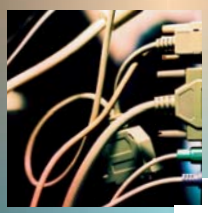
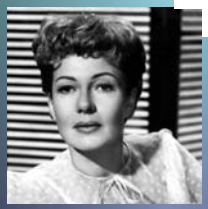
NEWS FROM THE RESEARCH COUNCIL OF NORWAY AUTUMN 2003 VOL. 10

TELL'US
SCIENCE IN NORWAY





GEOLOGICAL PHENOMENA, ICT, ALZHEIMER'S ENIGMA AND SPECIAL DIETS FOR FISH ARE AMONG THE RESEARCH TOPICS BEING EXPLORED BY NORWAY'S NEW CENTRES OF EXCELLENCE.

The Research Council of Norway

TELL' US
SCIENCE IN NORWAY

THE NORWEGIAN CENTRES OF EXCELLENCE

Bjerknes Centre for Climate Research
www.bjerknes.uib.no/

Centre for Quantifiable Quality of Service in Communication Systems
www.ntnu.no/Q2S/

International Centre for Geohazards
www.geohazards.no/

Aquaculture Protein Centre
www.nlh.no/apc/

Centre for the Study of Civil War
www.prio.no/cscw/

Centre for the Biology of Memory
www.cbm.ntnu.no/

Center for Advanced Study in Theoretical Linguistics
uit.no/castl/

Centre for Ships and Ocean Structures
www.cesos.ntnu.no/

Centre for Molecular Biology and Neuroscience
www.cmbn.no/

Physics of Geological Processes
www.fys.uio.no/pgp

Centre for Integrated Petroleum Research
www.uib.no/cipr/

Centre of Mathematics for Applications
www.cma.uio.no/

Centre for Medieval Studies
www.uib.no/cms/

AUTUMN 2003 VOL. 10

The Research Council of Norway

The Research Council of Norway has initiated a Centres of Excellence (CoE, in Norwegian SFF) scheme. The scheme entails that outstanding research groups, operating under co-ordinated management and research plans, will receive long-term funding to engage in world-class basic research. The CoEs will receive annual grants from the Research Council averaging MNOK 10 to 20 for a maximum of ten years, based on host institution pledges to cover a considerable proportion of the CoEs' expenditures. Moreover, the CoEs are free to raise funding from other sources.

Norway has established 13 Centres of Excellence thus far. Read about them on the following pages.

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The Research Council of Norway is the country's central organisation for the funding of basic and applied research in all disciplines, and for advising the Government on research policy matters. As a strategic body, the Research Council identifies target areas, evaluates research and promotes innovation in industry and the public sector. One important goal is to raise the general public's awareness and understanding of research.

Apropos

In this issue of *Tell'Us* we have presented Norway's 13 Centres of Excellence (CoEs). By nature, research involves communication between researchers at the national and international levels. This is also vital to ensure communication and information that capture the interest and attention of the general public.

On the one hand, projects and methods have a natural position in the public debate. On the other, research results produced by the institutions must actually reach other researchers and society-at-large to be of use to them. The sharing of knowledge across sectors and national frontiers is among the Research Council's ideals.

Paal Alme (Photo: Eva Brænd)

Paal Alme
Executive Director
Public Relations and Information

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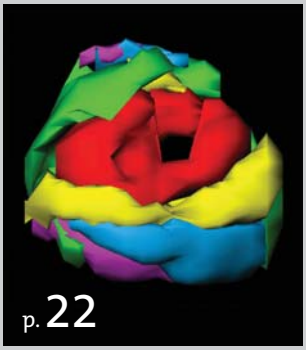

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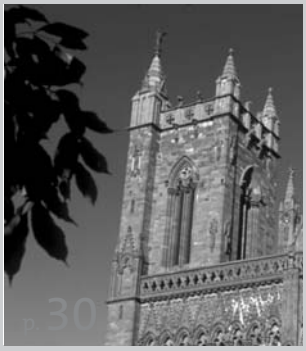

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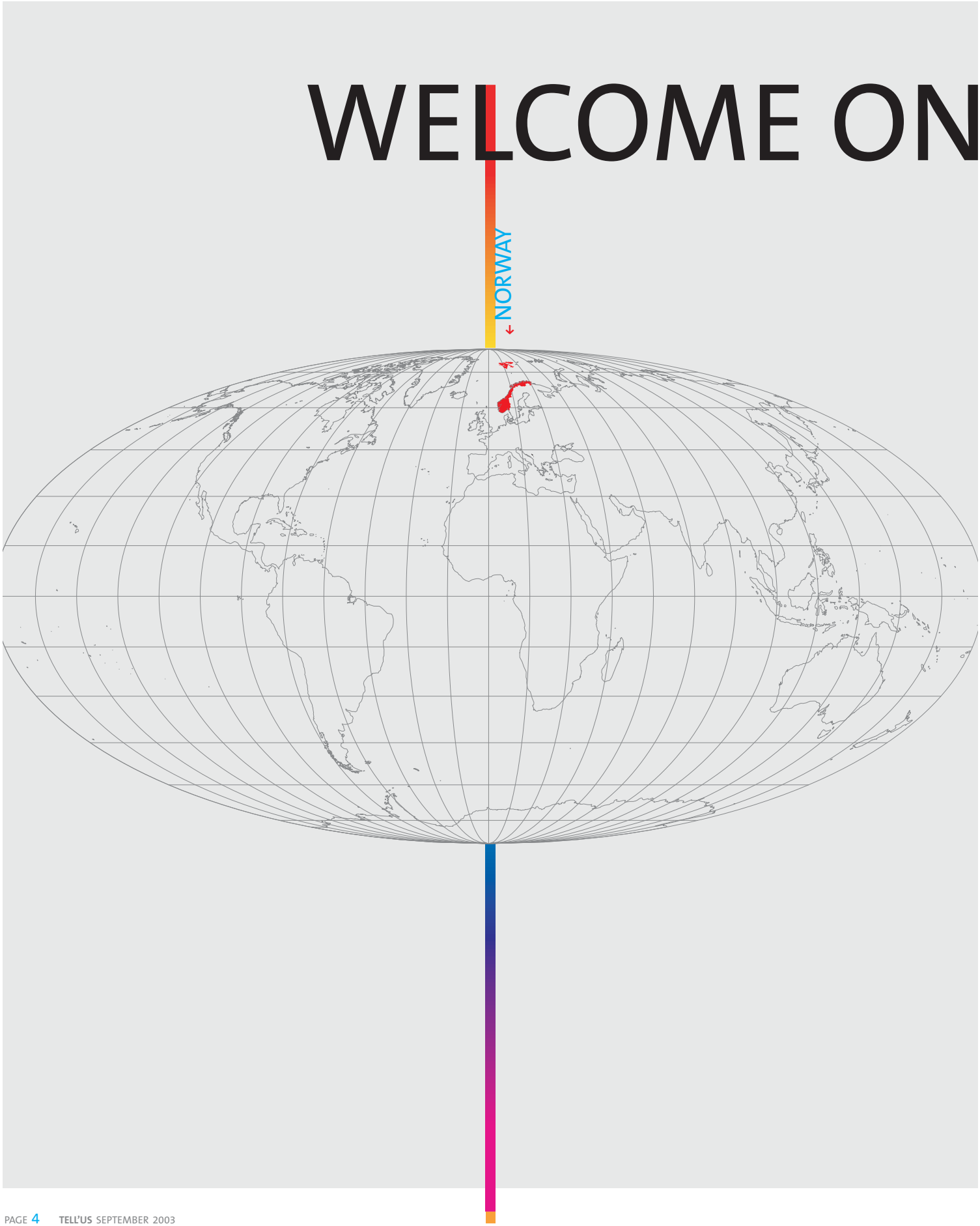
Norges **forskningsråd**
The Research Council of Norway

WELCOME ON



A JOURNEY
through the world of outstanding international research


Mona G. Rygh (Photo: Eva Brænd)

THIS EDITION OF *TELL'US* IS A SPECIAL ISSUE devoted to Norway's 13 Centres of Excellence (CoEs). It contains reports on research projects at the highest level, revolving around subjects ranging from civil war and linguistic development to brain cells and oil reservoirs.

About a year has passed since the Research Council of Norway introduced the hand-picked centres. The CoE scheme gives outstanding research groups with sufficiently good research plans the opportunity to devote themselves fully and completely to basic research of international calibre.

Research is inherently international, and one significant aspect of the CoEs' activities is their extensive collaboration far beyond the boundaries of Norway. Several of the centres also have international experts on their staffs.

The Research Council has great expectations of the scheme, which was established following extensive research policy debates and a comprehensive selection process. Read about the history of the Norwegian CoE sheme at the back of the magazine. In the same section, Norway's Minister of Research offers some reflections on the importance of promoting the very best research.

The CoEs are brimming with knowledge, enthusiasm and exciting research on topics that really whet the Editorial Board's curiosity. All the *Tell'Us* reporters had to do was to sharpen their pencils and decide where to start. The problem was deciding where to stop!

We hope the reports will take you on an amazing journey and provide a bit of useful knowledge in the process. □

Mona Gravningen Rygh
Editor

→ **RIDING A WAVE:** The entire group feels we are riding "The wave", says CoE Director Eystein Jansen. 'Team Bjerknes' is concentrating on the ocean's impact on climatic change. (Photo: Getty Images)

OUR UNCERTAIN FUTURE – "WEATHER" OR NOT WE ARE PREPARED FOR IT

'To become one of the world leaders in climate research.' That is the objective set by a number of Norway's most prominent climate researchers who have now joined forces under the same roof in Bergen, a city famous for its many rainy days. Among other things, they will be exploring the oceans' impact on climatic change.

[BY BÅRD AMUNDSEN]

THE GROUP'S VERY NAME implies high standards. 'The Bjerknes Centre for Climate Research' is named after Vilhelm Bjerknes, the physicist who was founding director of the Bergen School of Meteorology and thus paved the way for virtually all modern-day weather forecasting the world over. For nearly a century, Bjerknes has been one of the few Norwegian scientists with a truly international reputation. The centre's name is also a tribute to his son and colleague Jacob Bjerknes, long-standing head of the Weather Forecasting Service in Western Norway and a pioneer in research on climatic phenomena such as El Niño.

"The name definitely obligates us to set out sights high", confirms CoE Director Eystein Jansen. "Thus far, we have assembled several of Bergen's climate research communities into a single large group. Although CoE funding will probably constitute no more than one-half to one-third of our total budget, it is this money that will enable us to co-ordinate and focus our research. Now we are in a position to initiate exciting new projects we could not otherwise have addressed. This is what can make us world class."

Deep ocean currents and ice

The Bjerknes Centre will employ about 40 researchers. Combining the skills of physicists, geophysicists, mathematicians, geologists, computer experts, biologists and several other specialty groups under the same roof has been important for Jansen, himself from the Department of Earth Science at the University of Bergen, as well as for his colleagues Peter Haugan from the Geophysical Institute at the same university, Harald Loeng from the Institute of Marine Research and Helge Drange from the Nansen Environmental and Remote Sensing Center (NERSC).

The researchers currently being assembled can look back on some major discoveries in recent years. Several of them have created quite a stir. For example, members of the group contend they have found clear indications that the deep ocean currents of the North Atlantic are in the process of weakening. Another discovery is that the ice in the Arctic Sea has decreased by 10 per cent over the past 30 years.

Re-thinking the ocean

'Team Bjerknes' will be concentrating on the ocean in particular because they are convinced there is a connection between changes in ocean currents and fluctuations in weather and climate.

"The climate models devised thus far have largely concentrated on the atmosphere", explains Loeng. "Here at the Bjerknes Centre, we want to involve the ocean in a way no one has ever done before. In our opinion, many of the greatest challenges in climate research are related to the ocean and ocean currents. In distinct contrast to the atmospheric system, the ocean is a sluggish system. The two systems – the ocean and the atmosphere – are totally different, but obviously impact each other. The Gulf Stream will be one of the main focuses of our research."

Unanswered questions

Bjerknes researchers will seek answers to several unanswered questions in the field of climate research. For example: Do processes in the tropics cause climatic changes at northerly latitudes, in north-western Europe, for instance? Or is it the other way round? There is currently considerable disagreement among international researchers on this issue. Another pressing question involves the extent to which human beings actually influence the climate.

Vilhelm Bjerknes

In the early 1900s, Norwegian Vilhelm Bjerknes advocated putting the variables associated with predicting the weather into an exact mathematical-physical equation. It was in 1917, after the outbreak of World War I, that Bjerknes left his job as head of the Department of Geophysics in Leipzig to accept a chair in Bergen. Along with colleagues, he founded the 'Bergen School', paving the way for Bergen methods in meteorology. These methods gradually became accepted and used all over the world. Before the Bergen School, weather forecasting was mainly based on studies of the distribution of air pressure, but the new model emphasised the physical qualities of the air, especially its temperature and humidity. Bjerknes explained the predominant low-pressure fronts formed at our northerly latitudes as wave-like developments along zones with sharp temperature contrasts. The term Arctic front became a key concept. Through a growing network of observation sites connected by telegraph, it was possible to identify what Bjerknes called 'furrows in the face of the weather'. Early on, Vilhelm Bjerknes advocated 'calculating the weather', the way we do today. Modern-day weather forecasting is largely based on huge equations and tremendous computing power. □

← A METHODOLOGIST: Vilhelm Bjerknes (1862–1951) worked at institutions in several countries, but it was as a professor of geophysics in Bergen that he developed the methods that laid much of the foundation for modern-day weather forecasting. (Painting: Rolf Groven: Portrait of Vilhelm Bjerknes (1983). © Rolf Groven/ BONO 2002. Photo: © Geophysical Institute, University of Bergen)

Researchers in Bergen have already carved out reputations as some of the most prominent names in paleoclimatology, i.e. past climatic change. They have found evidence that there have been natural climatic changes of great magnitude over the past 10 000 years, long before man began to influence nature.

