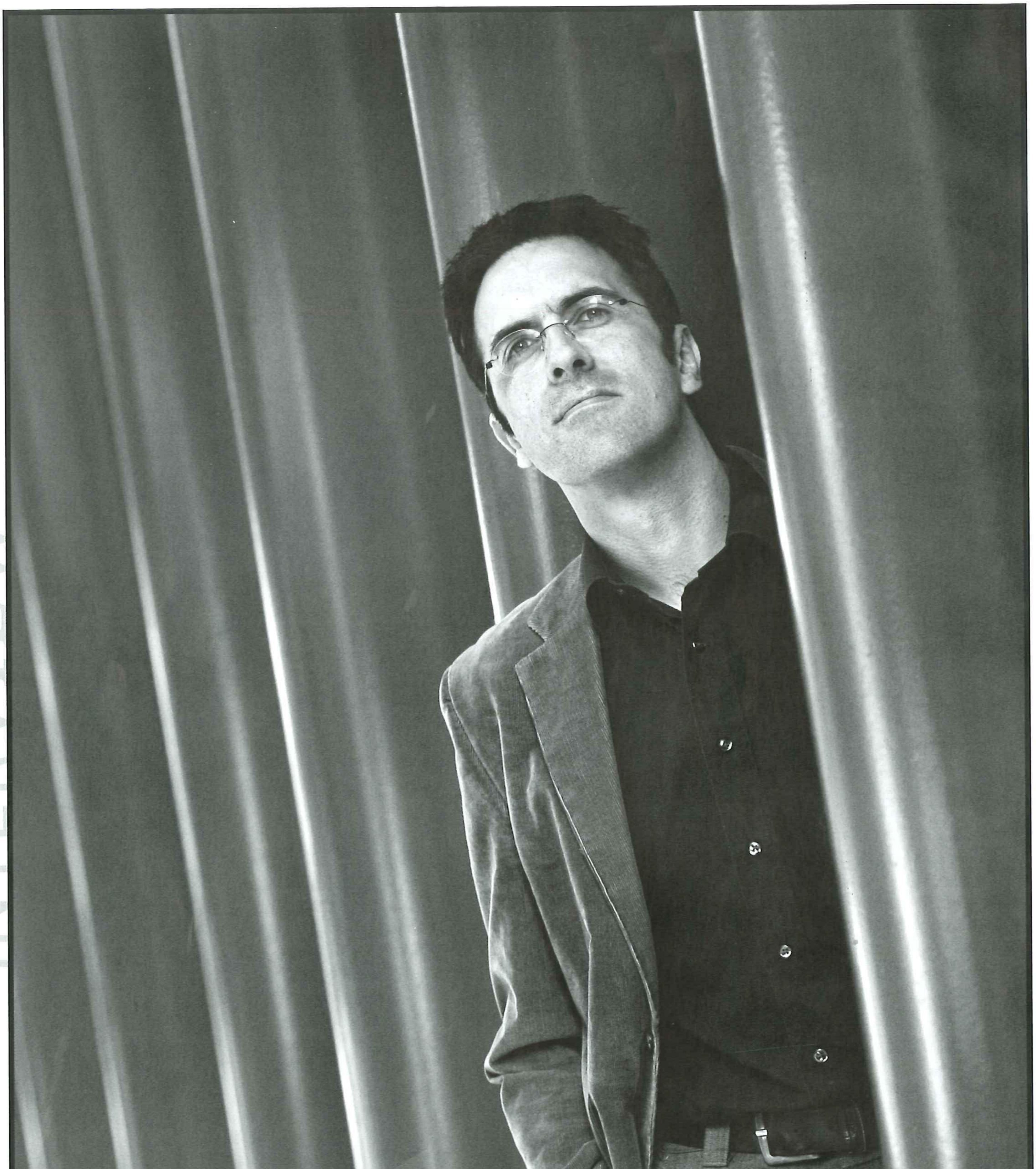
INTERVIEW



Photo's: Nout Steenkamp/FMAX

'We can see Holland's Green Heart beating'

Back when he was an aerospace engineering student, Professor Dr Ramon Hanssen wasn't really into aircraft. Spacecraft were more his thing, particularly the way satellites could be used to observe the Earth. This field of science has undergone unexpectedly rapid development over the ensuing years. In September, Professor Hanssen delivered his inaugural lecture as professor of earth observation at TU Delft.

Jos Wassink

In 1987 you enrolled in the BSc aerospace engineering programme, yet two years later you switched to geodesy. Why the change?

"I was very interested in the space aspect of aerospace engineering, but at the time this aspect had hardly been developed at all. But around that time Professor Karel Wakker, of the Aerospace Engineering faculty, and Professor Rainer Rummel of the Geodesy faculty, began collaborating on a project in which they showed how spacecraft could be used for earth observation. This was what I had wanted to study at university, so it was at that point that I also knew where I could study the subjects that really interested me."

