

Hypothesis

NWO's magazine for science august 2010

Issue 3 Volume 17, international edition

INTERNATIONAL POLICY

Crossing the borders

INDIAN WISDOM
Poetry explains
mathematics

COLLABORATION
Searching for
software errors



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Innovation and quality are the spearheads of NWO's strategy for the future of science in the Netherlands. Together with scientists, national and international science organisations and commercial companies, NWO develops and finances top quality research programmes. NWO transfers the knowledge generated by its programmes to a wider public so that society can make full use of this. NWO's grants fund the work of more than 4300 researchers at universities and (NWO) institutes.

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Some remarkable quotes. Feel free to react through redactiehypo@nwo.nl

Herman van Rompuy, President of the European Council, was particularly pleased that the importance of the strategic cooperation between the EU and Latin America and the Caribbean was reaffirmed at the EU-LAC Madrid Summit on 18 May 2010: 'This summit has given us the opportunity to address many global issues that concern both our regions, such as natural disasters, the economic crisis and climate change. We have reaffirmed our commitment to an effective multilateral system to meet global threats and challenges.'

'We believe that the wish to make Europe a world-class, second-to-none knowledge society means that Europe must become a hotbed of top talent. This demands the retention – or repatriation – of European scientists and scholars on a much bigger scale than we do now, as well as active efforts to attract talent from abroad, to work with us but also, and most crucially for the visibility of Europe, to train with us', says the **European Research Council** in its 'Contribution to the Consultation to the Future "EU 2020" Strategy'.

At the joint press conference following the executive-to-executive meeting with Chinese Prime Minister Wen Jiabao, EU President **Manuel Barroso** was quoted as follows: 'The announced Europe-China Year of Youth in 2011 also offers us an excellent opportunity to step up our relations by focusing on our young people, a very important resource for our societies.'

Science and Research Commissioner **Janez Potočnik** talked about the challenges for the near future in an interview in *Research*EU* (April 2010). He is convinced that the 21st century will be dominated by two key issues, namely *sustainability*, understood not only in the environmental sense but in economic and social terms as well, and *global governance*.

Germany has published a position paper on the Eighth European Framework Programme, FP8, which will come into force in 2014. A key point in the German paper is that FP8 should be open to international collaboration and that even greater emphasis should be placed on this in the thematic priorities than is the case for FP7. Close coordination between FP Programme Committees and the Strategic Forum for International Cooperation (SFIC) is also needed, with FP8 promoting the implementation of the SFIC roadmap.



Boundless passion

International cooperation is an important aspect of the strategy and approach of the Netherlands Organisation for Scientific Research (NWO). Why? For various reasons. Science is by definition not limited to national boundaries. Curiosity about the Big Bang, how an ethnic group develops its own identity, or the behaviour of apes, is the same

in each country. Gravity is a universal force, whether you live in the Netherlands or in Samoa. Water always follows the path of least resistance, whether that be in the River Rhine in the Netherlands or in the Yangtze River in China.

In addition to this, researchers with various cultural backgrounds complement each other. In my own career as a scientist I have personally experienced how stimulating it is to collaborate with international colleagues. During my time as the director of CERN, I was responsible for more than 8000 researchers from 85 different countries. There I saw in practice how stimulating it is to work on a common goal from the perspective of different backgrounds. Jan-Karel Lenstra, director of the NWO institute Center for Mathematics and Computer Science, says the same thing later on in this *Hypothesis*: Collaboration happens as a matter of course in science. As a scientist within a certain discipline, you and your colleagues are like-minded souls with a single objective: simply doing beautiful research.

Organisations like NWO have the duty to make that possible. With this in mind we maintain contacts with scientific organisations in other countries, we sit at the negotiating table with the European Commission to safeguard European budgets, and we visit emerging science nations like China and India to give Dutch research a firm footing there.

We also take a good look at our own funding instruments: how can we make it as easy as possible for Dutch talent to look beyond national boundaries? And how do we make our country interesting for talent from abroad? Fortunately, as a small country we have a lot to be proud of. Good research institutes, strong universities and a sizeable number of individual talented researchers, such as the ERC grant winners Pieter Zuidema and Titia Sixma, about whom you can read more in this *Hypothesis*. And ultimately that is what we are here for: ensuring that people with a passion for their subject can help the world to take a step forward.

Jos Engelen
Chair NWO

How can I win an ERC grant?

Grants from the European Research Council are among the biggest that European scientists can win. What happens behind the scenes and how can you maximise your chances? Two new Dutch ERC laureates spill the beans.

text Mariette Huisjes
photos Harry Meijer



PIETER ZUIDEMA

Pieter Zuidema (1970) studied biology at Utrecht University and gained his doctorate with an NWO grant for research into sustainable forest management in the Amazon region. Since 2002, he has been a university lecturer at the Institute of Environmental Biology of Utrecht University. Zuidema supervises various NWO-funded PhDs.

ERC grant?

Last year, Pieter Zuidema won a starting independent researcher grant from the European Research Council for his research into the effect of CO₂ on the growth of tropical forests in Bolivia, Cameroon and Thailand over the past 100 years. Zuidema wants to use this information to predict how these forests will respond to climate change. He received 1.7 million euro with which, besides himself, he can fund three PhDs and a post-doc over a five-year period.'

How did you prepare for the selection procedure?

'My university offered a coaching programme for selected ERC candidates. I benefited a lot from that. We were trained to say in five sentences what research we wanted to do, which outcomes we expected and why these are important. And we also watched our own presentations on video with an actor giving us tips about body language and our facial expressions.'

Did you find it difficult to promote yourself?

'Yes. I am used to working in a group and doing everything in a team context. Suddenly it was all about me; there was no longer any 'we', just 'me' and I had to find ways of selling myself. I found it extremely difficult. However, it's a skill that is increasingly required within the scientific world and so I have expanded my own boundaries a bit.'

Once you had passed the first round, you had to come and defend your proposal in person in Brussels. What happened?

'In the waiting-room I realised that I had landed in the middle of the future crème de la crème of European science. Everyone in their thirties; some Germans wearing a tie and their best suit, some Brits slovenly dressed and wearing trainers. I was wearing a blazer but no tie. When you entered the room they did their best to put you at your ease, but it remained a hostile environment. You knew nobody and everybody was testing you.'

What are the crucial factors during the presentation and the answering of questions?

'Charisma is incredibly important. You must remain

calm and be yourself. Look at each committee member in turn. Answer the questions confidently without giving the impression that you are a robot but that you are sensitive for comments. You can find lists of questions that such a committee might pose. Apparently the interviews can become incredibly tough. That did not happen in my case; the questions focussed on the subject of my research and were posed with interest. I was not pushed into a corner or snapped at. I therefore left the presentation with a positive feeling.'

What were you doing when you heard that you had won the grant?

'It was in July; I was with my family on a camping holiday in Scotland. Every few days we checked our e-mail, because I knew that the message from Brussels could arrive at any moment. In the village of Bettyhill on the desolate northern coast of Scotland the good news reached me. We immediately wanted to celebrate with a meal out. At the first – chic – restaurant we were turned away at the door due to our muddy camping togs, and in the second restaurant we were given risotto in which the chanterelles were replaced by sweet corn. And on top of that it was raining, as is mostly the case in Scotland. However that could not dampen our spirits.'

What has winning the grant meant to you personally?