The Nansen Environmental and Remote Sensing Center and the Geophysical Institute have collaborated to develop a new, global climate model they call the 'Bergen Climate Model' (BCM). It has taken six researchers three years of effort to develop the model. Having boosted climate researchers in Bergen into the international limelight, the BCM is about to lead to some exciting results.

"Neither of the groups co-operating on the BCM would ever have managed anything like this on its own", observes Drange.

Long-term funding

"Long-term funding for research, like the CoE funding, is exactly the type of support we need to go after the big, important discoveries in a discipline like ours", says Jansen. He and his colleagues see their main objective as devising a system for forecasting climate change comparable to the system for forecasting weather that Vilhelm Bjerknes established in the early decades of the 1900s. In many ways, Bjerknes' vision for weather forecasting is directly related to the vision the Bjerknes scientists of today have for dramatically improving climate research.

Jansen, Haugan, Loeng and Drange report that there is great enthusiasm among the Bergen-based climate researchers involved in the project. "We view our CoE status as confirmation that we are moving in the right direction, and that what we have accomplished thus far is only the beginning of something far greater. The entire group feels we are riding a wave", smiles the CoE Director. □

Bjerknes Centre for Climate Research

Objective: The Centre aspires to be a leading international centre for research on climatic change.
Participants: The University of Bergen is the lead institution. The Institute of Marine Research and the Nansen Environmental and Remote Sensing Center are active participants.
Annual allocation from the Research Council: MNOK 17
Number of full-time positions: Approx. 50
Contact: Professor Eystein Jansen, Tel.: (+47) 555-83491, E-mail: eystein.jansen@geo.uib.no
Website: www.bjerknes.uib.no, Bergen climate model: www.bcm.uib.no

↑ **CoE DIRECTOR:** Eystein Jansen (Photo: Bård Amundsen)

HELPING TELECOMS MEASURE UP

Telephone services used to be few in number and simple, but dependable. Today's services, involving mobile phones and the Internet, are far more diverse, but vary considerably in terms of quality. These services are vital in a modern society, but how good are they really in terms of technology and quality of service? Are they good enough?

[BY MENTZ INDERGAARD AND GJARNE RØSJØ]

↑ **NO MORE PROBLEMS:** The quality of Internet and telecom services may improve in future. There is and will be an immense need for objective quality criteria to describe security, dependability and accessibility. (Photo: Stockbyte)

Packet switching

The Centre for Quantifiable Quality of Service in Communication Systems will concentrate on the Internet and other packet switching networks. These networks are characterised by the fact that all data, be it sound, images or text and figures, is transferred as series of "packets" carrying digitised information.

For example, an E-mail message with an attachment is divided into packages that are sent to the recipient separately. The packets are labelled so the recipient can put them in the right order in the event any of them get shuffled about along the way. All this is supposed to happen without users even noticing. The packets are transmitted through electrical cables, optical cables and/or radio lines that can be compared with roads, and they must pass a number of Internet hubs that correspond to intersections.

If there is a lot of traffic or there are access problems due to errors in some part of the Internet, it is possible to route the packets differently. If many users have to share the same traffic resources, delays arise, and hubs sometimes discard packages which must then be re-transmitted. Established international protocols contain detailed instructions regarding how the elements in a network should behave. While packet switching is an outstanding technique for a number of Internet services, it presents a challenge for services such as streaming sound and video. □

PROBLEMS WITH ICT? *The Centre for Quantifiable Quality of Service in Communication Systems* will be researching the quality of communications services and determining how to measure quality of service.

Modern-day communications services, from telephony and e-commerce to submitting tax returns, streaming video and searching databases, are expanding rapidly in terms of type and volume. We use the digital network arena to retrieve and provide information, to be entertained and to entertain, and to provide and receive services. Our needs span the range from insignificant to vital, from strictly confidential to fully public.

User perception and Quality of Service

Quality of Service is related to users' needs and expectations. It is easy to identify poor speech quality in a phone conversation, flickering and poor picture quality on a TV screen, the length of time needed to connect to the Internet or a long wait to retrieve data from a web server. On the other hand, it is difficult to quantify the exact quality of a speech connection or a video transmission, and how can we distinguish between serious E-mail and spam quickly and conveniently? Can we be certain the E-mails we send actually reach the designated recipient? The availability and dependability of digital services are even more problematic. Can we rely on access to our E-mail accounts so we can read our messages? Can we count on completing a phone conversation? The CoE's task is to produce new knowledge and train personnel that can assess the quality of such services in the broad sense.

New technology and new opportunities

Packet switching (see separate box) and new technical solutions such as optical networks offer tremendous transmission capacity. The technical foundation has been laid so that most communications services that appeal to large user groups can be offered on the basis of packet switching.

Technical solutions are often designed very differently, despite the fact that they perform the same functions. E-mail from Norway to Australia is routed via many different co-operating Internet providers equipped with vastly different technical solutions. This is because the systems have been expanded gradually, based on different technologies and levels of investment. Their quality depends on the investments made on the basis of assessments of customers' needs and their willingness to pay.

The quality of technical solutions

A digital communications network hub is extremely complex *per se*. A network featuring numerous hubs entails a mind-boggling level of complexity. Accordingly, it is quite a challenge to evaluate and measure the total Quality of Service. Account has to be taken of errors in the systems, different types of threats to security and dependability, and last but not least, the typical user's behaviour when using the system. As a technology, packet switching is an especially challenging way to ensure the perceived quality of sound and video, while also offering opportunities to provide new services. The CoE's research will include studies based on mathematical models, laboratory experiments and measurements in authentic systems.

One of the centre's partners, UNINETT, has long experience of operating data communications networks. The CoE will be using the most modern parts of the network run by UNINETT as a full-scale laboratory.

Security and dependability

Society's dependence on communication networks and the exponential growth in their use call for high standards of dependability and accessibility. Reduced access in digital communication systems and reduced access to services on the Internet due to random errors or defects are everyday occurrences. Lately, however, the risk of deliberate, malicious acts being perpetrated through these systems has increased. A society that wants to increase efficiency through the widespread use of modern technology must remain vigilant to avoid potential adverse consequences of the same technology. Added risk is a key aspect of evaluating Quality of Service. There is and will be an immense need for objective quality criteria to describe security, dependability and accessibility.

It is impossible for an ordinary user him- or herself to fully comprehend the complex system solutions underlying a service. Users must therefore rely on others to ensure that a service is good enough.

Quality of Service and the community

Quality of the Service should probably depend on how much we pay for it. Some phone conversations are more urgent than others and streamed classical concerts ought to have better sound quality than background music. When video conferencing, it is important that images are sharp and the sound totally synchronous. Stock prices should be available instantly to maintain realistic trading conditions and ensure secure transactions.

Private users can sometimes accept variations in quality and accessibility. For institutions and industry, however, it is absolutely necessary that services are consistently of adequate quality. Good, stable services are essential, not least in emergency situations when an ambulance and doctor are needed immediately. There is a large number of possible service providers, and whether they are private individuals, institutions or enterprises, users require knowledge about measurable quality to make well-founded decisions. Internet providers and service providers also require knowledge to choose the right solutions and invest appropriately on behalf of society-at-large.

Good communication is vital

Society-at-large is completely dependent on net-based services being good, and very vulnerable if there are periodic disturbances or total failures. The centre's research will add to our knowledge about the requirements that can and should be posed, how the systems can be further developed and how it will be possible to guarantee quality cost-efficiently. The CoE's skills development programme will give the Norwegian ICT industry competitive advantages. Equally important, it will ensure Norway more individuals and groups with top-notch expertise in modern communications systems. □

Centre for Quantifiable Quality of Service in Communication Systems

Objective: The centre's primary tasks are research and researcher training. The CoE will build up expertise and solutions that can help ensure the quality of future Internet services, for example, the transmission of multi-media services, electronic commerce, electronic mail and other Internet-based interaction.
Participants: The Norwegian University of Science and Technology (NTNU) is the lead institution. Partners: the Department of Telematics and the Department of Telecommunications at NTNU, together with UNINETT. Telenor supports the Centre.
Annual allocation from the Research Council: MNOK 12
Number of full-time positions: About 12 in 2003, increasing to 30 in 2004
Contact: Professor Peder J. Emstad, Department of Telematics, NTNU, Tel.: (+47) 735-94326, E-mail: peder@Q2S.ntnu.no
Website: www.ntnu.no/Q2S

↑ **QUALITY OF SERVICE:** Researchers at the Department of Telematics and the Department of Telecommunications comprise the core of the CoE. L. to r. Professor Bjarne E. Helvik, Department of Telematics, Professor Peder J. Emstad, Department of Telematics (CoE Director) and Professor Peter Svensson, Department of Telecommunications. (Photo: NTNU Info/Rune Petter Ness.)

MITIGATING THE RISK OF NATURAL

Every year, tens of thousands of people lose their lives in different types of natural disasters. Natural disasters also cause material damage for hundreds of billions of NOK. Improved knowledge will make our planet safer.

[BY BJARNE RØSJØ]

"SIMPLY PUT, OUR WORK is all about saving lives and reducing material damage. While we can't prevent natural disasters such as floods, landslides and earthquakes, we can perform research to mitigate the damage they cause", explains Dr. Farrokh Nadim, Director of the International Centre for Geohazards (ICG), which is hosted by the Norwegian Geotechnical Institute (NGI) in Oslo, Norway's capital city.

The International Centre for Geohazards has no time to waste. NGI's CoE application to the Research Council of Norway cited statistics indicating that more than 25 000 people lost their lives due to natural disasters in 2001. Material damage in 2001 alone was estimated at USD 500 billion.

"*Geohazards* are events due to geological characteristics and processes that present threats to people, property and natural or man-made habitats. The ICG's goal is to develop knowledge that can help save human lives and mitigate the damage to infrastructure and the environment caused by these hazards", relates Nadim.

The most common geohazards on land are landslides caused by powerful rains, floods, erosion, earthquakes or human intervention. At sea, huge underwater slides are caused by earthquakes and other geological processes. Activities related to offshore exploration and the production of oil and gas are also potential triggers for underwater slides.

The poor are the most vulnerable

Natural disasters with the most serious consequences have a tendency to strike poor people and densely populated 'hotspot' areas, such as Central America, where Hurricane Mitch alone caused more than 10 000 deaths in October 1998. The Inter-American Development Bank (IDB) has ascertained that the many natural disasters in Central America are among the most serious impediments to improving the standard of living in the region. It is extremely difficult to achieve economic development in areas where vital segments of the infrastructure are sporadically demolished by floods, landslides and other natural disasters. NGI is involved in projects in Nicaragua and El Salvador, for example, with financial support from the Norwegian Ministry of Foreign Affairs and the Norwegian Agency for Development Co-operation (NORAD) to build up the capacity of local engineers and geologists for dealing with landslides. Experience from these projects will be analysed and further developed at the new International Centre for Geohazards.

"Natural disasters are not limited to poor countries. Even here in Norway, more than 2000 people have been killed in different types of slides over the past 150 years, and human lives are still lost in slides or avalanches every year. If only we knew more about forecasting and prevention, many lives could be saved in Norway and abroad. In addition, we could prevent colossal material damage", says Nadim.

On land and at sea

Farrokh Nadim's vision is to make ICG the world's leading research group in geo-related natural hazards, both onshore and offshore, within five years. "Underwater slides are fundamentally different from slides onshore, so we must approach the two differently. The subsea slides are usually a lot larger, and they have a significantly greater run-out distance. Obviously, an underwater slide would be capable of inflicting appalling damage on subsea installations", Nadim points out.

The Centre will attach considerable importance to training students and researchers from Norway and abroad, and there seems to be no shortage of eager

DISASTERS

← **TREMENDOUS DAMAGE:** A landslide in the eastern Norwegian municipality of Trøgstad in 1968. (Photo: Scanpix)

recruits. "There are no comparable programmes available in this field anywhere in the world. As a result, we have already received numerous queries from students and researchers who want to come to the Centre, and a number of international institutions have contacted us to be part of our network. There is substantial interest in developing this type of knowledge, as evidenced by the fact that international development co-operation agencies and development banks have signalled considerable interest in the new centre. I believe that ICG is being introduced at just the right time", states NGI's Deputy Director Oddvar Kjekstad.

Prevention and mitigation efforts

"One of the reasons why natural disasters claim so many more lives in Central America than in Norway is that the region has a very high level of geological activity, including volcanic activities and major earthquakes. To make matters worse, that particular hotspot is hit by monsoon rains and tropical storms on a regular basis", explains Nadim, who came to Norway from the USA 20 years ago. A native of Iran, he developed an interest in geotechnology at an early age because Iran is a mountainous country that experiences substantial seismic activity and has major landslide problems.

