Science invest in excellent research. On 1 July 2014, six teams of scientists received a total of 81 million euros for the establishment or improvement of research facilities. These videos give a brief introduction to these research projects.

Playlist: National Roadmap for Large-Scale Research Facilities

Since 2008, NWO has funded the Responsible Innovation programme. This programme focuses on the ethical and societal aspects of new technologies with the aim of ensuring that these aspects are taken into account in the early stages of technology development. That will enable technological advances to be properly embedded in society. In the Responsible Innovation programme researchers from different fields work side by side for example, an engineer, a psychologist and an ethicist.

Playlist: Maatschappelijk verantwoord innoveren (MVI) - NWO-onderzoeksprogramma

NWO has its own channel on YouTube: www.youtube.com/NWOvenC with videos and animations about Dutch scientific research. From large-scale research facilities and complexity research to biofuel production in developing countries and eating to trust.

Science in view? NWO on YouTube

www.youtube.com/NWOvenC
SCIENCE IN THE NETHERLANDS

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