'It was an enormous boost. All of a sudden I found myself lunching with the chancellor. And to a certain extent you enjoy an instant international reputation. As well as a lot of money you also gain a lot of prestige. Doubts about my qualities as a researcher will always remain, but these have now become a lot less.' 📧

'I realised that I had landed in the middle of the future crème de la crème of European science'



Part 12 in the series 'Close up' in which the spotlight is put on the person behind the science.



This year, Titia Sixma obtained an Advanced Grant from the European Research Council for her research into the structure and function of ubiquitin, a protein that transmits signals which determine what happens in or with a cell. By describing these processes in detail, she hopes to understand how ubiquitin works and how it could possibly be used to develop new treatments against cancer. Sixma received an award of 2.3 million euro. With this, three PhDs, two postdocs and a technician can be appointed over the next five years to study the attachment of ubiquitin.

How did you decide to submit a proposal for this prestigious grant?

'I took a good look at the list of people who have received an Advanced Grant in recent years and considered if I would be good enough to justify the effort of submitting a proposal. However, I realised that not all outstanding scientists take the time to write such a proposal. The award rate is therefore quite high: sixteen percent. Apart from your research proposal you are evaluated on the basis of your track record over the past 10 years. This concerns factors such as publications, citation scores, memberships of committees or the Royal Netherlands Academy of Arts and Sciences – KNAW. In 2000 and 2001, I published several articles that had a lot of impact. These therefore counted this year, but will no longer count next year. So I thought: it's now or never; let's get moving.'

Did it take you long to write to the proposal?

'It had to be ready in May and I started writing round about the Christmas of the year before. Of course I was not continuously writing, but I spent a lot of time thinking about it and discussing my ideas with others. At the Netherlands Cancer Institute,

where I work, it is common practice to allow colleagues to read and give feedback on draft proposals. That process helped me enormously. Another factor that helped me is that I had decided to devote all my attention to my group in this period and not to be available for juries, committee work and other similar activities.'

What does a convincing proposal for an Advanced Grant look like?

'You must choose a subject that is innovative and which also seeks an answer to a big question. Furthermore, it must tie in with your current work and you must be motivated to commit several years to the subject. It took me quite a bit of time and racking my brains to come up with a suitable subject. Writing such a personal proposal forces you to rise above your everyday work and to think about what the next logical step is for your research: how can different individual lines of work be pulled together and what do you want to do in five years time? That in itself is an extremely useful and inspiring exercise.'

And how can you show that you are a very good scientist?

'Show what you have done and discovered. The trick is to blow your own trumpet without becoming annoying.'

What happens during the rest of the procedure once you have submitted your proposal?

'Your proposal is sent to referees. Unfortunately, you are not given the opportunity to respond to their comments. The procedures for NWO grants do have such a round and I very much appreciate that. With the ERC it took ages before I heard something and then that was immediately the final result.'

They had said that this would come at the end of November but in the end it was two weeks later. You receive an e-mail and then you must log into a website. I can still see myself sitting at home in the evening, with shaking hands above the keyboard. There were five documents. Only upon reading the third document did I realise that I had obtained a grant. I quickly mailed two colleagues from the Netherlands Cancer Institute, who had also submitted an application. Fortunately, it later turned out that they were amongst the winners as well.'

What did you do to celebrate?

'Here we always round of the week with informal drinks for the entire institute on Friday afternoon. By chance that was the next day and so we treated all colleagues to snacks.' 🍷



'Blow your own trumpet without becoming annoying'

TITIA SIXMA

Titia Sixma (1962) studied chemistry and is group leader at the Netherlands Cancer Institute in Amsterdam. In addition to this she is honorary professor of Structural Biology at Erasmus University Medical Center Rotterdam. Sixma has received various awards including a TALENT and PIONIER grant from NWO. She is a member of the Royal Netherlands Academy of Arts and Sciences – KNAW – and serves on various national and international committees, such as the scientific advisory committee of the European Molecular Biology Lab.



Worldwide science

Scientific issues are rarely limited by national boundaries. Some research projects are only possible as part of international consortia. What does NWO do for science at an international level? And how do researchers benefit from this?

text Sonja Knols illustrations Harry Meijer

‘Conducting research together is the main objective of our international policy.’ Says Jan Karel Koppen, director of Policy Development and Support, succinctly. ‘Issues faced by science now, are not limited to national boundaries. That is why we facilitate the exchange of people and infrastructure between different countries, and why we try to use money and knowledge as efficiently as possible, together with sister organisations, governments and the European Commission.’

Obviously, large-scale equipment such as that at CERN or ITER, are too expensive for a single country to cover the costs. The involvement of several countries in something like that is necessary. Yet Koppen does not only think in terms of large things. ‘Smaller scale research frequently has an international component as well. Take, for example, research into water management. That is not only important for our delta. Other water-rich areas in the world can benefit from the knowledge acquired in the Netherlands. Conversely, we can also learn from the approach that other countries have developed.’

‘We want to build up sustainable research collaborations based on equality from the viewpoint of joint strengths and with a mutual interest’

Sharing knowledge is only one side of the coin. Researchers employed in the Netherlands should not experience any hindrance from national boundaries during their collaboration with qualified colleagues abroad. By strengthening the collaboration, researchers also automatically gain good access to knowledge, sources and equipment that are not available in the Netherlands. And that is no less the case for emerging science countries such as China and India. ‘These countries have fantastic facilities that our researchers can gain enormous benefit from. Moreover, the conditions there give a different perspective on Dutch research. Think once again about water management: the Chinese Yangtze river is an important research object for us with respect to sedimentation. And our Rhine

Delta is in turn highly interesting for the Chinese.’ It is important that we do not act as a ‘Western know it all’ in our relationships with India and China. ‘We want to build up sustainable research collaborations based on equality and joint strengths, and with a mutual interest.’

EUROPE FIRST ‘We have firmly established ourselves within Europe,’ is how Koppen describes the position of NWO. ‘As soon as research policy is mentioned, we sit at the table with the European Commission in an advisory role. For example, our chair, Jos Engelen, together with the Director General Business and Innovation from the Ministry of Economic Affairs, is a member of a workgroup responsible for identifying important societal challenges for Europe. This Joint Programming process will probably serve as input for the forthcoming Eighth Framework Programme (see box). In addition to this we are the leading party for a number of ERA-NETS (see box) and we cooperate on a one-to-one basis with our European sister organisations.’

EUROPEAN INITIATIVES

Framework Programme: The complete package of EU grants for scientific research and technological development. Since 2007, the Seventh Framework Programme has been operational and this will run until 2013. The budget for this is about 50 billion euro. This programme includes initiatives such as the European Technology Platforms, Joint Technology Initiatives, Joint Programming, and ERA Networks. Plans for the Eighth Framework Programme are currently being made.

See: www.senternovem.nl/egl

ERA-NET: Network of national research councils such as NWO focused on a certain theme, with a joint programming, evaluation and funding of research. See the article on page 18 of this *Hypothesis*.

See: ec.europa.eu/research/era

ERC: European Research Council. ‘European NWO’. Has its own budget, made available by the European Union under the Seventh Framework Programme. At present, the ERC is mainly providing grants comparable to the Innovational Research Incentive Scheme: the ERC Starting Independent Researcher Grants and ERC Advanced Investigators Grants. Researchers who wish to submit an application for these can contact NWO and EU Liaison for advice.