"The ICG partners were particularly gratified to have been granted a long-term CoE allocation since experience has shown how difficult it usually is to fund preventive efforts. Coming in and cleaning up in the aftermath of a disaster tends to generate more publicity. CoE status will give us the time we need to work on developing new knowledge. Provided the Centre is successful, I am convinced we will be able to secure new funding from other sources ten years from now", concludes Nadim. □

International Centre for Geohazards

Objective: The Centre's goal is to be an international centre of expertise on basic and applied research on geo-related natural hazards (geohazards), such as slides, earthquakes and tsunamis.

Participants: The Geological Institute is the lead institution. The University of Oslo (UiO), Norwegian University of Science and Technology (NTNU), Norwegian Seismic Array (NORSAR) and Geological Survey of Norway (NGU) are all partners.

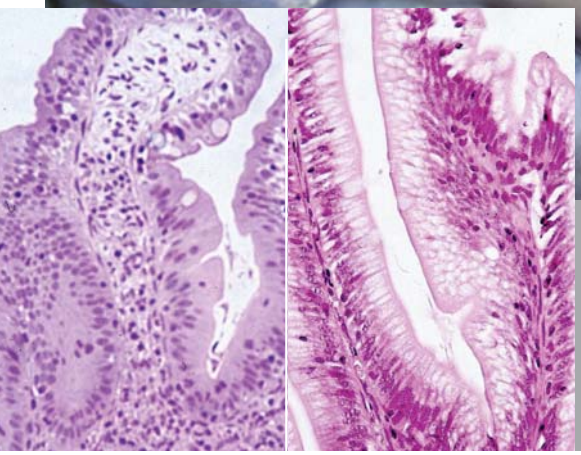
Annual allocation from the Research Council: MNOK 12

Number of full-time researcher positions: 20–25 in 2003

Contact: Dr. Farrokh Nadim, Tel.: (+47) 220-23000, E-mail: Farrokh.Nadim@ngi.no

Website: www.geohazards.no/

↑ **GEOHAZARDS EXPERTS:** L. to r.: CoE Director Farrokh Nadim of NGI, Professor Hilmar Bungum of NORSAR, and professors Kaare Høeg and Anders Elverhøi of the Department of Geology at the University of Oslo. The marks in the rock bear witness to violent times on this site roughly 10 000 years ago, as the vast inland ice cap pulled away from the area where the university now stands. (Photo: Bjarne Røsjø)



↑ **LUCKY LOX:** Will salmon be chock full of antioxidants from berries and vegetables in future? Researchers at the Aquaculture Protein Centre are interested in finding feeds that promote good fish health. (Photo: Image Bank)

← **INTESTINAL HISTOLOGY:** Wheat and soybeans are cultivated and refined for use in food for humans, but that does not necessarily mean that fish stomachs can tolerate the same ingredients. Here, microscope images of normal (l.) and inflamed mucous membrane in the intestines of an Atlantic salmon. The inflammation was triggered by soya. (Photo: Aquaculture Protein Centre)

IT IS NOT PRIMARILY because nutritionists think salmon have *unhealthy* diets that researchers are keen on finding alternative sources of fish feeds. It is just that, at its present pace of expansion in Norway, the fish-farming industry will soon challenge the ocean's capacity to produce enough food for these fish-eating fish. Most farmed salmon feed currently consists of valuable edible fish, while the rest consists of vegetable nutrients, such as wheat, corn, rape and soya.

"We have to find types of feed other than fish meal and fish oil. Fish-farming profits would be enhanced significantly if only salmon could be made into vegetarians. These days, the cost of feed accounts for 50 to 60 per cent of the total cost of salmon-farming. Today's low salmon prices are forcing us to think in entirely new directions", comments Trond Storebakken. He is director of the Aquaculture Protein Centre, a collaboration between the Agricultural University of Norway, the research institute AKVAFORSK and the Norwegian School of Veterinary Science.

Picky eaters

"Salmon are picky eaters. They are made to eat fish. Accordingly, it is no mean feat to switch them to a vegetarian diet. Both wheat and soya are refined and grown as food for humans, meaning they are not the best diet for fish stomachs", Storebakken continues. "In fact, protein resources derived from plants can contain substances that are directly bad for the fish. Some soya is used in fish feed, but too much can cause serious changes in fish intestines. It is neither ethical nor reasonable in terms of production to feed fish too much soya", contends Storebakken. Initially, the CoE will examine how the anti-nutrients in vegetable products impact fish physiology, and then subsequently focus on how to eliminate the problems or prevent them from hurting the fish.

These days, ethics is increasingly important in the fish-farming industry. Consumers want to know whether the food they eat had a good life before ending its days in the refrigerated section of the grocery store. Although the research done at the Aquaculture Protein Centre will not have ethics as its main focal point, ethics will be an important aspect of generating knowledge about fish health and welfare, according to Storebakken. "The great war against the use of antibiotics has been won. Ethical issues are now being reasonably well attended to by the industry. Nonetheless, it is obvious that today's price situation squeezes profit margins, sometimes so much that ethics are not fish-farmers' highest priority", he adds.

Bacteria are a treat

Researchers have looked beyond the confines of the plant kingdom in their zeal to find alternate sources of fish feed. They are also considering protein-rich bacteria. Bacteria are, in fact, rich in minerals and proteins. A group of scientists at the University of Bergen under the direction of Professor Johan Lillehaug of the Department of Molecular Biology is now in the process of mapping all the genes of a bacterium that eats gas (methane). Researchers suspect that the bioprotein produced by these gas-eating bacteria may potentially be a cost-efficient supplement to the salmon's traditional fish-based diet. However, optimal bioprotein production

fishy business

Marine feed for farmed salmon could soon be in short supply. As a result, salmon are destined for a diet of vegetables and bacteria in future, although certainly not at the expense of their health or welfare.

[BY SIW ELLEN JAKOBSEN]

Aquaculture Protein Centre

Objective: The Centre will help develop the basic nutritional, physiological and technological knowledge needed to optimise the use of protein in fish feed. The Centre will work in three fully-integrated fields of research: 1) amino acid requirements and protein metabolism, 2) intestinal physiology and anti-nutrients, 3) raw feed ingredients and feed technology. In addition, there will be an extensive teaching programme.
Participants: The Agricultural University of Norway, AKVAFORSK and the Norwegian School of Veterinary Science.
Annual allocation from the Research Council: MNOK 10
Number of full-time positions: 182
Contact: Professor Trond Storebakken, Tel.: (+47) 649-49500, E-mail: trond.storebakken@akvaforsk.nlh.no
Website: www.nlh.no/apc/

↑ **CHANGE:** "Fish-farming profits would be enhanced significally if only salmon could be made into vegetarians", alleges CoE Director Trond Storebakken (Photo: Siw Ellen Jakobsen)

calls for knowledge about biological processes. This will be the focal point of the research done at the Aquaculture Protein Centre.

"As opposed to plant proteins, bioproteins have few negative qualities. The group will also have a unique opportunity to describe the processes underlying the development of the raw ingredients in this fish feed. Of course, the use of bio-protein derived from gas also entails significant value-added for Norway as a nation, rather than just selling the gas in the conventional manner", says Storebakken, sneaking in a plug for the product.

Enormous gaps in our knowledge

As a nation, Norway has a great deal to gain by researching alternative feed resources and metabolism, says the professor. "Substantial investments have been made in aquaculture research. This research has enabled the industry to develop quickly and become competitive. Meanwhile, the fish-farming industry is vulnerable and research funding tends to fluctuate in tandem with earnings in the industry. As a result, the research thus far has primarily been aimed at finding short-term solutions to problems users experience from time to time. Problems requiring resolution in the long term have been pushed aside", contends the CoE Director, who is well satisfied with the allocations to the centre for precisely that reason. "For the first time, we have the opportunity to think long term. We have never before managed to secure funding to perform research on an efficient, sustainable feed for farmed fish. The subject was not given priority because the feed used up to now has generally been more or less tolerable."

As researchers now address issues related to protein nutrition, they are discovering enormous gaps in our knowledge. "For example, we know very little about the salmon's amino acid requirements, and very little about its metabolism. This Centre will be filling many of those gaps in our knowledge", promises Storebakken.

An international group

The Agricultural University of Norway already has a centre for feed technology, FôrTek, which is relatively unique. It features a number of facilities for researching the technologies of all the usual process lines for the production of feed for livestock, pets and fish. FôrTek will be a key player in the work of the Aquaculture Protein Centre. "This fantastic 'laboratory' is a tremendous advantage for us", confirms Storebakken, looking out across a huge hall filled with new, state-of-the-art technology just waiting to be used.

"Much of what we learn about fish feed will be applicable to other species of animals, for example, cats and dogs", adds Edward Pérez, the Chilean who manages FôrTek. The day *Tell'Us* visited the Aquaculture Protein Centre, his lab was filled with eager young adults from virtually every corner of the world. *Tell'Us* visited on the same day as two new master's degree courses were starting, one on feed technology and one on aquaculture. The students, mainly from China, Chile and the former Yugoslavia, have come here to learn. "We don't know the meaning of the term 'diminishing recruitment'", smiles Storebakken, who is also proud that women are actually over-represented among this year's class of students. □

CIVIL WA

– the scourge of our time

In 2002, 31 armed conflicts took place in the world. Only one of them (India/Pakistan) was a conflict between two states; the rest were civil wars. Notwithstanding, civil wars remain less researched than wars between nations. Specialists at PRIO's new centre aim to rectify this.

[BY BÅRD AMUNDSEN]

OVER THE PAST DECADE, Norway has attracted considerable attention as a mediator in international conflicts. Traditionally, Norway's foreign policy had just two dimensions: ordinary foreign policy and aid to developing countries. Over the past decade, however, *peace policy* has become an important dimension for this small country on the outskirts of Europe, owing to its active role in the efforts to find political solutions to conflicts in places as widespread as Guatemala, Israel/Palestine and Sri Lanka.

Norway also awards the Nobel Peace Prize and is home to several widely recognised research institutions in the field of international politics, including the International Peace Research Institute, Oslo (PRIO).

For the next five years at the very least, PRIO will be the headquarters of one of Norway's new Centres of Excellence: The Centre for the Study of Civil War. The CoE will play an important international role in performing crucial research on a topic deemed *the scourge of our time*.

Millions of lives lost

Millions of people have lost their lives in the wars fought since World War II. Although the world has become a more peaceful place since the end of the Cold War, civil wars cost hundreds of thousands of lives even in the 1990s, and millions of others had to flee their homes. Untold human suffering, environmental destruction and tremendous financial burdens have been inflicted on individuals and society-at-large, especially in the poor part of the world. If we knew more about civil wars as a phenomenon, we could probably do more to prevent them from occurring and to settle conflicts already in progress.

The researchers at the Centre for the Study of Civil War have posed three cardinal questions: Why do civil wars break out? How are they sustained? What does it take to end them?

Kosovo and Afghanistan

Naturally, the researchers are not starting entirely from scratch. While it is evident that most civil wars are fought in poor countries, Northern Ireland and Basque Country have also experienced small-scale civil wars in recent decades. Although some are of the opinion that civil wars are primarily a question of skewed distribution of resources, the poorest rarely take up arms. Civil wars are often fought across ethnic dividing lines, making it easy to distinguish between friend and foe. Yet countries with numerous ethnic groups are not among those most prone to civil war. It appears that countries with one pre-dominant ethnic group and one large minority group are more predisposed to such conflicts. Researchers have also observed a clear correlation between civil war and political instability. Stable democracies are rarely or never given to armed internal conflicts.

It is every bit as important to figure out how to achieve peace as it is to determine where and why civil wars occur. Kosovo and Afghanistan are two fresh examples of the major powers trying to force peace on nations from the outside, but we do not yet know whether they have succeeded. Not least in the case of Iraq, we know that economic sanctions often cause worse problems for civilian populations than for those the sanctions were intended to punish.

At least in the short term, mediation and conflict resolution entail less adverse fallout for civilian populations and appear to have brought good results in Central America and perhaps now also in Sri Lanka. Norway has acted as peacemaker in both places.

Under the carpet

Oslo's new international research centre on civil war is headed by the American Scott Gates, formerly a professor of Political Science at Michigan State University.

While on sabbatical in the mid-1990s, Gates visited Norway and more or less by chance met the two Norwegian researchers Nils Petter Gleditsch and Ola Listhaug. The three discovered mutual interests in issues related to democracy and peace. Gates returned to Oslo for an extended research leave, met his spouse-to-be right there at PRIO and learned to speak Norwegian.

"It was an overwhelming, wonderful surprise to be selected one of the first Centres of Excellence in Norway. We have managed to assemble a great team of highly skilled researchers. Several of them, for example, professors Jon Elster, Kaare Strøm and Ola Listhaug, are not primarily experts on conflict. They will bring new perspectives into this important field of research", states Gates, whose own speciality is the recruitment and disarmament of rebel soldiers.

In the past, civil wars were highly controversial in international organisations like the UN, which tended to sweep them under the carpet. According to Gates' colleague, Professor Nils Petter Gleditsch, this has changed dramatically since the end of the Cold War. "The UN is no longer afraid to discuss civil wars, and the Research Department of the World Bank has assembled a highly prestigious group of

← **POST-COLD WAR:** Although the world has become a more peaceful place since the end of the Cold War, civil war cost hundreds of thousands of lives in the 1990s. (Photo: PhotoAlto)

researchers in this field", relates Gleditsch. He has been instrumental in building up the CoE, and will be leading a working group on environmental and resource-related conflicts, one of a total of seven groups currently in the pipeline.