Who is Ramon Hanssen?

In 2008, Professor Dr Ramon Hanssen (39) was appointed Antoni van Leeuwenhoek professor at the Faculty of Aerospace Engineering. This special professorial post allow 'excellent scientists' to become professors at a relatively young age, without having to assume all the usual professorial responsibilities, such as management and teaching. Last September, during his inaugural lecture, entitled 'Geodesy. A Space Odyssey', Professor Hanssen questioned Europe's ambitions for manned space missions to the Moon and Mars. Hanssen believes that earth observation should be the primary objective of space missions. Information returned by satellites can form the basis of a whole range of services. His spin-off company, Hansje Brinker, which provides information about dike subsidence, is one example. Professor Hanssen studied aerospace engineering and geodesy at TU Delft, and in 2001 received a first for his doctoral thesis on radar interferometry, his current research field.

When did you first learn about earth observation using radar?

"In late 1994, a year after I graduated. The history of radar interferometry is very interesting, because we used satellites that weren't developed for that purpose. The ERS-1 satellite, which became operational in 1992, had been developed for other applications, like radar measurements of the sea surface, with the idea being to use the satellite to detect oil spills or measure wind forces. Then, in early 1993, the first publications appeared showing how interferometry could be used to very accurately calculate the distance between the satellite and the Earth's surface from the phase of the signal (see text box). The first incredible subject that made the cover of *Nature* magazine was an earthquake in California [28 June 1992, Landers, *ed.*], with colours graphics showing the ground movement caused by the quake. They had used one image taken just before the earthquake, and another from just after. This allowed the distance between the satellites and the Earth's surface to be calculated to within a few millimetres, with each colour cycle representing a movement of 28 millimetres. This was the breakthrough, because it was the first time that the effects of an earthquake were visualised in such measurable quantities."

Was that when you realised this was the subject for you?

"Yes, I had the opportunity to conduct doctoral research on the subject. It was all completely new. In the Netherlands, we were gradually becoming interested in measuring ground movement, for example as a result of natural gas extraction in the province of Groningen. The way it's now done takes years and costs lots of money. But just imagine being able to do it using a satellite measuring reflections off the Earth's surface from satellites that are already up there. This was a fascinating idea. It appeared to be a powerful technique, offering major application possibilities."

But it also meant you had to go to the United States.

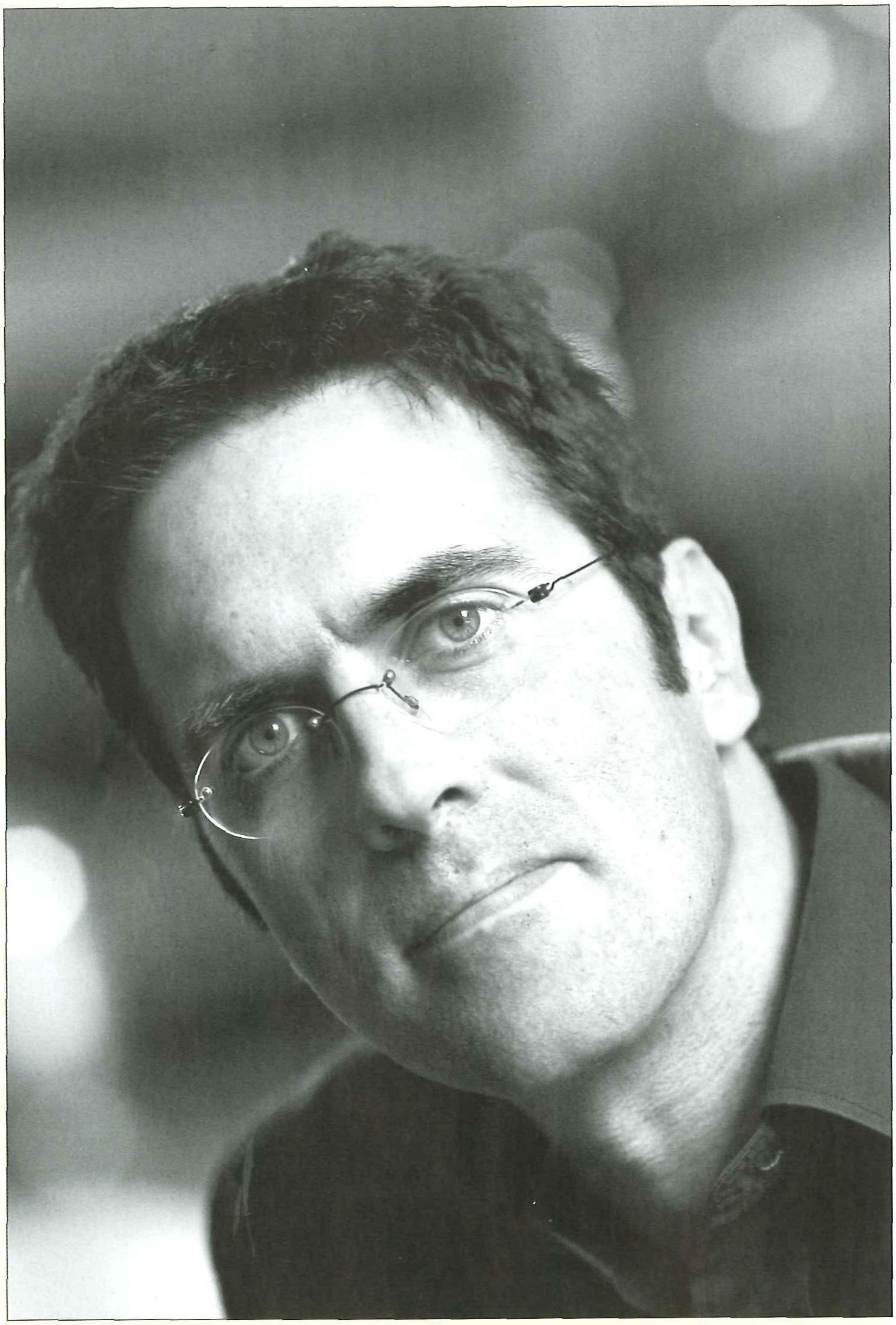
"I started here, in collaboration with TNO, but nobody was really working on this in the Netherlands. At the time, the US was leading the pack, although now it's the other way around. Back then the gurus were at Stanford University, so that's where I spent a year doing my doctoral research."