See: erc.europa.eu

ESF: European Science Foundation. European network organisation for science. Funds for ESF grants are contributed per programme by participating national research organisations such as NWO. The ESF includes, for example, the EUROCORES, large-scale European partnerships for specific research themes.

See: www.esf.org

NWO AND CHINA

Programme: Cooperation China (NSFC).

Set up: NWO has a memorandum of understanding with the National Natural Science Foundation of China (NSFC) in Beijing. The programme has two parts. The first focuses on promoting contacts. It offers Chinese researchers the possibility of a short stay in the Netherlands and Dutch researchers can go to China. The programme also facilitates joint seminars in China or the Netherlands. The second part focuses on joint research projects in which research teams consisting of Chinese and Dutch researchers can request research funding for several years within a theme. Each year a new theme is chosen. The programme started in 2010 with the theme 'Waterways, Harbours, Estuaries and Coastal Engineering'.

Objective: Facilitating contacts and sustainable collaborations between Dutch and Chinese researchers in the natural sciences.

Budget: 3 million euro from the Netherlands plus matching from China.

Duration: Calls in 2010-2012 (pilot phase).

Programme: Joint Scientific Thematic Research Programme (JSTP).

Set up: JSTP seeks to facilitate the collaboration between Sino-Dutch research teams with the same high ambitions who want to work on joint research projects. This is realised by means of research funding for a period of several years and via calls for proposals that reward complementary expertise between Chinese and Dutch research teams in areas that both China and the Netherlands excel in. Calls shall be published each year and each year a different theme shall be chosen within which multidisciplinary research in both the natural and social sciences can be carried out. In 2010, the theme 'Hybrid Conversion of Biomass' has been chosen. In addition to this JSTP offers the possibility to organise Sino-Dutch thematic dialogue seminars. Seven research funding bodies are collaborating in JSTP, three from the Netherlands and four from China.

Objective: Facilitate sustainable collaborations between researchers in both countries by funding joint research projects and thematic seminars.

Budget: 4.8 million euro from the Netherlands plus matching from China.

Duration: Calls in 2009-2011 (pilot phase).

In addition to this, NWO participates in large collaborative ventures with China. An example is CO-REACH, Co-ordination of Research between Europe and China, coordinated by the Royal Netherlands Academy of Arts and Sciences (KNAW). For an overview of NWO's international activities, see: www.nwo.nl/international

This approach allows NWO to be active in several areas at once, explains Coordinator Policy and External collaboration Cynthia Naus. 'We influence European science policy, develop joint funding instruments with various partners and examine how our own grants can be internationalised.' This last aspect could make it easier for researchers with a Dutch grant to go abroad, or for foreign researchers to come and do research in the Netherlands with Dutch funding. 'And of course NWO takes all of the European developments into

consideration when it formulates its own policy. For example, the new themes in the recently launched NWO strategy have been inspired by research questions that are currently of international interest,' she says in closing.

STRATEGY During the next strategy period, NWO wants to more clearly focus on the world beyond national boundaries. As the ambassador for the quality of Dutch science it wants to ensure a good positioning of the Netherlands in the rest of the world in collaboration with partners such as KNAW (Royal Netherlands Academy of Arts and Sciences), VSNU (Association of Universities in the Netherlands) and the Ministry of Education, Culture and Science. Europe takes a prominent position in this. Investment in personal grants, such as the Innovational Research Incentives Scheme and Rubicon, form an instrument to create an internationally competitive research climate.

'Within the EUROHORCs (EUROpean Heads Of Research Councils) – a body that brings together various European national research organisations – we have drawn up a joint plan to strengthen the so-called European research space. This European strategy takes centre stage in NWO's International policy,' says Naus. The aim of this plan is not only to make collaboration at a national level easier but also to make it easier for individual researchers to find their way within Europe. 'Stimulating the careers of individual researchers is an important line of action,' she emphasises.

This means that it must be easier for Dutch researchers to spend a period working abroad, but equally that the Netherlands must be attractive for foreign researchers. Therefore grants from NWO

are, and shall remain accessible, to researchers from throughout the world, on the condition that the research is carried out in the Netherlands. On top of this, NWO is making every effort to attract large-scale research facilities and strong institutes to the Netherlands, and to keep these here so as to increase the attractiveness of the Netherlands for foreign talent.

EMERGING ECONOMIES Besides Europe, the emerging science nations India and China are also becoming increasingly important partners for Dutch science. 'In the future China and India will be scientific superpowers. The Netherlands needs to build up relations with them as soon as possible,' says Koppen. 'Good researchers from both countries must, for example, know where to find their Dutch counterparts. Therefore at present we are mainly working on the establishment of firm contacts at a national level.' Saskia Matheussen, policy officer who mainly focuses on these countries: 'Together with KNAW and the Ministry of Education, Culture and Science, NWO is acting as the key representative for Dutch science in India and China. That is highly appreciated by the people there.'

However, making contacts is easier said than done. 'In China in particular, science funding is organised in a completely different manner from here,' laughs the NWO staff. 'There is a national research funding body, but the social sciences and humanities fall outside of this,' explains Matheussen. 'Much of the funding is arranged locally, by institutes or individual universities.'

However, in India you have to deal far more with the government. 'There are councils, yet these

NWO AND INDIA

Programme: Cooperation India (DST).

Set up: Together with the Indian Department of Science and Technology (DST) NWO funds Indian-Dutch research projects under an annually changing theme. The themes are chosen on the basis of mutual interest and strengths. The first call opened in 2010 for the theme 'New Medical Devices for Affordable Health'.

Objective: Encourage sustainable research collaboration by funding joint research projects with a certain critical mass.

Budget: 4.5 million euro from the Netherlands plus matching from DST India.

Duration: Calls in 2010, 2011 and 2012 (pilot phase).

Programme: Social Science Collaboration India-Netherlands (SSCIN).

Set up: Together with the ICSSR, the Indian Council of Social Scientific Research, NWO has set up an exchange programme for researchers. This programme focuses on staff from universities or research institutes.

Objective: Encourage partnerships between researchers and their institutes in India and the Netherlands in the area of social scientific research to strengthen the quality and potential of the research in both countries.

Budget: 10,000 euro for visitors to The Netherlands or 500,000 rupees for visitors to India

Duration: From 2008 onwards.

Programme: New INDIGO: Networking Pilot Programme on Biotechnology and Health

Set up: Within the New INDIGO project, NWO is working with research funding bodies from various European countries and India. They are jointly implementing the Networking Pilot Programme aimed at facilitating multilateral networks in the area of Biotechnology and Health. Within a network project, researchers from at least two European countries and India collaborate.

Objective: Collaboration between the Indian scientific community and institutes who seek access to the European research area, and European researchers who seek access to the Indian scientific landscape.

Budget: 50,000 euro per partner within a funded project.

Duration: 2010-2012.

mostly promote the interests of their own institutes. The only overarching body is the government, which operates more remotely.' Nevertheless the first concrete successes have already been achieved with India as well. Matheussen: 'In 2008, we signed a contract with India to spend 1.5 million euro on joint projects. Although it is not a particularly large programme, it is the first time that we have set up something together. And in this case, the monetary value is certainly relative. Normally it would cost an Indian researcher a year's salary to visit the Netherlands.' ❏

Further information: www.nwo.nl/international



Young researchers off into the big wide world

In 2010, NWO has awarded Rubicon grants to 33 young and promising researchers. Dutch researchers who have recently gained a doctorate can use the grant to gain research experience abroad. Foreign researchers can use it to undertake research in the Netherlands.