Fresh points of view

"The CoE at PRIO aspires to be at the cutting edge of research in this field", confirms Gleditsch. "The field we will be exploring is very hot at the moment, politically speaking, and we want to produce research results that can be applied in Norwegian foreign policy and hopefully also by international agencies. We know, for example, that the UN secretariat is deeply interested in developments related to armed conflicts."

Although the CoE's focal point will be political science, it will have a clear interdisciplinary target. Karl Ove Moene, Professor of Economics at the University of Oslo, leads a working group that will be studying the relationship between globalisation and conflict. He argues that since peace policy has become such an important component of Norwegian foreign policy, it would be ridiculous not to back it up with research. He also points out that conflicts play a key role in whether or not developing countries achieve favourable social and economic development.

Well-known names

Before the CoE application was even posted, PRIO did a thorough job of recruiting top-notch people in disciplines ranging from economics, history and political science, to philosophy and sociology. Eminent 'expat' Norwegian researchers such as Kaare Strøm (Professor of Political Science at the University of California San Diego) and philosopher Jon Elster (Professor of Social Sciences at Columbia University) will be playing an active role. Strøm will head a working group that aims to determine the significance of various systems of governance, e.g. democracy, presidential government and federalism, for internal conflicts. Jon Elster's group will assess the role of individuals and their decision processes in perpetuating violence. PRIO's well-known international periodical, *Journal of Peace Research*, has helped ensure the new CoE an immense contact network that spans the world.

The CoE's methodological toolkit includes game theory, micro- and macroeconomics, quantitative statistical analyses, comparative case studies and historical source criticism. The participants aspire to collect new empirical material and develop new theories. □

Centre for the Study of Civil War

Objective: The Centre will study why civil wars break out, how they are sustained and what it takes to end them.
Participants: The International Peace Research Institute, Oslo (PRIO) is the lead institution. The University of California San Diego, the Norwegian University of Science and Technology and the University of Oslo are active partners. The research staff includes political scientists, economists, sociologists, historians and philosophers.
Annual allocation from the Research Council: MNOK 9
Number of full-time positions: 10–12
Contacts: Professor Scott Gates, E-mail: scott@prio.no and PRIO Director Stein Tønnesson, Tel.: (+47) 225-47731, E-mail: stein@prio.no
Website: www.prio.no/cscw

↑ **CoE DIRECTOR:** Scott Gates (Photo: Bård Amundsen)

MEMORIES OF THE

People's long-term memories store aural impressions at one site in the brain, visual impressions somewhere else, smells a third place, etc. But how are those impressions brought together to make integrated memories?

[BY BJARNE RØSJØ]

"IF YOU WANT to understand the mechanisms that cause Alzheimer's, senility and other types of memory dysfunction, it is a great advantage to understand how normal memory works. One of the objectives of our research is to ensure that it helps improve the treatment of memory dysfunction in the long term", states the director of the Centre for the Biology of Memory (CBM), Professor Edvard Moser.

Located in the city of Trondheim in central Norway, the CoE consists of researchers who have already earned sterling reputations in the international arena. The researchers at CBM will be focusing particular attention on the tiny, secretive hippocampus structure, an older part of the cerebral cortex.

In June 2002, the group published an article in *Science* where they disclosed, among other things, that they had discovered a new memory system in the brain. "Scientists have known for a long time that the hippocampus plays a key role in human and animal memories. Information from the outer layer of the cerebral cortex generally takes one of two routes into the hippocampus, and our discovery is that the two routes handle different memory functions. Only the one is necessary for recollecting memories, but both can deal with recognition", relates Moser.

Parenthetically speaking, recollection is the process that takes place if you answer "Minsk" when asked for the name of the capital of Belarus, while recognition is what happens when you select the right name from multiple choices such as "Minsk", "Moscow" or "Odessa".

↓ **KEY INDIVIDUALS:** L. to r. Mona Kolstø Otnæss, Robert Biegler, Edvard Moser (CoE Director), Klaus Jenssen, Sturla Molden, Gry Therese Storsveen, Frode Tuvnes, May-Britt Moser and Kirsten Gjerstad Kjelstrup. (Photo: NTNU Info/Rune Petter Ness)

Keeping track of memory

The hippocampus is a tiny fold under the cerebral cortex that is shaped like the tail of a sea horse – hence the name. The hippocampus is absolutely decisive for the ability of humans and animals to store sensory impressions as memory tracks, and this will also be an important part of the research to be done at CBM.

"The hippocampus is connected to nearly the entire cerebral cortex through associated structures, somehow co-ordinating the connections between various parts of the memory. Our long-term memory is not located at one particular place in the brain; it is spread out: Aural impressions are located in one place, olfactory impressions somewhere else, visual impressions a third place, and so on. The prevailing theory, which is far from proven, postulates that the hippocampus links the different storage structures for a certain period of time after something has been memorised. This is necessary because the direct connections between the various areas in the cerebral cortex are relatively poor, and probably not good enough to make a network able to sustain a memory as such. However, there is an indirect connection through the hippocampus", explains Moser.

A vulnerable structure

After a certain time, possibly as much as several years, memories have become so permanent that the direct connections through the cerebral cortex are sufficient. CBM's researchers intend to examine how this change is made by measuring electrical activity in neurons, mainly in the hippocampus, but eventually also in other parts of the cerebral cortex. "Once we have made sufficient progress, we will ex-

Centre for the Biology of Memory (CBM)

Objective: To establish a leading international centre for the biology of memory. The researchers will identify how the neurons in a normal brain work together to encode and store memory.
Participants: Lead institution: Norwegian University of Science and Technology (NTNU). The partners consist of several leading international memory researchers who will be affiliated with the centre through part-time positions.
Annual allocation from the Research Council: MNOK 10
Number of full-time positions: Approx. 30
Contact: Professor Edvard I. Moser, Tel.: (+47) 735-98278, E-mail: edvard.moser@cbm.ntnu.no
International researchers: Carol Barnes and Bruce McNaughton (Tucson, USA), Richard Morris (Edinburgh), Menno Witter (Amsterdam), Alessandro Treves (Trieste), Ole Paulsen (Oxford), Randolf Menzel (Berlin)
Website: www.cbm.ntnu.no/

← **STAR:** US film diva Rita Hayworth (1918–87) was one of the first celebrities to go public when she developed Alzheimer's, a brain disease researchers are working hard to understand. The USA's largest Alzheimer's foundation bears Rita Hayworth's name. (Photo: Scanpix)

amine the differences between the processes that take place immediately after learning, and those that take place a long time later, after the memories have become independent", adds Moser.

It is important to bear in mind that the hippocampus is a vulnerable structure. It is nearly always the first brain structure to go in the event of cardiac arrest, since it is extremely susceptible to oxygen deficiency. People with a defective hippocampus lose the ability to remember new experiences, but their childhood memories often remain more or less intact.

How is memory actually stored in the cerebral cortex? "There is quite a bit of indirect evidence that storage takes place in the synapses, i.e. in the contact points between the different neurons in the brain. Many of the molecular processes that take place there are inconstant. We know, for instance, that synapses can change, becoming more or less efficient at transmitting signals between the cells", Moser elucidates.

The brain is like a computer

The researchers at CBM will strive to develop techniques and methods for measurement that can explain how neurons in the hippocampus and associated neocortical areas work together to make memory tracks. One important aspect of this work involves placing microscopically thin electrodes inside the hippocampi of rats, then measuring the slight changes in electrical activity that take place during learning. The experiments are taking place under the strict control of the Norwegian inspection authorities, who have been impressed by how well the animals are treated.

"We are especially interested in changes in electrical activity of the type known as action potentials (AP). The AP signals are so strong that they are passed on to other cells, in a process reminiscent of what takes place in a computer. There are no fractional action potentials; they are all-or-none, i.e. they have a value of 0 or 1. The action potentials are transferred in different patterns of activity, and there is reason to believe that the patterns are information carriers", recounts Moser.

The patterns probably reflect the fact that memory tracks are not stored in single cells, but in networks of cells. "We have to use sophisticated mathematics and information processing to identify and compare these patterns. That is one of the reasons why we need an international network of researchers. It is a huge advantage to be located close to the strong mathematics communities at the Norwegian University of Science and Technology (NTNU)", continues Moser.

Breaking new ground

CBM's research builds further on long traditions in Norway, a country that has made considerable pioneering efforts in brain and memory research. "Professor Per Andersen of the University of Oslo laid a large part of the foundation for neurophysiology at the international level, and his research group was among those that discovered the fundamental principles that govern how the hippocampus works. Mention must also be made of Professor Terje Lømo, who made one of the most fundamental discoveries in the biology of memory back when he was student at the University of Oslo. He was the one who discovered that the connections between neurons can be strengthened by a process known as long-term potentiation", recollects Moser. □

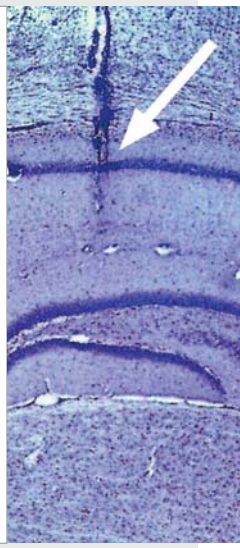
↘ **PATTERNS:** The researchers strive to develop techniques for measurement that can explain how neurons in the hippocampus and associated neocortical areas work together to make memory tracks. One important aspect of this work involves placing microscopically thin electrodes inside the hippocampi of rats. The picture shows a cross-section of the hippocampus with the arrow pointing to an electrode. (Photo: Special Neuroscience Group, Norwegian University of Science and Technology)

Use makes the brain grow stronger

The brain can be compared with a computer that generates more storage and processor capacity the more it is used. The information is stored in the synapses between neurons in the memory areas, and frequent use induces the formation of increasingly more synapses.

"The brain has a lot in common with a computer, including data retrieval, data storage in a network, and data retrieval again. The most important difference is that the brain is not static, but changes constantly. In a nutshell, use makes the brain grow stronger. We can measure this physically by observing neurons in the brain as they develop more synapses", says Edvard Moser. "Of course, the more information you put into your brain, the more synapses can be formed. It is impossible to ever fill it up completely!"

Professor Moser cites the example of rats living in a setting where they have ample opportunity to climb and to go on journeys of discovery. They develop more synapses and richer cellular networks than rats that live in simple boxes without any particular stimulation. "There is reason to believe the same applies to people. When it comes to sustaining brainpower, it all boils down to 'use it, or lose it!'". □



THE MIRACLE OF HUMAN LANGUAGE

Human infants have an ability that sets them apart from all other newborn creatures: their tremendous capacity for learning language. Linguists aspire to understand more about this miracle by dissecting and analyzing sounds and words.

[BY SIW ELLEN JAKOBSEN]

↓ **WORDS:** This book contains Evangelical texts from the 6th century in Jesus Christ's own language, Aramaic.
↘ **INTERNATIONAL:** The picture of a sign outside a tourist information centre was taken at the fish market in the western Norwegian city of Bergen. (Photos: Scanpix)

↖↓ **SO TO SPEAK:** A child is genetically predisposed to learn any language at all – both verbal and non verbal. Sculpture by Norwegian artist Gustav Vigeland (1869–1943). (Photo: Samfoto)

"YES, IT IS NOTHING short of a miracle that a baby's brain can perceive structures as complex as grammar at a time when the child still has such a long way to go developmentally otherwise", remarks Curt Rice, CoE Director for the Center for Advanced Study in Theoretical Linguistics (CASTL) at the University of Tromsø. "Just imagine, human infants learn to speak a language at the same stage in their development, regardless of where in the world they live and which language they are learning. Isn't that incredible?" asks the linguist, fascinated.

Rice's fascination will serve him well as he addresses the research task ahead. He and his colleagues are, in fact, planning to compare hundreds of languages. This field is called comparative linguistics, and it will be one of the main activities at the new CoE. "This is painstaking work that calls for extraordinary patience", admits the professor. "But the staff is driven by its zeal to understand more of 'the big picture'."

"A child is genetically predisposed to learn any language at all. We hope to be able to describe what this entails, but there are no shortcuts here. To better understand the phenomenon, we quite simply have to learn more about what language is. How are the world's languages built up? What are the similarities and differences between them?"

While the language researcher finds the differences between languages exciting, he is absolutely fascinated by their many similarities. "Take Japanese and Turkish, for example. Although there are no historic ties between these languages, their word order is strikingly similar", he reports.

Finding such similarities helps researchers put the pieces of the puzzle in place. "Think of a child's brain as a 'black box'. To begin with, the child may have very few 'switches' it can turn off or on when learning to talk. There is a limit to how many choices the child has", Rice suggests, maintaining that linguistic research may have a great deal to contribute to psychological research.

Babes and bucks

The CoE Director faces his task with humility. "Our status as a Centre of Excellence gives us a chance to immerse ourselves in what we are most interested in for many years ahead. While that is very agreeable, we know we are being watched closely and that expectations are running high.

Shortly after the appointment of the CoE was made public, Rice received an E-mail from the US linguistic guru Noam Chomsky of the Massachusetts Institute of Technology (MIT). His message really brought home to the researchers the uniqueness of their situation in a global context. The world-famous language researcher extended his congratulations, writing: "That's really fabulous news. It would be hard to invent something better. Can't think of anything like it anywhere. But just think of the responsibility you all now have to the future of the field."