You can now show images of subsidence over gas reservoirs, mounting stresses in the southern parts of the country, and shifting dikes in the northwest, in millimetres per year. It's fantastic, but how much time and effort does it take?

"The first time is very difficult, but once you know the tricks it becomes increasingly simpler. This is all cutting-edge when compared with earthquakes, which cause shifts of several metres, while in our case we're talking millimetres. The signal is only just above the noise level. A second issue is the terrain in the Netherlands. In California, you've got desert, and each time the satellite passes over it looks the same: rocks, sand and stones. While here, in the Netherlands, everything changes. The satellite passed over yesterday. When it returns in 35 days time, Technopolis Innovation Park will have had a few more buildings constructed and the trees will have lost their leaves."

I can see the department of public works being interested in shifting sea dikes, and the Wadden Sea Association wanting to know about seabed subsidence. Can they process the satellite data themselves, or must they come to you? ▸▸

Interview



'In the Alps, Italy and Spain, whole areas are slowly sliding down the mountain. Entire villages are gradually slipping away'

"For the moment, the subject appears to be a bit too specialised to start training people within those organisations. In the Netherlands, we're the only ones to specialise in this field."

But you did start your own company, Hansje Brinker, to supply the data?

"As for the dikes, we're now trying to make the transition to the end users, the water boards and department of public works, which are both keen, but we're still waiting to see if operational use is possible. Scientifically speaking it's always rather touch and go, which makes it less interesting for commercial entities. As for oil and gas extraction, this is about to change, and international providers are now appearing on the scene who can also do this kind of analysis."

How did the department of public works react to subsiding the dune in the sea defences at Petten? Did they know about it?

"It was known that such processes could occur. There was an argument over it in 2005, when someone said that subsidence could increase to forty centimetres per century. The department couldn't really respond to that assertion, because there hadn't been enough measurements taken and the processes involved weren't sufficiently known."

Was that argument your cue to start focusing on that area?

"Yes, we wanted to see what was happening there. The advantage of using a satellite is that you compile records. The data are stored somewhere, and if you were to go looking for it now, you could go back as far 1992. This gave us the lead. We found subsidence of two millimetres per year, which is twenty centimetres per century, if you assume a linear progression. This is comparable with the order of magnitude of the rising sea level, and it's half of the original claim made in 2005."

You are now able to measure ground movements to an accuracy of a few millimetres per year. Greater accuracy would appear to be pointless. Does this mean your job's finished?

"I think that history shows that a job is never finished. Take GPS for example. Once we got that working, we all thought it had reached the end of its development. Yet with GPS, the signal is delayed by moisture in the atmosphere, resulting in all sorts of errors. We have now reached the point where we can remove the errors and tell meteorologists how much water vapour is in the atmosphere. We will be seeing similar processes in ground movement measurements. The main signal is the result of natural gas extraction, but we can also see the natural subsidence of peat. In southwest Holland we saw the Green Heart area moving up and down some two centimetres with the changing of the seasons and groundwater levels. Behind our building here we had some reflectors that we monitored for five years, and they also showed a plot of land moving up and down. You could say that we can see Holland's Green Heart beating."