The majority of the successful candidates have obtained their doctorates in the Netherlands and will go abroad. Most of the young researchers are going to the United States. The United Kingdom is the second most popular destination. Other winners are leaving for Germany, China, Sweden and Belgium.

Three foreign researchers shall use Rubicon to carry out research at a Dutch institution. NWO hopes to attract more foreign researchers to undertake research periods in the Netherlands over the next few years, with a view to stimulating the circulation of knowledge.

The candidates were mainly awarded the grant due to the quality of their research proposal, the quality of the host institute and their quality as a researcher. The feasibility of the research and the mobility of the researcher also played a role in the evaluation.

Dutch institutions offering a year's accommodation to a foreign researcher receive up to 55,000 euro. Dutch researchers spending between 6 months and 2 years abroad receive a payment to defray their expenses, which depends on the destination they choose. NWO makes 1.7 million euro available for each Rubicon funding round.

Further information: www.nwo.nl/rubicon

Canadian tips

In the framework of ERA Instruments, a project within the Seventh Framework Programme, a European delegation has undertaken a study trip to Canada organised by NWO. ERA Instruments is a European network of funding bodies that finance instrumentation for the life sciences. The aim of the network is to exchange knowledge about technological developments and bottlenecks, to promote access to facilities and to improve grant instruments for infrastructure. The European initiative focuses on medium-sized equipment such as NMR scanners, microscopes and mass spectrographs for which investments of between 500,000 and 20 million euro are involved.

During the study trip, Canadian organisations such as Genome Canada, the Natural Sciences and Engineering Research Council of Canada and the Canada Foundation for Innovation



shared their experiences about financing and managing the infrastructure. The European representatives also took the opportunity to view various laboratories. This study trip, together with a later similar trip to China and Japan, has given the partners in ERA Instruments valuable tools for establishing an efficient approach for utilising the bio-instrumentation Europe already has or needs.

Further information: www.era-instruments.eu

Affordable healthcare

Dutch and Indian researchers will collaborate within the programme Medical Devices for Affordable Health. The research must put forward solutions for societal problems in the area of affordable healthcare in both the Netherlands and India. In addition to this, the programme must facilitate Dutch and Indian expertise in the area of medical equipment in five domains: (1) Minimally invasive techniques, (2) Medical optics and acoustics, (3) Medical image processing, (4) High-precision instrumentation, (5) Safe extramural care.

Further information: www.nwo.nl/subsidyguide



First aid for moving researchers

Borders within Europe are becoming increasingly vague. The ERA-MORE network has been set up to make it easier for researchers to move with their family to another European country to do research there. The network consists of 200 Mobility Centres spread across Europe, who provide tailored assistance to researchers and their families who emigrate within Europe. The Mobility Centres provide researchers with advice and support in a wide range of areas. For example, information about grants, vacancies, training, intellectual property rights, visas, accommodation, social security payments, language courses and childcare.

The four Dutch mobility Centres are:

- Nuffic (Netherlands organization for international cooperation in higher education);
- VSNU (Association of Universities in the Netherlands);
- EG-Liaison (the centre of expertise for the European Framework Programme in the Netherlands);
- Tilburg University.

Workshop connects project partners

One of the joint research programmes between the Netherlands and China is the Joint Scientific Thematic Research Programme (JSTP). This programme promotes sustainable collaboration between researchers from both countries by funding joint research projects and thematic seminars. Each year a different theme is chosen. This year the theme is 'Hybrid conversion of biomass'.

A workshop was held at Delft University of Technology to give Dutch and Chinese researchers the opportunity to write a joint proposal. Researchers interested in the call could submit an expression of interest for the workshop in advance. In this statement both intended partners had to briefly describe their ideas. During the workshop the Sino-Dutch research teams introduced themselves. They said who they were, what their research interests and strengths were and what they considered to be a scientific challenge. Discussions with the



other participants produced new insights. The researchers were then given time to incorporate these new insights into the research proposals. The final applications had to be submitted one month after the workshop.

A previous edition of the workshop held last year in Beijing demonstrated that the quality of the research proposals significantly improved if the researchers were given the opportunity to meet each other face to face. NWO therefore intends to use this approach more often.

Further information: www.nwo.nl/jstp

European cooperation with China



CO-REACH (Co-ordination of Research between Europe and China) is a network of 16 European research organisations which realise and finance collaborative programmes with China. CO-REACH receives its funding from the Sixth Framework Programme of the European Commission as an ERA-NET Co-ordination Action. The network improves the coherency and coordination of research collaboration between the EU Member States and China. Within

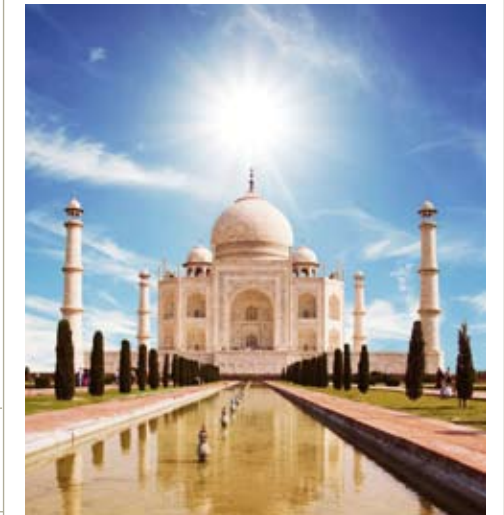
CO-REACH, NWO has set up a programme for the social sciences together with the Chinese Council for Social Sciences. This programme focuses on five thematic priorities within the social sciences and humanities: Demography, Family and Welfare; Cultural Heritage; Law, Governance and Policy Making; Participation, Co-determination, Employment and the Quality of Life; and Labour Market Change, Migration and Social Cohesion.

In each joint research project of the pilot call, which ran until May 2010, at least two researchers or research groups from different European partner countries took part, plus at least one researcher or research group from China. Researchers or research groups from other countries were allowed to participate in the project on the condition that they bore their own costs. Meanwhile the successor, CO-REACH II, has been approved. The negotiations are in full swing.

Further information: www.co-reach.org

New INDIGO

New INDIGO, the Initiative for the Development and Integration of Indian and European Research, is a consortium of European and Indian science and technology organisations involved in promoting research cooperation between Europe and India. In the New INDIGO project, 23 European and Indian partner organisations aim to create coherent synergy in Europe's partnership with India in the area of science, research & technology.



To attain this goal, the programme will identify research hotspots in both Europe and India from the viewpoint of common scientific interests and complementary expertise. Besides this, a call for research projects and their evaluation and follow-up by a committee of highly qualified scientists will pave the way to structuring high-quality collaborative research. Furthermore, sharing experience with other geographic ERA-NETS and comparing their respective outputs will contribute to the strengthening of national and international standards of science and technology programming and programme management. With this, the overall quality of coordinated research projects will improve.

Further information: www.newindigo.eu



Dutch-French research team searches for errors in software

text Sonja Knols
photos CWI, Shutterstock

For the past year, French and Dutch researchers have been working together in Amsterdam on the development of software that can automatically detect errors in computer programs. This is a practical example of international collaboration.