Rice believes it to be a coincidence that one of the world's best linguistic research communities is located in the Arctic city of Tromsø in northern Norway. However, the professor from Minneapolis is well aware of how he himself ended up there: "I guess it was all a question of women and money, like most other things here in life", he remarks with a grin, continuing: "My Norwegian-born wife brought me to Norway when we finished our studies in the US. We were going to spend a year thinking about what we wanted to do; a year at what is now the Norwegian University of Science and Technology (NTNU) in Trondheim. However, that year led us to two academic positions at the University of Tromsø. We've been here for nearly ten years now", says the American with amazement. Rice is very modest about his own mastery of language. "A linguist has to be very careful about saying that he knows a language", he explains, in virtually perfect Tromsø dialect.

Along with the four other researchers behind the centre: Peter Svenonius, Knut Tarald Taraldsen, Ove Lorentz and Anders Holmberg, Curt Rice knows how this outstanding professional community developed in Tromsø: 'depth'. "We have all chosen to go to great depths in our chosen fields. When you work in a field of research as narrow as ours, it is a unique situation to have colleagues at the same university to talk things over with."

When the five applicants submitted their application for CoE status, they were one of four research groups from Tromsø that applied, and one of a total of 129 applicants altogether. Two of the four from Tromsø passed pre-qualification, but the Center for Advanced Study in Theoretical Linguistics was the only one that passed through the eye of the needle and made it to the finals. "We feel privileged. The CoE allocations will be a springboard for new applications, for example, with a view to forming a network of centres in Europe. Hopefully, we are poised on the threshold of a decade as a CoE, but our work will continue far, far longer than that", promises the professor. The CoE director is already cultivating close contacts with European linguists from his temporary base at the University of Leiden in the Netherlands this year.

EU project

Rice's colleague, Peter Svenonius, is heading a major EU-funded project about online learning. The goal of the IGLO (Intercomprehension in German Languages Online) Project is to learn a foreign language, taking one's own first language as a point of departure. One individual in Leiden and one in Tromsø who want to learn German will be offered different types of training and different challenges. "This is a good example of how theoretical linguistics can be used in actual practice", points out the CoE Director, who hopes the CASTL Project can be used for a similar scheme.

"CoE status means a great deal to the researchers in Tromsø, as does the money", Rice concedes. Although many of the other CoEs have large external sources of funding, that does not apply in the humanities. The CoE funding is sufficient to employ about 15 individuals as fellows and at the post-doc level. They have no need for expensive, sophisticated equipment.

Naturally, the CASTL researchers stand no chance of comparing hundreds of languages all on their own. Accordingly, the centre will forge ties with colleagues at other universities the world over.

Languages die – and new ones are born

The situation for the world's languages is dramatic. About 50 per cent of today's 6000 languages may disappear over the next century. And linguists can do little about it, other than document them. "Since this CoE was established, we have received queries from a number of people who are interested in preserving languages. We can offer them moral support, but little more. Languages die when people stop using them. It has nothing to do with the language *per se*, but with policy. When one language gains alpha-status by becoming the language of instruction, others are bound to die. In contrast to what many would contend, the media has little influence on language usage. Language is in constant flux. The changes primarily take place in dialogue between people. That is how it has always been, and how it always will be.

"However, the future of linguistic diversity is not all gloomy", adds the linguist optimistically. "New languages are popping up all the time, and that is really exciting!" □

← **ABROAD:** American Curt Rice has lived in Norway for nearly ten years. Last year, he was on a research sabbatical at the University of Leiden in The Netherlands. Here, in Amsterdam. (Photo: Siw Ellen Jakobsen)

Center for Advanced Study in Theoretical Linguistics (CASTL)

Objective: Researchers at the Center aspire to conduct comparative studies to explore the distinguishing elements of linguistic variation, and to determine the parameters along which languages are distinct from one another.
Participants: The University of Tromsø co-operates with the University of Cape Town, the University of Botswana, the University of Venice, the University of Durham and the University of Ohio.
Annual allocation from the Research Council: MNOK 6
Number of full-time positions: Approximately 20
Contact: Professor Curt Rice, E-mail: curt.rice@hum.uit.no
Website: uit.no/castl

Floating airports that can be towed to new locations, large fish farms that can be submerged to deeper waters to avoid algae blooms on the ocean surface, semi-submersible tunnels across the Atlantic: The future is just around the corner.

[BY BJARNE RØSJØ]

Foresight into a marine future

PROFESSOR TORGEIR MOAN'S VISIONS are by no means pie in the sky; they are plausible extrapolations of development trends that can already be identified. "We monitor trends. Then we extrapolate them into the future and devise notions about what kind of marine structures might be needed", he explains.

Moan and his co-workers are primarily interested in trends in three areas: Offshore oil and gas production is moving into increasingly deeper waters. In shipping, there is a clear trend towards faster vessels, and in aquaculture, there is a trend towards larger facilities and more industrialisation in general. "All these trends call for new types of ocean structures", Moan points out. He is director of the CoE called Ships and Ocean Structures, located in the city of Trondheim in central Norway. He and his colleagues plan to spend the next ten years developing many of the visions whose contours can already be identified, and many new ones as well.

"Offshore structures, ships and aquacultural plants may seem like three very different areas of technology, but we are engaged in basic research that addresses issues common to many types of ocean structures. It is important to understand how vessels, oil platforms, pipelines and other ocean structures react when exposed to extreme stresses and strains. In a nutshell, we will be making mathematical models to describe how ocean structures behave, especially when exposed to waves, currents and wind. We will use statistical methods to describe the chaotic variations in ocean behaviour, and then to calculate how these variations affect different types of structures", he reports. "We will also work on how to develop new methods to control or regulate the structures' behaviour in the ocean."

Extreme mathematics

Once completed, the mathematical models will help optimise the design of future marine systems. From the engineering point of view, this work is about minimising the resources needed to build the structures, while ensuring they comply with all safety standards.

The ocean structure researchers in Trondheim are especially concerned with describing how ocean structures behave in rough seas, where so-called non-linear effects are highly significant. One example of a non-linear effect is when waves get so big that they no longer beat rhythmically against the side of the ship, but wash over the deck. Vessels and other ocean structures all have to be designed to endure such situations, which can often pose severe strain on materials.

Aquaculture on the rise in Norway

The marine research communities in Trondheim have long experience of offshore/oil-related activities and shipping, and now aquaculture is in the process of becoming an important new area. "There is talk of a five-fold increase in aquaculture and fish-farming production in Norway over the next 20 years. In practical terms, that means the entire production process will have to be industrialised to a far greater extent than it is today. Facilities will have to be far bigger, meaning they can no longer be located in the innermost reaches of the fjords. Instead, the facilities will have to be out in open waters, and the fish farms will probably have to be designed so they can be towed from place to place and/or raised and lowered in the water. The latter is not least important because it will make it possible to move the fish farms out of the way of dangerous algae blooms in surface waters", observes Moan.

The new, industrialised fish-farming industry will also require new types of vessels, new types of tools for collecting feed, and a new infrastructure for transport and processing. In short: the designers face many challenges, as do those whose job it will be to develop new, basic knowledge and expertise.

"The tremendous advances made in computer technology in recent years have paved the way for developing new mathematical and numerical methods of this type. I believe this trend will continue, and that there will always be a need for new, improved models. The continuous development of new knowledge about the behaviour of ships and ocean structures will serve as the basis for engineering new types of structures."

Training trends

Moan and his colleagues attach a great deal of importance to training PhD students, and expect to produce about 35 doctorates over the next 10 years. "That may sound like a high number, but the fact is that the three people who constitute the management team have already trained 80 to 90 PhD students. In other words, we're not starting from scratch! We've been doing research in this area for many years, but we now have the opportunity to consolidate our efforts and to address even more challenging problems", concludes Moan. □

↑ **TEAM:** Professor Odd Faltinsen (left) and CoE Director Torgeir Moan. (Photo: Bjarne Røsjø)

Ships and Ocean Structures

Objectives: To create a leading international centre to produce basic knowledge about the behaviour of ocean structures by integrating theoretical and experimental research in hydrodynamics, structural technology and automatic control. To establish a platform for the innovative design and operation of the vessels, platforms and fish-farming structures of tomorrow.

Participants: The Norwegian University of Science and Technology (NTNU) is the lead institution. The partners are the research groups involved in ocean structures and marine hydrodynamics at the Marine Technology Centre at NTNU, the Department of Engineering Cybernetics at NTNU, MARINTEK and the Massachusetts Institute of Technology (MIT).
Annual allocation from the Research Council: MNOK 13
Number of full-time positions: 30–35
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E-mail: torgeir.moan@marin.ntnu.no
Website: www.ntnu.no/cesos/

Photos: Getty Images

↙ → OUR COMMON FUTURE?: Left: A cross-section through a vessel carrying liquid cargo, illustrating sloshing in two adjacent compartments. Right: Futuristic new design for aquaculture pens (fish farms). (Drawings: B. Stenberg)

← ← MARINE ENVIRONMENT: Professors Torgeir Moan (l. to r.), Olav Egeland and Carl M. Larsen with their marine structure models. (Photo: NTNU Info/Rune Petter Ness)

↙↘ **EXCELLENT WORKING CONDITIONS:** Tone Tønjum (l.), the only female group leader at the Centre for Molecular Biology and Neuroscience, enjoys the very best working conditions. That view is shared by Senior Engineer Karen Marie Gujord (r.), depicted here in the process of purifying antibodies (Left photo: Siw Ellen Jakobsen. Right photo: Carina Knutsen, University of Oslo.)

"BRAIN STORM

Never before have so many top people in neuroscience and molecular biology put their heads together to 'brainstorm', quite literally.

[BY SIW ELLEN JAKOBSEN]

HAVING DEVELOPED THEIR OWN special technologies and methods, each of these particular heads of research groups shares a common interest: They want to understand how neurons communicate and the role DNA damage plays in the development of neurological diseases. Scientists are especially curious about what takes place when neural communication goes awry, resulting in neurological disorders. This is a vital issue in terms of those afflicted by Alzheimer's, Parkinson's and epilepsy, for example. Although a great deal of research has been done on these diseases, scientists have not managed to expose the mechanisms underlying them. Patients suffering from neurological diseases often fail to get adequate treatment, quite simply because scientists do not understand the diseases well enough.

Small revolutions

However, at least now scientists know where to look for answers. And now that the neurobiologists at the University of Oslo are delving into the work being done on DNA by their colleagues at Rikshospitalet (the National Hospital), it is safe to say the years ahead should bring numerous small revolutions. "There are signs to indicate that one important cause of neurological disease is that cells are exposed to damage that DNA repair mechanisms are not able to fix. Through broad interdisciplinary collaboration, we should be able to identify important principles that can tell us how these disorders arise", explains CoE Director Ole Petter Ottersen. He will be heading the Centre for Molecular Biology and Neuroscience, a unique group in a global context.

Original research is often conceived in the overlapping areas between traditional disciplines. Ottersen and his colleagues have tremendous faith in this Centre not least because the 11 group leaders who have joined forces have spheres of interest that overlap to such a large extent. They have also engaged in considerable dialogue earlier.

"The time was finally right to formalise what has long been informal collaboration between the groups", states Ottersen.

Angling for a lead

The CoE director is not interested in trying to predict where the Centre will make its greatest advances. He does, however, admit to having considerable confidence in one of the Centre's newest laboratories, built up around a field known as multi-photon technology. This technology enables scientists to examine physiological processes in living cells at a whole different level of detail than was previously possible. "This is a distinct advance in the study of living material. I think we will produce a great deal of interesting data about what takes place when neurons break down over time, for example, in the case of Alzheimer's. Be that as it may, we will no doubt have to go on numerous fishing expeditions before we can understand the mechanisms underlying neurological disorders. The more lines we cast, the greater our chances of catching a fish", adds Ottersen.

Better than in the US

One of the many lines cast landed in the office of Professor Tone Tønjum, the Centre's only female group leader. She aspires to learn more about the mechanisms for how genetic imbalances can cause diseases. To get to the bottom of

← **PICTURESQUE:** The figure shows a three-dimensional model of a brain structure, compiled using computer graphics methods developed at the CoE. The microscope is used to collect data about tiny components in the brain. Data from numerous cross-sections are combined and made into a three-dimensional model. This figure illustrates how information is sorted in the brain structure in question. Different colour coded areas process different types of information; in this case, information from different areas of the body surface: red for the face, green for the torso and other colours for arms and legs.
(Illustration: Jan G. Bjaalie and Trygve Leergaard)

MING"

Centre for Molecular Biology and Neuroscience

Objective: The Centre aspires to carve out a leading role in mapping and explaining genetic mutations in the neural system to prevent neurological diseases and to understand how the brain ages.
Participants: The Center is comprised of 11 research groups, each of which has made a name for itself at the international level. The group leaders are: Ole Petter Ottersen, Jon Storm-Mathisen, Jan G. Bjaalie, Niels Chr. Danbolt and Johan F. Storm of the University of Oslo, Erling Seeberg, Tone Tønjum, Arne Klungland, Stefan Krauss and Torbjørn Rognes of Rikshospitalet (the National Hospital) and Michael Koomey of the Biotechnology Centre at the University of Oslo.
Annual allocation from the Research Council: MNOK 21
Number of full-time positions: Approx. 100

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Website: www.cmbn.no/
The Centre was profiled in a Scandinavian supplement to *Nature*, 12 December 2002. There is a link to the article on the Centre's website.