So the technology has reached the end of its development, but a lot can still be gained from interpreting the data?

"We can now conduct an earthquake analysis by just pressing a button. This gives you an instantaneous view of what has happened because of the quake. Interpretation and technological development go hand in hand."

The real question of course is whether you can see the stresses mounting?

"Yes, we can, and they're mounting. Take for example the North Anatolian fault, which is the 1500 kilometre-long fault line running from eastern Turkey to Athens, Greece. Continents are rubbing against each other along this fault line at a rate of about two centimetres per year. It's not a continuous process, but rather happens in spurts. The stress builds up and then suddenly it's released at one particular point. Later the same process will occur further down the line. This is what causes earthquakes, like the big one in Izmit, Turkey in 1999, when a few hundred kilometres-long section suddenly shot loose and shifted four and a half metres, resulting in 30,000 dead. After the last earthquake, the stress starting mounting elsewhere. I've likened this process to the bristles on a pair of brushes: if you put their bristles together and push one brush along the other, the bristles will be released one by one. This process is now hanging on by the last bristle, so to speak. And just down the line is Istanbul. We know that all the preceding bits have already shot loose."

So Istanbul's next?

"We know that the area has four and half to five metres of stress built up. The question is: will it all be released in one big bang, as happened in the past, or will it be released in a series of small shifts that gradually reduce the stress?"

Radar measuring down to the millimetre

Satellites circle the Earth in fixed orbits. As the Earth rotates inside the satellite's orbit, after a certain period of time, say twelve days for example, the satellite will reappear above the same point on the planet. During each passage, radar pulses are transmitted. These pulses are reflected off the Earth's surface and then picked up again by the satellite. For each pixel of the radar image, this results not only in an intensity, but also in a phase of the reflected wave. Since the phase is related to the distance of the satellite to the reflection point, a time sequence of distance measurements can be recorded, the relative precision of which is in the order of magnitude of a few millimetres. This allows for the detection of minute surface movements arising from tectonics, volcanic activity, natural gas extraction and the like.

What is your opinion about that?

"I'm not a geophysicist. I just observe what occurs. And I don't see any small shifts occurring."

You also act as a consultant to the European Space Agency (ESA) on the design of new satellites. What are the current trends?

"The most important change is that one operational satellite is now on its way, Sentinel-1."

What's an operational satellite?

"Until now, satellites were mainly prototypes and spin-offs of applied research. Using the measuring data from those satellites is often difficult, because most of those projects are one-offs. It's different in meteorology. There is the Meteosat series, which has been up there since 1977. The second and third generations of weather satellites are now on the way. These are good examples of operational satellites. Not only is there a community of users buying the data, but the supply of data is ensured."

Will radar measurements go the same way?

"Yes. The EU and ESA combined to launch the GMES (Global Monitoring for Environment and Security) programme, which has now been renamed 'Copernicus' and involves a series of five missions using satellites equipped with radar, and later, other technologies as well. Those missions are intended for operational use with applications, including emergency response, fishery, agriculture, security and shipping detection."

What will be detected here on Earth?

"In the event of natural disasters, like floods, detailed information will be rapidly made available. And ships will have to be more careful about discharging oil on the high seas, because they're sure to be spotted now. Fishery fleets can also be tracked to ensure they don't venture outside the allotted fishing zones. Europe spends a lot of money subsidising various crops, which can now be checked from space. There are dozens of applications."

And in your own field, radar interferometry?

"In interferometry, landslides in southern Europe are a major application area. In the Alps, Italy and Spain, whole areas are slowly sliding down the mountain. Entire villages are gradually slipping away, damaging tunnels and pipelines, and we will now be able to see this happening. In an economic sense, there will be extra spin-offs in the technological and service industries. My view is that when Europe decides to release the data – like the Americans have been doing for years – people will develop and market applications. It will then belong to all of us. Until now, satellites belonged either to space agencies or to the realm of science, but the man in the street had little use for them. The results will now become more tangible. The Continuon power company for instance wants to map subsidence in towns, in order to spot stresses on gas pipelines. Such stresses have already caused explosions. I hadn't realised that our data could be applied to a field like that. And for our students, this offers an interesting perspective for designing new applications themselves."

Won't that mean much more business for your spin-off company, Hansje Brinker?

"I don't have any ambition to expand the business. I like exploring the border zone between research and application. A company enables you to give more direction to the applications. It's a fascinating process that I learn a lot from, but it's not something I want to expand further."

Another possible career switch would be music. You are a successful scientist, as well as being an accomplished percussionist. Have you ever wished for the reverse?

"During my school years that was indeed a question I asked myself, but today I consider this the ideal combination. To earn a living in music you must make many more compromises about what you will or will not do, but I'm now in a position where I can just to do the things I really enjoy."

◂◂