French government funds that are spent in the Netherlands. That would seem to be a utopia. Yet that is exactly what is happening at present in the ATEAMS project at the NWO Institute Center for Mathematics and Computer Science (CWI) in Amsterdam. In the brand new wing of the building on the Science Park Amsterdam, CWI director Jan Karel Lenstra and ATEAMS project leader Paul Klint recount the development of this international collaboration.

'It was a beautiful example of what I term *yo-yo management*', says Klint. 'From top-down it was decided that we would collaborate and from bottom-up the collaboration was realised.' Yet how did that yo-yo gain momentum?

'CWI and the French *Institut National de Recherche en Informatique et en Automatique* (INRIA) have already enjoyed close relations for many years. We both operate in various large consortia such as ERCIM, the European Research Consortium for Informatics and Mathematics. For strategic rea-

'It was a beautiful example of what I term yo-yo management'

sons both institutes wanted to operate at an international level. In view of our mutual relationship, it was obvious that we would seek a partnership with each other at some point. When the current CEO of INRIA received more money than he could spend in his own country, he immediately sought contact with us in order to realise his international ambitions', says Lenstra with a touch of pride.

MASOCHISM Thus far the top-down story. Now it was the researchers' turn. INRIA evaluates new project proposals in a similar manner to NWO. That INRIA director Michel Cosnard was keen to see a project realised with CWI was certainly not enough. 'I had to defend our proposal there in a number of selection rounds and the atmosphere was at times far from pleasant', says Klint. 'After all it was their money which we would "take away" from there.'

Klint laughingly brushes aside the other obstacles he came up against. 'Yep, perhaps you have to be a super masochist to start on something like this. Dutch bureaucracy multiplied by French bureaucracy... Now let's just say that it has provided me with some interesting perspectives on life,' he recalls with a twinkle in his eyes.



ONLY THE BEST In June 2009, the first French researchers from INRIA Nord Europe in Lille set foot on Dutch soil, initially for a period of four years. 'What makes this project so unique is that we have a team that consists of French and Dutch researchers who are physically all working at our institute. And that their research is paid for by both Dutch and French government funds', emphasises Klint once again. Yet aren't the government funds from France only spent on the French researchers? 'No. We have a central project budget, half of which comes from France and half from the Netherlands. If vacancies arise within the project, we can simply take on the best candidates. Nationality does not play any role in this.'

That hiring of new people immediately illustrates a major difference between the French and the Dutch approach, says Klint. 'If a vacancy arises then we are used to initiating a procedure. The French approach is completely different. Within INRIA there are a large number of potential vacancies, many of which are not covered by the budget. A central interview procedure is started for all of

these vacancies and subsequently the budget is only used for the best people. This means that if the vacancy from another project team attracts better candidates, the vacancies on my project will not be filled.' Klint was initially surprised by this approach but now he is quite positive about this type of selection procedure. 'With this approach

Agreement French-Dutch computer science collaboration: ATEAMS. From left to right Paul Klint, Michel Cosnard and Jan Karel Lenstra.

CWI AND INRIA



Both CWI and INRIA are first and foremost research institutes that focus on both mathematics and computer science. INRIA is not organised in the same way as CWI. CWI is a single institute at a single location which employs all of its staff. INRIA has 10 different locations. Furthermore, the institute itself employs 1700 people but reports about the work of 3000 people. This is because INRIA also positions staff at universities to ensure a strong embedding in university research. In that sense the fact that researchers from INRIA are now working at CWI is not particularly unusual. However, this is the first time that INRIA has stationed its personnel abroad. (Photo: the INRIA building in Lille).





you always know that you are definitely taking on the best people. This really is selection on the basis of quality!' Lenstra endorses this. 'At NWO, the quality of the candidate is only the most important selection criterion in the case of the Innovational Research Incentives Scheme and the Spinoza Prize. For nearly every other type of grant the content of the research is the key factor. Perhaps we should consider using the French model more often in the Netherlands.'

GATEWAY TO NEW MARKETS This first project will run until 2013. Ultimately, CWI is hoping for an even more intensive collaboration in the longer

ERRORS IN SOFTWARE

Most modern-day equipment contains software. Not only computers and mobile phones, but also cars, washing machines and coffeemakers contain chips that are directed by lines of programming language. If you were to print out every line of programming language that exists in the world then it is estimated that this would encircle the Earth nine times.


Each program contains a few errors. In some cases it is simply a typing mistake made by a programmer on a bad day. However it usually concerns more complex problems, which are caused by different programmers working on the same program. Each person has their own way of doing things, as a result of which the consistency in the program is lost. At present more than half of all programmers do not work on producing new programs but on rectifying errors in existing software.

ATEAMS is searching for a solution to this problem. The ultimate aim is to produce a computer program that can independently check and rectify errors in other programs. However that is easier said than done, as just like in spoken language, there are many different computer languages some of which even have their own dialects. Errors can come in all different shapes and sizes. And that is the very challenge that computer scientists now face. At an abstract level they are now searching for a common element for all of these errors, so that they can be automatically recognised.

term, which might possibly result in European funding. Indeed even a federative partnership with the French Institute is something that neither Klint nor Lenstra dismiss out of hand. 'Via INRIA we have access to new resources and people. For example, all of a sudden Algerians, Moroccans and other Francophones are applying for jobs here, whereas previously CWI was invisible to them. On top of this, the collaboration provides us with new markets for our results. First of all, INRIA itself is a user of our models, but it also has very good relationships with large French technology companies such as Airbus. In France a "jobs for the boys" mentality prevails. Those in high positions usually

'We're not driven by the money. We simply want to do good research'

know each other via the *Grande Écoles*, a somewhat more elite form of education. It is very difficult for an outsider to get a foot in the door.' In turn, CWI provides its French partner with a wealth of specific knowledge, for example about certain new methods. 'INRIA has a stronger focus on computer science than on mathematics. Here at CWI we are strong in both aspects', say mathematician Lenstra and computer scientist Klint.

What are the success factors for such a collaboration? 'Trust', say both CWI representatives unanimously. 'One reason why Paul has become the project leader of the first joint research project is because for many years he has enjoyed a good relationship with his French counterparts at INRIA,' says Lenstra. 'On top of this both parties must be highly enthusiastic and you must assume that the bureaucracy will eventually adjust itself to the new situation', adds Klint. 'Yet most important of all is that we are kindred spirits. We're not driven by the money but by the content. We simply want to do good research', says Lenstra emphatically. Finally, Klint has another piece of good advice for those who also want to work like this with foreign colleagues: 'Do not think that everybody speaks English.' The fact that Klint can express himself in fluent French has certainly made the entire process much easier, echoes his boss. 

Fleeing fledgling

Hannah Dugdale is a biologist from the University of Oxford (UK). She received a Rubicon grant to come to the University of Groningen and search for the answer to the question why individuals breed cooperatively. As a study object, she focuses on the cooperatively breeding Seychelles warbler. A report on catching fleeing fledglings.

It's my final day in the field and I awake to the sound of waves breaking on the beach next to the research station and sunlight flooding in through the window. There is a cooling breeze on the veranda and I relish the absence of mosquitoes as I plan the day's fieldwork. But while arranging the logistics I turn my back, for one second, on my breakfast and a sneaky skink (a type of lizard) runs off with my apple. Never mind, I'm eager to start work as there is one unringed fledgling that's been avoiding me all field season, and I'm determined to catch her.