↗ **CURIOUS:** CoE Director Ole Petter Ottersen, is especially curious about what takes place when neural communication goes awry, resulting in neurological disorders. (Left photo: Eva Brænd / Right photo: Image Bank)

these enigmas, Tønjum and her colleagues at the Department of Microbiology at Rikshospitalet are studying primitive organisms known as microbes.

"Primitive organisms like these can cause disease, but they can also help us understand the functions of other cells. They are easy to study, and we can turn their genetic characteristics off and on at will. Many of the basal life processes in these microbes have a high transfer value to humans", she explains.

Tønjum quite recently returned to Norway following five years of study at US universities. She returned home to funds from the EU, the Wellcome Trust, the Research Council and CoE funding: "I have the best working conditions I could possibly want. I feel privileged and highly motivated", says the enthusiastic professor, proudly showing us around a laboratory equipped with splendid new instruments. "In addition to these enviable facilities, there is a very positive milieu here. As a result, I believe we can generate new knowledge and establish a good learning environment at the Centre."

Discovered new genes

One of the brainstormers Tønjum believes will be an important contributor to this constructive community is Professor Erling Seeberg, who occupies the office next to hers. He heads the Section for Molecular Biology and is deputy director of the CoE. In autumn 2002, *Nature* presented the latest discovery made by Seeberg's group, i.e. a new group of genes that are crucial for gene repair. Pål Falnes is the main author of the article and plays a key role in the sub-project. Seeberg discloses that while the discovery is fundamental in nature, it may be instrumental in the future treatment of cancer. He explains: "Our genes are constantly exposed to damage. It might come from radiation, such as UV rays, or it might be due to chemical substances around us. But first and foremost, DNA is damaged by components that occur in our cells naturally, for example, oxygen or alkylating compounds. This damage must be repaired if the genes are to function normally and prevent cancer cells from forming. Fortunately, we have hundreds of genes that help protect us against such damage. Our research group has now discovered and described the function of a new type of genes that perform such repairs. They reverse unwanted chemical modifications to DNA. If we can introduce these genes into cancers, they may help facilitate treatment", he clarifies.

Fitful sleep

Despite fresh funding, new laboratories, splendid instruments and being published in *Nature*, Ole Petter Ottersen sleeps fitfully. He worries that others may possibly be sleeping too well.

"The allocations to the Centre of Excellence are tremendously important, providing sorely needed impetus for Norwegian research. However, that doesn't mean the job is done or that researchers finally have enough. It worries me that a country as affluent as Norway is not more advanced when it comes to investment in research and development. In our case, the CoE allocation accounts for no more than 20 per cent of our aggregate funding."

The Centre for Molecular Biology and Neuroscience has signed a letter of intention with the pharmaceutical company GlaxoSmithKline and other investor groups regarding ideas developed in conjunction with the CoE project. By forging links to industry, scientists hope to realise some of the commercialisation potential of their research. □

Physics of Geological Processes

↑ **LEADERS:** Professor of Physics Jens Feder (r.) and Professor of Geology Bjørn Jamtveit are director and deputy director of the CoE, Physics of Geological Processes. (Photo: Anita Thorolvsen Munch)

Objective: To create a centre to study the physics of geological processes by pooling the expertise of researchers in the fields of geology and physics. The Centre will produce new, interdisciplinary scientific insight which will be disseminated rapidly to the classroom and applications. The Centre also plans to develop a new master's degree programme that will give students an interdisciplinary background in geology, physics and computer science.

Participants: The departments of Physics, Geology, and Informatics at the University of Oslo, as well as guest researchers from a number of institutions in Norway and abroad.

Annual allocation from the Research Council: MNOK 14

Number of full-time positions: Approx. 30

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Website: www.fys.uio.no/pgp

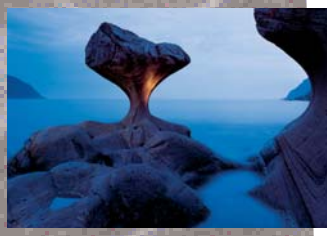


Photo: fdc

SEEKING ORDER IN CHAOS

Physicists and geologists have joined forces to break new ground through cross-disciplinary collaboration. These scientists have set their sights on a common goal: To determine what is actually taking place right under our feet. Their results may entail huge benefits for the oil industry, the mining industry and areas prone to earthquakes.

BY ANITA THOROLVSEN MUNCH

IN TIMES PAST, geologists packed their knapsacks and went out into the field to identify and describe species of rock and other geological systems. The chaos of nature offered few opportunities to achieve a *quantitative* understanding of the processes that once created, deformed and transformed various rock types.

That was then. Now, the 'down-to-earth' geologists have allied with the more 'generalising' physicists to move from *describing the state* of geological systems to *tracing the evolution* of geological processes. By combining physicists' insight into the processes and patterns of complex systems with geologists' knowledge of how the earth looks today and has looked in earlier times, the stage is set for unlocking some of the mysteries hidden in the earth's crust.

Forecasting the future

Professor of Physics Jens Feder and Professor of Geology Bjørn Jamtveit are director and deputy director, respectively, of the CoE known as the Physics of Geological Processes (PGP). The CoE's research will examine processes 'underlying' earthquakes, volcanoes and the formation of mountain chains, as well as deformations in the earth's crust, and the transport of gases and liquids such as oil in the lithosphere (the brittle uppermost shell of the earth). The group will also research the processes that take place in the interfaces between mineral grains, and between mineral grains and liquids. Their results may break new ground and benefit the oil- and mining industries as well as areas prone to earthquakes.

Photo: Scanpix

Photo: Image Bank

"Our goal is to gain sufficient understanding of geological processes to be able to make quantitative descriptions of them. That would enable us to forecast the future development of a geological system. If we can just manage that, the relevance of our research will escalate dramatically", says Bjørn Jamtveit.

Patterns in chaos

Nature is rife with patterns of stripes, spots and waves. The earth's crust is replete with pores and crevices filled with liquids. Reciprocal action between the liquids and the rock around them has a profound impact on the development of the earth's crust. Earthquakes, volcanic eruptions, the formation of different types of ore deposits and the way in which oil and gas circulate and are trapped are all examples of geological processes that can be influenced.

Statistical physics can quantify what goes on in the earth's crust, and explain how and why rocks crack and how liquids and gases move around. The researchers use different statistical methods, such as fractal geometry to describe seemingly chaotic processes or structures in nature.

"Fractal geometry can be used to describe and model landscapes. We believe it will be possible to find well-suited models for a large number of natural phenomena and patterns. Such models must, however, be tested in the laboratory first", confirms Feder.

Understanding the earth's 'machinery'

Four components are consistently involved in this research: field work, computer simulation, theory and experiments.

"The computing power achieved through ever faster computers makes it possible to simulate increasingly more complex natural processes and patterns. This represents a tremendous advance for scientific research in general", remarks Jamtveit.

"Computer simulation and theory are two areas where physicists are traditionally strong. The quantitative models are simplified replicas of what we see in nature. They contain components that represent the most important parts of nature's machinery", continues Jamtveit.

"We use theory to determine how different processes are related, and to compare what takes place in nature with what we see in computer simulations and in the laboratory."

One of the most serious challenges related to modelling is that the earth's mantle circulates like a liquid, while the lithosphere (outer shell of rock) is more brittle and cracks. To describe the mantle's currents, researchers use continuum mechanics, a good method for describing the dynamics of liquids. In the lithosphere, many fractures change over time and are therefore difficult to describe using continuum mechanics.

"Making an adequate and consistent physical model of how the break-up of the lithosphere is linked to the viscous flow of the underlying mantle is one of many formidable challenges facing us. Fortunately, one of the world's leading geodynamic modellers Yuri Podladchikov (previously at ETH-Zürich) has recently signed a full professor contract with PGP and the University of Oslo. Together with professor of applied mathematics Hans Petter Langtangen, Podladchikov and his collaborators at PGP will represent an internationally leading research environment in computational geodynamics."

↑ CROSSING DICIPLINES: Physicists and geologists have met in the field before. Here, Albert Einstein and Victor Goldschmidt having soup and discussing geology on an excursion in 1930. The CoE Physics of Geological Processes aims beyond the "soup stage" of cross-disciplinary research. (Photo: Courtesy of Physics of Geological Processes)

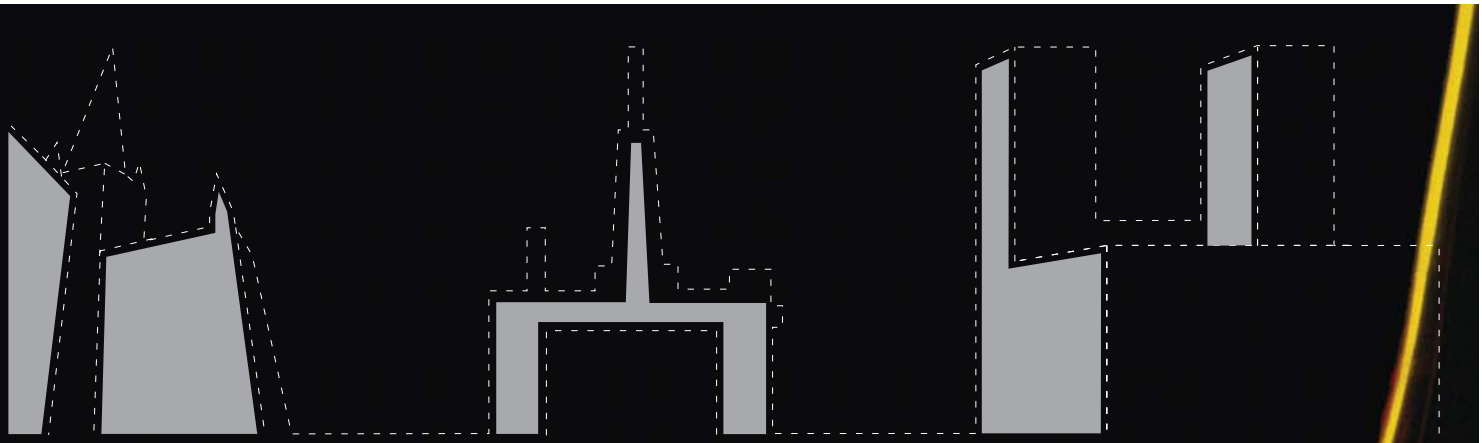
What goes around comes around

"Nature is interwoven, not divided into separate categories. It is important to be cognisant of what takes place at the interfaces between the various spheres: the biosphere, the geosphere, the hydrosphere and the atmosphere", elaborates Jamtveit. "That makes multi- and cross-disciplinary research a natural part of natural science. The trend towards more interdisciplinary research is absolutely essential. The CoE process has had favourable ramifications by contributing to the formation of more interdisciplinary research groups in Norway."

"We have overlapping interests", agrees Feder. Interest in all aspects of science is a prerequisite for good interdisciplinary collaboration. Generally speaking, everything we do is very competitive, but not within the group. Our focus is consistently on scientific merit. That makes co-operation easy", he adds, also pointing out that the CoE will mainly concentrate on basic research.

"It is demanding to embrace more than one subject area. However, boldness is of the essence. To be a first-rate CoE, we must dare to make mistakes", Feder says with conviction. "If our centre is still a Centre of Excellence ten years from now, we will have dared to risk moving into unknown territory, where finding a path is as important as finding an answer." □

← NATURE'S CHAOS: Nature is rife with patterns of stripes, spots and waves, according to the researchers. This picture shows cracks in a rock face in the Antarctic, on a mountain named the Troll Castle. The liquids that have streamed through the cracks have reacted with the rock around the crack, causing it to turn green.
(Photo: Håkon Austrheim, Professor of Geology at the CoE)



Oiling the wheels of society

According to petroleum researchers, Norway will be producing oil for more than another 50 years and gas for at least 100 years. This means the oil industry operates with the same future perspectives as any other in Norway.

[BY SIW ELLEN JAKOBSEN]

IT ALSO MEANS that Norway's oil adventure is far from over. There is a huge potential for producing more oil in the North Sea. According to oil industry calculations, for example, revenues from existing fields can be increased by about NOK 450 billion. However, attaining that goal will require further technological development, which will require more basic research and closer cross-disciplinary collaboration. The Centre for Integrated Petroleum Research at the University of Bergen (UiB) has been set up for precisely that purpose.

That being said, professors Arne Skauge and Magne Espedal feel no performance anxiety about the task before them. "Even if our research helps enhance the production of oil in the North Sea only a few tenths of one per cent, the CoE will have been a profitable investment. These investments are peanuts compared with the potential earnings, so we are reasonably certain we will be able to make the investments pay ", says Skauge.

Conservative prognoses

Not long ago, people were referring to the North Sea oil as a sunset industry. Why so much optimism all of a sudden?

"We are recovering far more from the proven oil reservoirs than we ever thought possible originally. This is because technological advances have allowed us to understand the fields so much better. Previous prognoses for oil production were no doubt conservative estimates. Fields that began producing in about 1970, like Ekofisk, will be producing oil until 2050, and possibly even longer", reports CoE Director Skauge.

"The sun is by no means setting on the Norwegian oil industry. It would be wrong to think so. To enhance recovery, we have to follow up in terms of expertise and human resources", states Espedal, a professor of mathematics at the Department of Mathematics at UiB. He represents one of the six departments at the university that are involved in the Centre (see fact box).