I pull on my long-sleeve top, pour on the mosquito repellent and head off to the other side of the island, with mist nets on my shoulder. Walking under the canopy I hear the Seychelles warblers singing. I stop to check a territory and I'm happy to see a newly fledged chick being fed. When I reach the marshland I begin to whistle – straight away

the unringed fledgling flies to a nearby pisonia tree. She's taunting me, singing back to let me know she's there! High above, in the same territory, fly the two adult females: the dominant female and her adult daughter. If I don't catch the fledgling, to collect a small pin-prick of blood, I'll never know which adult female is her mother.

A cloud of mosquitoes follows me as I put up the nets. A whole morning goes by, but nothing, she does not want to go into the net. I watch her flit between trees as she forages on insects on the undersides of leaves. I move the nets into her flight path, but it's as if she knows – she flies past, skimming the top of the nets. I'm beginning to think that I'll never catch her, but then, as I do my final round of net checking I see a little unringed brown bird in the net – it's my elusive Seychelles warbler!

Two months later I'm back in my office in the Netherlands, where I'm fortunate to have a one-year Rubicon fellowship. Office life is much the same as in the UK, interrupted by the delight of discovering stroopwafels (treacle waffles) and the horror of mistaking buttermilk for milk when making tea. My colleagues laugh at this event, but it's a real benefit to be working closely with them in Groningen. I'm handed the genetic data straight from the lab, we discuss the analysis and I quickly run the parentage code. I'm excited to finally have the data, but it's then a long wait as the program runs, and runs, and runs. Who was the mother of that elusive fledgling?

It's three whole days until my computer finally beeps. The analysis is complete. My eyes skim the lines of text, searching for my Seychelles warbler. Suddenly they stop, there she is, but no, she's not the offspring of the dominant female, she's the offspring of the dominant's daughter! Rather than dispersing and battling with other females to gain her own breeding territory, the daughter decided to stay at home and help her mother. The benefit of helping is that occasionally, as with this elusive fledgling, the daughter is able to breed herself. So the mystery is unravelled, and another link in the family tree is established. Now for the next field season to see if the unringed fledgling will stay and help as well.

Doing research is often intensive and tiring but hardly ever boring. Some researchers stare day and night at a computer screen to make an important discovery. Others busy themselves in their laboratories with pipettes and petri dishes in search of new knowledge. A few spend entire nights on a mountain in Chile with their telescopes focused on our boundless universe. Some go underground and creep through dark tunnels in search of our past. However, they all share one thing in common: enthusiasm. Scientific research sometimes leads to unexpected eureka moments. A day in the life of a researcher.



ERA-NET as a lubricant for European cooperation

An open European market, not only for goods and services, but also for the funding of the best research. That appears to be a basic premise for a healthy exchange of knowledge that supports a competitive European economy. And although such an open market is still a long way off, the first steps in this direction have been made.

text Mariette Huisjes illustration Carolyn Ridsdale photos Shutterstock



By definition science crosses borders. No researcher will be put off collaborating with a good research partner because he lives in a different country. Yet systematically working together on a large scale with colleagues from different countries on a single subject is far from easy. As then how on earth can you ever get such a project funded at the same time and under similar conditions, if there are at least a handful of different funding bodies involved, each with their own rules, practices and policy? ERA-NET (European Research Area Networks) is a policy instrument from the European Commission that provides a solution to this problem. It makes grants available, not to researchers but to the national organisations that fund their work. This enables them to set up joint international research projects and to bring together the best researchers in a given discipline.

BIODIVERSA On behalf of the Earth and Life Sciences divisional board of NWO, Dr Jan Dijkhof has been involved in the ERA-NET Biodiversa right from the outset. Biodiversa is a network that seeks to strengthen research into biodiversity in Europe by harmonising existing activities and exploring opportunities for new research. How Biodiversa came into being is typical for how things usually go, says Dijkhof. Three or four organisations take the initiative and invite partners from other countries to join their proposal for an ERA-NET. This gives rise to a sort of follow me effect. A striking aspect of the Biodiversa initiative is that not all of the participating organisations are scientific funding agencies. Environmental policy organisations – such as the environmental ministries from France and the United Kingdom and the environmental agency from Sweden – are also participating. The call that was launched after the network had been approved and the programme finalised, therefore requested research proposals that were not only scientifically challenging but also relevant for biodiversity policy. For example, research into a dangerous virus that threatens European amphibians. In South America this virus has already caused the extinction of various species, and it is now starting to enter Europe. Thanks to support from Biodiversa, an international team of experts can carefully monitor its prevalence and immediately eradicate it where it emerges. In this manner, the best scientists from throughout Europe search for solutions to real problems, based on the latest scientific insights. That inspi-

res everyone involved. ‘The preservation of biodiversity is ideally suited to such an approach’, believes Dijkhof. ‘It is a good example of an urgent issue which is no respecter of national boundaries. Comparable problems are air pollution, climate change or marine research. For subjects like these, being able to carry out coherent comparative research that covers the entire of Europe is extremely useful.’

A striking aspect of the Biodiversa initiative is that not all of the participating organisations are scientific funding agencies

In total, 18 organisations from 14 different countries are now taking part in Biodiversa. Would it have been possible for them to have worked together without the support from Brussels? Dijkhof does not think so. ‘Many consultations are needed to get so many organisations to agree on a common line. Those two or three million euro from Brussels ensure that nobody needs to go begging to their directorate for funds to cover the travel and meeting costs. Partners from Central and Eastern Europe might not have been able to participate without these funds, whereas these countries have a lot of good researchers as well. I certainly think

ERA-NET

Aim With the European Research Area Network (ERA-NET) the European Union wants to harmonise the various national research programmes and allow researchers within a certain discipline to collaborate with each other. ERA-NET must counteract the fragmentation of European research and enhance its quality.

Approach This instrument was deployed by the European Commission at the start of the Sixth Framework Programme (FP6) in 2002 and was continued in the Seventh Framework Programme (FP7), which started in 2007. An ERA-NET is a transnational network of research funding agencies focused on a certain theme. The European Commission makes money available, which administrators can use to travel and hold meetings. By doing this they smooth the way for a joint procedure in which research proposals can be called for and evaluated. In FP7 the ERA Networks are linked to the thematic priorities of the EU. Brussels determines the subjects for which proposals can be submitted.

Numbers There are now about 70 ERA Networks, and these cover subjects varying from astronomy to aging and nanoscience to changing European culture. NWO participates in 15 networks and coordinates 4 of these.

Budget No separate funds for ERA Networks were earmarked in FP7 but a budget was set per theme dependent on the demand for this type of cooperation.

Further information: www.cordis.europa.eu



that this support is necessary in the start-up phase, as a sort of lubricant to get the collaboration going.'

TEETHING PROBLEMS Although Brussels pays for the costs associated with setting up an ERA-NET, the research itself is financed by the funding agencies. Many teething problems still remain in this respect. The call for proposals is transnational, the proposals are submitted by transnational partnerships, and the evaluation and prioritisation of the proposals is in the hands of a transnational committee. And then? If the network has a so-called virtual common pot, the funding takes place nationally. Therefore each researcher is paid by a funding agency in his own country. This can mean that a proposal that ranked third or fourth is not funded, even if the selection committee considers it to be both good and important. After all, if the funding organisation one of the depends upon has reached the limit of its budget, then the project cannot go ahead. Consequently, many of the parties involved would prefer



to see a real common pot being worked with. In that case the research funding would also be transnational: all of the participating organisations would make their budget available for funding the best research proposals. And that would also be the case if it meant that money from a French taxpayer ended up funding a Danish researcher or vice versa. Several ERA Networks have managed to realise such a real common pot but the idea usually meets with opposition from national governments or even legal impossibilities.