Formidable challenges

In the 1990s, experiments were undertaken to enhance quantification and reservoir descriptions using mathematical models. Attempts were made to produce numerical methods to describe what takes place when oil flows through a reservoir. This research enjoyed moderate success. "There is a great deal more to gain from taking a more cross-disciplinary approach", Espedal points out. The two colleagues agree that their work is challenging and difficult.

"An interdisciplinary approach generally means working with the lowest common denominator and making numerous compromises along the way, but that is not the case in this research. Here, we have to be willing to go in depth into disciplines other than our own specialities. Scientists have to take an in-depth approach to all the disciplines and make them work together as a whole. A geologist must have considerable insight into mathematics and a mathematician must have a good understanding of geology. We need the best mathematics, the best geology and the best physics to understand the processes involved. The two agree that this is the greatest challenge facing the CoE.

CoE = attractive

The concept is difficult and it will take time to build up a staff that can work well together, concede the two professors, but the foundation has already been established. Researchers from the various departments at the University of Bergen began to collaborate on petroleum-related issues already in the early 1980s. This informal collaboration is now being put into a system, but the CoE must also involve partners that can fill the gaps in its knowledge. Skauge does not consider this a problem. "After being awarded CoE status, we have received a great deal of favourable attention from

Centre for Integrated Petroleum Research

Objective: The Centre aspires to contribute to extended production by increasing recoverable reserves in existing oil and gas fields.
Participants: The departments of Mathematics, Physics, Geology, Geophysics, Microbiology and Chemistry, all at the University of Bergen, are involved in the CoE.
Annual allocation from the Research Council: MNOK 14
Number of full-time positions: Approximately 50 in 2003
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Website: www.cipr.uib.no/

↑ **TEAM:** Professor Magne Espedal (left) and CoE Director Arne Skauge. (Photo: Siw Ellen Jakobsen)

↑ **DECOMPOSED FLOW MODEL:** A numerical model of a fault zone. The model is divided into units that are allocated different types of flow properties based on flow experiments, among other things. (Illustration: Centre for Integrated Petroleum Research)

← **ELEGANT:** Oil researchers will be studying the multiphase flow of water, oil and gas in the reservoirs. (Photo: Floyd Dean/Getty Images)

researchers in Norway and abroad. The CoE opens opportunities to work in a long-term perspective. Otherwise, the term 'long-term research' hardly exists in the oil industry. Now we can delve into issues that require many years of research without worrying about fluctuating oil prices and funding sources that run hot and cold. The uncertainty has been reduced considerably."

Help from the industry itself

Both professors are of the opinion that basic research has been at a disadvantage compared with short-term applied research in the oil industry in Norway. At the same time, they are less than pleased with the distinction made between basic and applied research. "It is not entirely appropriate in this case. Naturally, the problems we deal with are defined in relation to the production of oil. They have to be solved from the practical point of view, but we require a theoretical platform for finding practical solutions. That is why basic and applied research go hand in hand", asserts Skauge, who stands with one foot in industry and the other in the world of academia. He has been head of reservoir technology research at Norsk Hydro's research centre in Bergen for the past 20 years, at the same time as he has had a part-time job at the University of Bergen as professor II in reservoir physics for the past 12 years.

The Norwegian oil industry is footing most of the bill for the Centre for Integrated Petroleum Research. Today, 60 per cent of its activities are funded by the industry, and the researchers expect that proportion to increase in the years ahead.

Rendering the natural sciences visible

Close co-operation with industry gives the petroleum research community a broader selection of human resources to draw upon. Highly qualified people are not to be taken for granted in this industry. Many were recruited in the 1970s, and will soon be approaching retirement. The recruitment situation is not dramatic as yet, but the general decline in recruitment to the sciences gives cause for concern.

"We hope and believe that the establishment of this CoE will help render the natural sciences more visible and attract more students into the system. It will also allow us to accept more PhD students than we have had the capacity for in recent years", reports Skauge.

Difficult field

When oil production began in Norway in the 1970s and 1980s, the oil companies found immense reservoirs that were relatively easy to tap. Companies have not discovered any more major fields in recent years, but they have located a number of smaller ones that are far more difficult to tap. "The small fields are more complex. It is challenging to describe them, to model production and to boost the recovery rate", remarks Skauge, continuing: "Geologists have to ascertain which physical characteristics applied when the reservoir was formed. Was the area made up of sandstone, lime, quartziferous sand or did it have a high content of clay? Then they set up a geological model based on a classification by species of rock. The geological model must be further simplified into a reservoir model before we can calculate the multiphase flow of water, oil and gas in the reservoir. The transition from the geo-model to the reservoir model is extremely complex, and depends on close, interdisciplinary collaboration.

"We hope we can devise practical solutions that the oil companies find interesting, but we cannot solve all the problems associated with production on our own", smiles Skauge.

Although the research at the CoE is aimed at boosting the recovery rate, the CoE director points out that some of the research may also be applicable to exploration activities. □

Just asking for problems

Without algebra and geometry, neither US Lara Croft nor Norwegian Solan Gundersen could make their 3D appearances in the computer games in which they star.

[BY SUSANNE MOEN]

COUNTLESS PROBLEMS HAVE been solved by figures and formulae. But mathematicians long for even more problems. In fact, they claim the problems they encounter inspire them to develop even more sophisticated mathematics. Accordingly, they expect to make great strides in the development of theory by joining forces with problem-suppliers such as physicists, computer experts, astrophysicists and economists in the CoE *Mathematics for Applications* at the University of Oslo.

No maths without applications

"Mathematics is driven by applications", explains CoE Director Ragnar Winther, professor of mathematical modelling at the Department of Informatics at the University of Oslo. He explains that mathematics does nothing in itself, but that it is a practical subject and an essential tool for other natural sciences. All mathematical problems are a factor of their times as well as of the technology of those times. What needs to be calculated today? What can we calculate today?

The Abel Prize

The Abel Prize is a new international prize for mathematics which was awarded for the first time in 2003. The prize was introduced last year in connection with the 200th anniversary of the birth of one of the giants of mathematics in the 1800s, the Norwegian Niels Henrik Abel. To be awarded annually by the Norwegian Academy of Science and Letters, the prize consists of NOK 6 million (approx. € 800 000).

As there is no Nobel Prize in mathematics, many believe the Abel Prize will become the Nobel of mathematics. The highest distinction that can be obtained in mathematics at present is the Fields Medal, which is awarded every fourth year but involves no money, just honour and recognition.

One of the most important mathematicians of our time, Jean-Pierre Serre of France, was the very first winner of the Abel Prize, awarded in Oslo on 3 June 2003. Serre has been making profound contributions to mathematics for more than half a century, and continues to do so in areas such as topology, algebraic geometry and number theory. □

← THE FIRST WINNER: Jean-Pierre Serre, winner of the Abel Prize 2003. (Photo: Abel Prize Secretariat)

Computers opened a new mathematical reality

"The world-famous Norwegian mathematician Niels Henrik Abel had no opportunity to study the mathematics we study today", remarks Winther. "First of all, he had no possibility to even recognise the problems that concern us: How can we design an optimal production strategy for an oil field? Can we calculate economic development? Second, he did not have the technology needed to make the sophisticated calculations we make today.

"By using a computer instead of a pencil and paper, we can solve entirely new types of equations, meaning mathematics has changed drastically. Today, we can make calculations with several million variables in the equations", says the professor.

In principle, there are no limits. Computers are made with increasingly more memory. Right now the machines are out in front, while mathematics is lagging behind: We can no longer fully utilise computers' capacity by running mathematical calculations alone. *Mathematics for Applications* plans to do something about that situation.

Three keys to CoE success

Professor Winther is cautious, but clear, when he responds to the question of why their application was successful, making *Mathematics for Applications* one of Norway's thirteen Centres of Excellence.

"First of all, we have assembled a staff of top-notch researchers. Second, we have a project concept that takes a highly interdisciplinary approach and includes all relevant subjects. Third, our application *per se* was very carefully prepared", continues Winther. "We worked hard to draw up a good, well-written application that conveyed an accurate description of what we plan to accomplish. That may have been a decisive factor", smiles the CoE Director.

Pre-occupied with recruitment

Another extremely favourable element pointed out by the scientific experts who evaluated the application is the centre's focus on recruitment. One of them writes: "One of the most interesting features of the project is the creation of a new educational programme [...]". The programme, called Applied Mathematics and Data, has now been established at the University of Oslo. Instruction began in 2002, and about 30 students participate in the programme. The subject will eventually be offered at the bachelors, masters and PhD levels.

Further, the centre plans to spend the majority of the funding it receives from the Research Council on recruitment positions. "We plan to have 15 to 20 recruitment positions at the Centre at any given time", relates Winther.

"It is vital to the field to recruit bright new talent, and we believe the establishment of a Centre of Excellence can enhance public awareness of the subject, making it easier to recruit people. We also aspire to be international and we intend to forge ties with professionals from abroad who will join us at the Centre."

→ **THE SCIENCE BEHIND THE ART:** It takes sophisticated geometry to animate Solan Gundersen in the Flåklypa Grand Prix game. This three-dimensional computer model consists of 200 000 triangles and rectangles joined together to make larger, preferably curved surfaces. (Illustration: Caprino Video Games)

World-class mathematicians

Cautious as he is, Winther does not blow his own trumpet when it comes to having a world-class position. However, the scientific experts' evaluations leave no doubt that all the key researchers in the group are international capacities in their fields.

Through the CoE scheme, the Research Council aspires to produce researchers and research of international calibre. The goal is quite simply to win more Nobel prizes for Norway. Does CoE Director Winther believe that?

"It seems a bit over the top, not least given that there is no Nobel Prize in mathematics. Of course, we do have the recently established Abel Prize" (see page 28), grins the CoE Director.

Ragnar Winther has not let the appointment go to his head. He reminds us opportunely that the CoE scheme in Norway is nothing special by European standards. Focusing on research groups by identifying the most progressive groups and granting them additional allocations is all the rage in Europe. "That translates into stiff competition", asserts the professor of mathematics.

Winther also points out potential disadvantages of the CoE scheme. "The Centres of Excellence will be foreign elements in the established university structure, and some people might have political objections to this form of elitism. It could result in conflicts. I am anxious to see how our Centre will function in the community." □

Mathematics for Applications

Objective: To further develop the theoretical foundation for sophisticated mathematical calculations using computing power and based on the following four pillars: geometry, stochastic analysis, differential equations and applications in physical subjects.

Participants: The University of Oslo (UiO) is the lead institution. The departments of Physics, Mathematics, Informatics and the Institute of Theoretical Astrophysics at UiO will collaborate with SINTEF Applied Mathematics as active partners. SINTEF is the Foundation for Scientific and Industrial Research at the Norwegian University of Science and Technology. The Centre will also sign individual agreements with employees at the Norwegian School of Economics and Business Administration and mathematicians at the University of Bergen and the Norwegian University of Science and Technology in Trondheim.

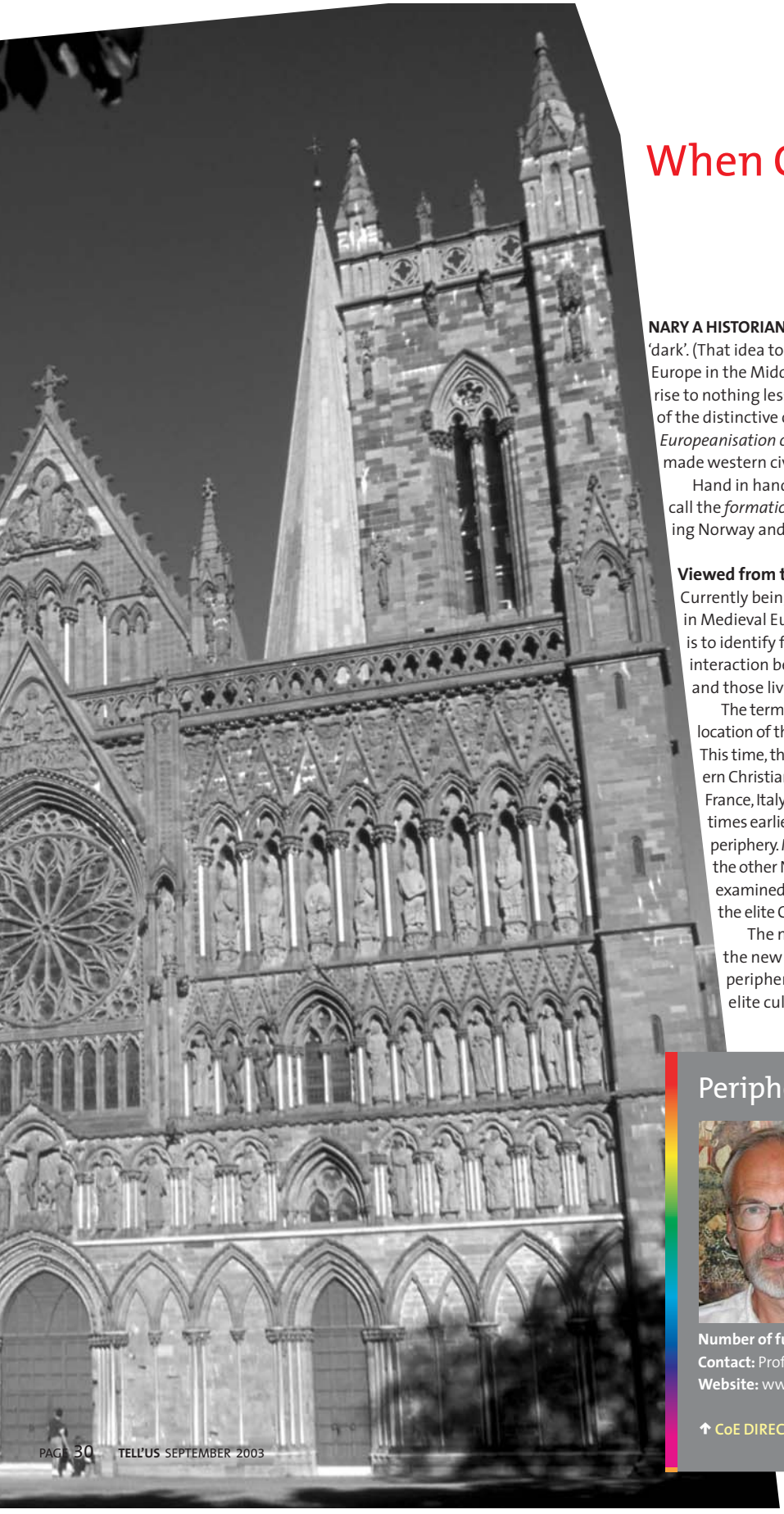
Annual allocation from the Research Council: MNOK 11