REAL COMMON POT Dr Coenraad Krijger, who on behalf of NWO Earth and Life Sciences has been involved in the management of Biodiversa since its inception, hopes and foresees that the European research field will slowly but surely become free of barriers. 'NWO is a major proponent of and leading party for international cooperation and of providing focus and mass in research areas. Unlike many other organisations, we are also prepared to participate in ERA Networks where we are required to transfer our budget into a real common pot. Science has no boundaries; the money should follow the quality. It really is that

'Science has no boundaries; the money should follow the quality'

simple. In the Netherlands some scientists also view transnational funding with a certain amount of trepidation. There is already so little money for research and the idea that some of this might even disappear over the border alarms them. However, the majority of researchers also see the added value and the possibilities that consolidating funds can offer, certainly in the longer term. I am convinced that transnational research funding holds the future. It is good for European research and accordingly for Dutch science as well.

FIRST STEP Krijger sees the ERA Networks as forerunners. They have demonstrated that although transnational collaboration requires a considerable administrative investment, it is both possible and fertile. 'I see that the experience in international collaboration, that has partly been acquired with the ERA Networks, is slowly but surely becoming embedded at the institutional level. People now know the foreign partners and are more inclined to pick up the telephone and contact them, and to do this outside the official networks as well. Ultimately, ERA-NET will make itself redundant. Undoubtedly an awful lot still needs to happen before we have a generally open research market and the funding can genuinely go to the best in science. Nevertheless, the ERA Networks are a successful first step towards a strong Europe with a healthy exchange of knowledge.' 

Water in the street

Shortly after the opening of the World Expo 2010 in Shanghai, NWO and KNAW jointly organised a meeting about water research in the Dutch part of Happy Street on behalf of the Ministry of Education, Culture and Science. With this initiative they wanted to showcase Dutch water research and demonstrate what the collaboration between China and the Netherlands has already yielded in this area. NWO employee Saskia Matheussen was there.

text Sonja Knols photos Holland Expo



During the lunch, a Chinese researcher who gained his PhD in the Netherlands bumps into his former Dutch roommate

SUNDAY 2 MAY

Straight from the airport we are driven to a lunch-time meeting with Chinese researchers who gained their doctorates in the Netherlands. They tell us about how they experienced their time in our country. Without exception they value their Dutch training and the contacts they established during this period. What surprises me most is that even the people who left science after gaining their doctorates still regularly speak with their former Dutch scientific colleagues.

In the evening we take a boat across the Huangpu River that winds its way straight through Shanghai. On the boat we meet the Dutch scientists who shall present their research tomorrow.

MONDAY 3 MAY

Today is the day of the meeting. I am pleasantly surprised by the quality of the research and the considerable enthusiasm of the people, but most of all by the fact that there are far more contacts between the two countries than you might initially think. For example, during the lunch, a Chinese researcher who gained his PhD in the Netherlands bumps into his former Dutch roommate. Now what's the chance of that?


The meeting is a great success. Those present are not only impressed by the knowledge that both countries have built up about water management, but in particular everyone realises that collaboration in this area is vitally important. New contacts are made and the Netherlands makes a very good impression on its Chinese colleagues. In

particular, the special VIP programme we hold in the evening for our Chinese funding partners is highly appreciated by the eminent guests.

TUESDAY 4 MAY

Today we first of all hold discussions with a delegation from the Chinese government about the reforms in Chinese higher education. International cooperation is high on the Chinese agenda. Not only must Chinese researchers go abroad, but the Chinese authorities would also like more foreign researchers to come and do research in China. This fits in perfectly with the ideas that the Netherlands has in this area.

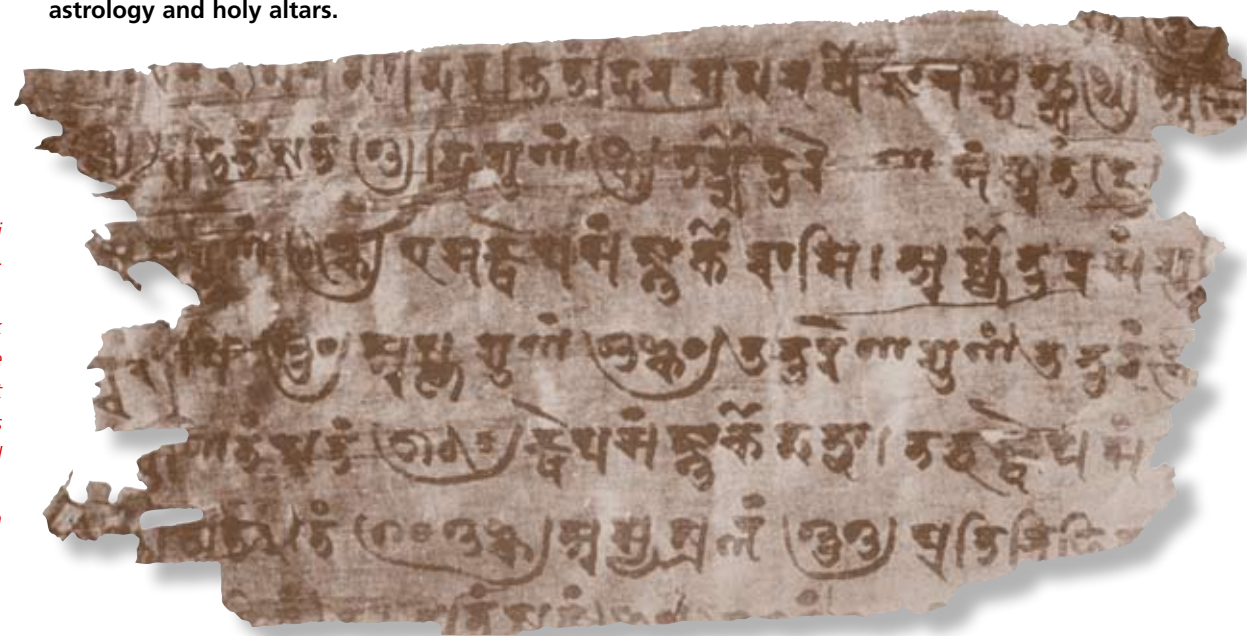
In the afternoon we visit the East China Normal University. In view of the theme of our trip we take a look at the State Key Lab of Estuarine and Coastal Research. I am impressed by the fantastic facilities and the quality of the research. Furthermore, this lab also proves to have strong connections with Dutch research groups. We close our three-day visit with a roundtable discussion with several large companies. The Chief Technology Officers of ASML, Akzo Nobel, Philips and Unilever join us to talk about the opportunities that China offers the Netherlands in the area of research and development.

Tomorrow we will once again leave this magnificent country. I have not seen a lot of the World Expo. In August I will get another chance when we return to set up a joint health research programme with the Chinese. 

Sanskrit verses in praise of mathematics

text Bennie Mols
illustrations Jan Hogendijk

The book *Mathematics in India* is the first publication to place traditional Indian mathematics completely within the cultural context of calendar problems, astrology and holy altars.



Part of the Bakhshali Manuscript (8th-12th century), excavated in Peshawar, Pakistan. This birch bark manuscript contains the oldest surviving document in which decimal numbers are used in a mathematical calculation. Copyright: Egbert Forsten Groningen, 1995.

The wise king whose army has been defeated, gathers the best advisers around him and remains firm in everything; then he will defeat the king whose army has not yet been destroyed.' No, this is not the start of a Greek or Roman epic. These are the opening words of an Indian poem that describes a mathematical calculation. It praises how you can calculate the sine of an angle, in modern mathematics known as the ratio between the length of the opposite side to the length of the hypotenuse. The poem was written in 15th century India in Sanskrit, the holy language of the Indians. Long before Western mathematicians discovered this, the Indians knew that you could express the sine of an angle as an infinitely long summation of increasingly smaller terms. In letters, the poem encodes five complex numbers that you need to approximate the sine by means of such a summation.

'We consider our Western form of mathematics to be self-evident, yet it is not', says Jan Hogendijk, professor of the history of mathematics at Utrecht University. And the Indian verses illustrate that beautifully. 'The Indians had a strong oral tradition. The verses are easy to remember, far easier than a series of complex numbers, for example. They were passed on from master to pupil. Mathematical verses deal with mathematical problems in a completely different way than we have learned at school. The traditional Indian mathematics was more associative than our mathematics. It did not know the formal form of "you advance a thesis that you subsequently prove" with which the ancient Greeks have completely imbued Western mathematics.'

RITUALS Yet even if you can read Sanskrit, how do you recognise such a verse as mathematics? This not only requires you to have a considerable



knowledge of Sanskrit, you also need to know a lot about Indian cultural history and mathematics. The American mathematician and Indologist Kim Plofker has exactly that academic background. Hogendijk therefore asked her to write a synthesis of the existing literature and her own research into Sanskrit texts, as part of the NWO MATHINDI project which ran from 2004 to 2006. The project resulted in the substantial academic volume *Mathematics in India*, which is internationally considered to be an important addition to the predominantly Eurocentric description of the history of mathematics.

'Verses are easy to remember, far easier than a series of complex numbers, for example'

Plofker studied the period 500 BC to 1800 AD. 'Until recently almost everything written about Indian mathematics in this period', says Hogendijk, 'revealed which mathematics was used, but scarcely described in which cultural context. Plofker, however, has studied Indian mathematics in its complete cultural context.' This context was mostly determined by astronomy. For example, the Indians had to calculate when in the calendar year the correct moment had dawned for the performance of religious rituals. They also used mathematics in astrology, in order to say something about earthly life based on the movements of the planets. And in the design of holy altars with complex geometric patterns they needed a good understanding of geometry. The most important Indian contribution to mathematics is the decimal system. Everybody in the world encounters it on a daily basis. Hogendijk: 'We blindly express numbers in combinations of the ten symbols 0 to 9. The Indians introduced this

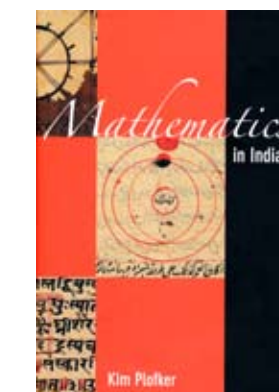
convenient system between 0 and 500 AD. Decimal systems had indeed been used earlier, but always with other symbols for the tens and not combinations of the symbols 0 to 9 as in 10 and 20, for example. Ultimately, the Indian system demonstrated its practical superiority compared to all other systems. However, that did not become clear until the 15th century in Italy.'

The second important contribution of Indian mathematics from this period is the use of the sine and cosine. These terms play a vital role in the mathematics of triangulation measurements. The Indians elevated poetic expressions of sine and cosine calculations into an art form.

MATHEMATICS FOR FUN

Plofker's study also reveals that the Indians undertook mathematical problems purely for fun even if the problem had no known application. Hogendijk: 'A famous example is the puzzle of finding two quadrants, which we would now refer to as x^2 and y^2 , such that "61 times one quadrant plus one is equal to the other quadrant": $61x^2 + 1 = y^2$. In the 12th century, Bhaskara discovered the solution with an ingenious method: $x = 226,153,980$ and $y = 1,766,319,049$. This turned out to be the smallest solution that consists of whole numbers.' Finally, Plofker also studied the influence that Indian mathematics has had on Arabic mathematics. Hogendijk: 'Indian mathematics came into the Arabic world via exchanges with Iran. For example, the Arabs adopted the decimal system of the Indians. They then created their own mixture of Greek and Indian mathematics. For example, the Indians had a method for calculating the area of a square for which the corners could be precisely surrounded by a circle. This method was also explained in poetic form. Yet the Arabs preferred the formal culture of "thesis-proof" that they knew from the Greeks. They therefore came up with a brilliant formal proof for this Indian method.' After 1800, the British rule over India exerted such a great influence that traditional Indian mathematics was slowly replaced by the more formal Western mathematics. Without teachers to explain how you should read the mathematical verses, the tradition was doomed to die. Plofker's study has vastly increased our understanding of traditional Indian mathematics, has unmasked myths about the uniqueness and superiority of several Indian mathematical contributions, and above all it has shown how deeply rooted mathematics can be in the culture of a region. ■

Left: page from the Arabian manuscript Leiden, Or. 168 (11th century). This is one of the oldest surviving documents from the Islamic world in which use is made of the decimal system.



Mathematics in India, Kim Plofker. Princeton University Press (2009)



The Innovational Research Incentives Scheme gives talented, creative researchers in different phases of their scientific career the opportunity to conduct their own research programme independently.

The hidden structure of language

Language is the key to international cooperation. Can we improve translation machines by allowing them to use past experience in roughly the same way as a human translator does? Vidi researcher Dr Khalil Sima'an thinks we can.

Of course you can look for rules to describe the structure of individual sentences. 'Yet the human use of language cannot be captured in rules', says Sima'an, who works at the University of Amsterdam. 'Language use depends on the place, time and community. Cultural influences and the interaction between users

'The human use of language cannot be captured in rules'

ensure a continuous stream of new words and constructions.' In his research, Sima'an hypothesises that language is not at

all bound by stringent rules but rather that the latent structure of sentences depends on the type of language use. Language processing is largely based on experience. A human translator searches within the expertise stored in his head for the correct translation in a certain context. For example, a good translator of Dutch knows that in Amsterdam people often use the word "them" instead of "they",

but still translates this correctly. Can a translation machine do that as well? Sima'an is working with his colleagues on experience-based models that expose hidden structures in language. At the same time his group is collaborating with RWTH Aachen University on uniting syntax, morphology and structures in a new translation model.

The new translation machine is being tested in practice by training it with real texts, some of which come from meetings of the European Union. Within a single language pair, the translation machine searches for the hidden structure that forms a bridge between two languages. Sima'an: 'A sort of fingerprint of the translator arises in the form of a stored experience in the translation machine.'

In his room at the new Amsterdam Science Park, Sima'an grins when he shows just how big a mess Google Translate can make when you enter somewhat longer sentences. A PhD student has made a breakthrough in this area under the partial supervision of Sima'an. By adding syntactic structure, the researcher has improved the accuracy of the translation that a machine like Google Translate can deliver.

Although Sima'an visibly takes pleasure in that result, it is not what drives him most. 'As a scientist you are interested in far more than the immediate outcome. I want to find out how humans are capable of storing experiences and discovering regularities in data.'