Number of full-time positions: Approx. 30

Contact: Ragnar Winther, Tel.: (+47) 228-52422, E-mail: rwinther@ifi.uio.no

Website: www.cma.uio.no/

↑ **FOR USE:** "Mathematics is driven by applications", explains CoE Director Ragnar Winther, professor of mathematical modeling at the Department of Informatics at the University of Oslo. (Photo: Susanne Moen)



When Christ and Europe came to

NARY A HISTORIAN would venture to contend anymore that the Middle Ages were 'dark'. (That idea took root during the Renaissance, and has been a burden ever since.) Europe in the Middle Ages was the birthplace of today's European states, and gave rise to nothing less than modern democracy and parliamentarianism. The formation of the distinctive culture that evolved involved a process known as the *Europeanisation of Europe*. Perhaps it also holds the key to determining what has made western civilisation such a dominant global factor for many centuries.

Hand in hand with the *Europeanisation of Europe*, is a factor historians like to call the *formation of western Christendom*. The process started in the 800s, reaching Norway and the rest of Europe's periphery a few centuries later.

Viewed from the periphery

Currently being set up at the University of Bergen, the CoE Periphery and Centre in Medieval Europe will be delving into medieval history. The CoE's main project is to identify formative traits of the *Europeanisation of Europe* by examining the interaction between Norwegians and other peoples on the periphery of Europe, and those living further to the south and west, in the centre of Europe.

The term periphery will be of the utmost importance, not least since that is the location of the new CoE to be known as "Periphery and Centre in Medieval Europe". This time, the study of the Middle Ages, Europeanisation and the spread of western Christianity will not be based on what took place in centres such as England, France, Italy, and similar areas west of the Rhine, as has been the case several times earlier. Instead, it will take its point of departure in the view from the periphery. More specifically, the study will be based on the view from Norway, the other Nordic countries and Eastern Europe. Previous research has generally examined the dramatic cultural changes that took place in the Middle Ages as the elite Christian culture proliferated from centre to periphery.

The new CoE will attempt to answer the following questions: How were the new cultural impulses really received in the periphery? How did the periphery influence the centre? What did the Middle Ages' international elite culture look like, viewed from the periphery?

Periphery and Centre in Medieval Europe

Objective: The Centre intends to identify formative traits of the Europeanisation of Europe by examining the interaction between periphery and centre.
Participants: The University of Bergen is the lead institution. The School of Mission and Theology in Stavanger and Cambridge University are partners. The project will include historians, theologians, philologists, archaeologists and art historians.
Annual allocation from the Research Council: MNOK 6
Number of full-time positions: 5–7
Contact: Professor Sverre Bagge, Tel.: (+47) 555-82325, E-mail: sverre.bagge@cms.uib.no
Website: www.uib.no/cms/

↑ CoE DIRECTOR: Sverre Bagge (Photo: Bård Amundsen)

Norway

What really happened 1000 years ago when the new, Christian European culture reached the periphery of the Continent, notably Scandinavia and Eastern Europe? Norway lends itself well to the study of this historical collision of cultures.

[BY BÅRD AMUNDSEN]

"If the CoE can generate fundamental new insight into our European past, perhaps it can also help us to understand changes taking place in Europe and the rest of the world today. I'm referring to changes associated with migration, cultural integration and identity", states the optimistic CoE Director, Professor Sverre Bagge.

Norway in the Middle Ages

The history of Norway during the Middle Ages is especially intriguing as the break between the local situation and the new future can be seen more clearly here than in most other places. Norwegians are also more familiar with their pre-Christian history than many other European peoples. In fact, that familiarity has an impact on Norwegians' identity even today.

The Christianisation of Europe commenced during the final stage of the Roman Empire. In the 900s and 1000s, the European periphery attained its zenith when the Christian doctrine reached the Nordic countries, the Baltic States and Eastern Europe. "Since that time, it has above all been the similarities between large parts of Europe's culture that have been striking, for example, much of the architecture", contends Bagge. "By the same token, this was not a one-way process where centre influenced periphery. The influence also went in the other direction. Just imagine what it must have been like, for example, for the Polish Copernicus, from his place in the periphery, to dare to controvert all 'the powers that were' by asserting that the planets revolve around the sun. Today we know that cultural influence is based on reciprocal action. But we still have a great deal to learn about how that interaction took place, and how it is still taking place."

"Medieval Europe was a gigantic laboratory for cultural influence", observes Professor Bagge. He, his colleagues at the CoE in Bergen and their international partners intend to find out more about that laboratory. Hopefully, they will be able to make discoveries that will open up entirely new perspectives on what actually happened.

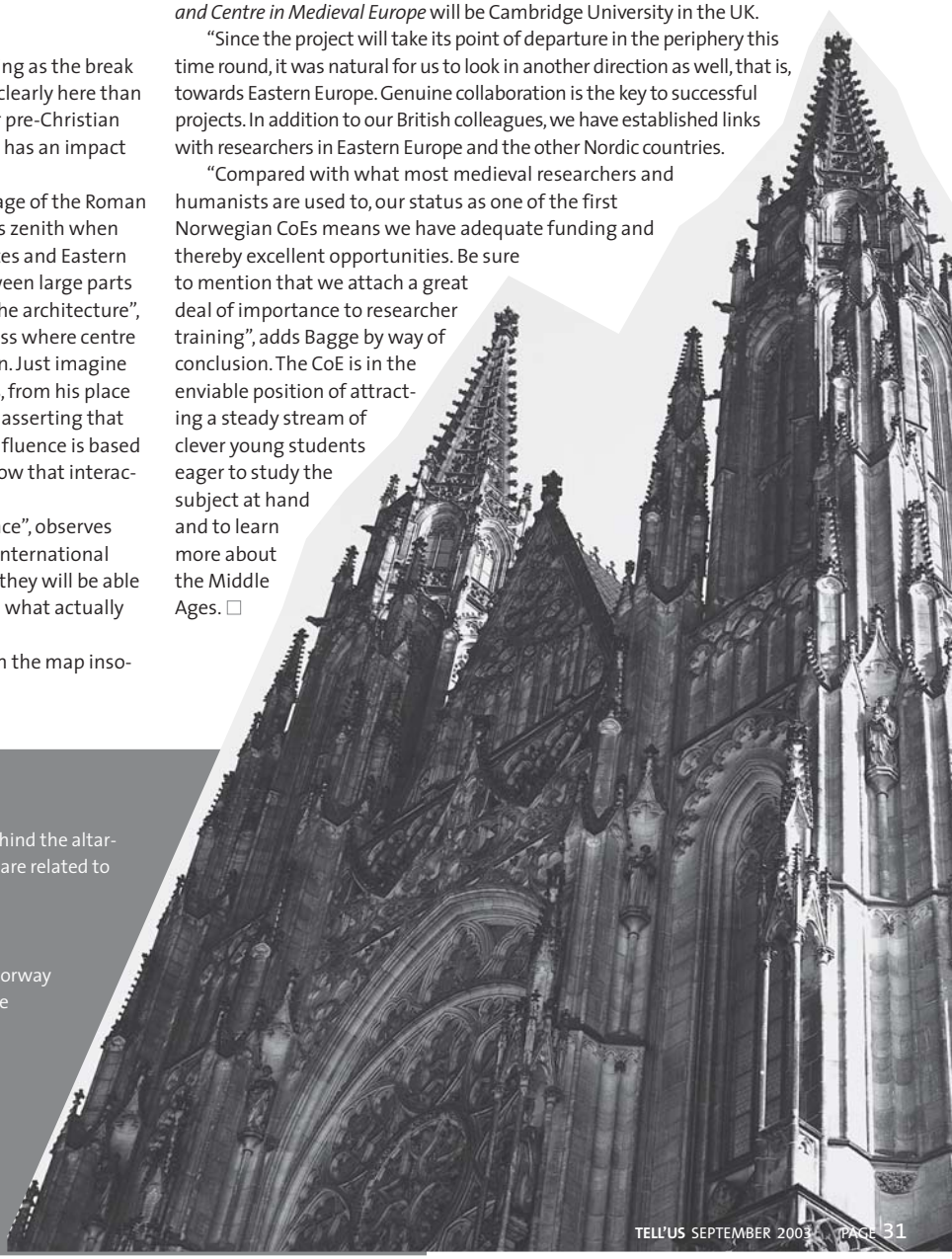
Sverre Bagge describes this as a project that can put Norway on the map insofar as European medieval research is concerned.

Eastern Europe

Bagge himself is a very central figure in Norwegian medieval research, having written several books about it. His medieval milieu in Bergen may possibly be the most internationally oriented one in Norway, and the Centre of Excellence is no exception. Apart from the School of Mission and Theology in Stavanger, the main partner in *Periphery and Centre in Medieval Europe* will be Cambridge University in the UK.

"Since the project will take its point of departure in the periphery this time round, it was natural for us to look in another direction as well, that is, towards Eastern Europe. Genuine collaboration is the key to successful projects. In addition to our British colleagues, we have established links with researchers in Eastern Europe and the other Nordic countries.

"Compared with what most medieval researchers and humanists are used to, our status as one of the first Norwegian CoEs means we have adequate funding and thereby excellent opportunities. Be sure to mention that we attach a great deal of importance to researcher training", adds Bagge by way of conclusion. The CoE is in the enviable position of attracting a steady stream of clever young students eager to study the subject at hand and to learn more about the Middle Ages. □



↗ **ART:** This picture (top right) shows the stained glass paintings behind the altarpiece in St. Vitus Cathedral (see below). The stained glass paintings are related to similar images in the Nidaros Cathedral (p. 30). (Photo: Scanpix)

←→ **CHRISTIANITY TO NORWAY:** Christianity and Europe came to Norway and the rest of the European periphery in the Middle Ages. There are many similarities between the Nidaros Cathedral in Trondheim, Norway and St. Vitus Cathedral in Prague in the Czech Republic. (Photo: Samfoto (p. 30) and Scanpix)

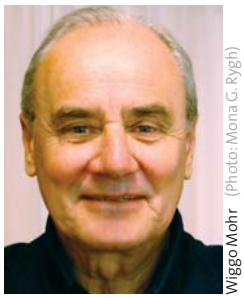
NO MERCY?

– THE STORY AND POLITICS OF NORWEGIAN CoEs

The Research Council's designaton of the new Centres of Excellence (CoE) marked the conclusion of the most far-reaching selection process ever to envelop Norwegian research. It resulted in the formation of 13 centres that will most certainly have an impact on international knowledge development. At this point, the story of the CoE scheme has barely started.

[BY MONA GRAVNINGEN RYGH]

THE PUBLIC SENTIMENT was that it was high time to enhance the quality of Norwegian research and ensure its international competitiveness. "High-quality research should be promoted and rewarded", stated the White Paper on Research presented in 1998–99. The then Ministry of Education, Research and Church Affairs asked the Research Council to explore the possibility of a 'Centres of Excellence' scheme.



Wiggo Mohr (Photo: Mona G. Rygh)

"Many leading research nations have similar centres", relates Senior Adviser Viggo Mohr of the Research Council. "Accordingly, we began by making a thorough evaluation of foreign CoE schemes and used it as the basis of our recommendations. The Research Council recommended that there be a public call for proposals for the CoE scheme, and that the application process be open to all Norwegian R&D groups."

The selection process *per se* proved highly useful

"The process of deciding which applicants should be accorded CoE status was inspiring. The Research Council received a large number of high-calibre applications. Many wished it had been possible to establish even more new centres right away", comments Mohr, who bears operative responsibility for the scheme.

Mohr emphasises that the CoE process and the application work *per se* have had favourable and even surprising ramifications – also for many of those not selected. Among those ramifications are new co-operation constellations and new, quality-promoting measures that have emerged as a direct consequence of the process.

Controversial

Although excitement and enthusiasm were the most common reactions to the scheme, some critical voices were also raised. Among other things, it was contended that 'hothouses like this may provide plenty of resources for good researchers, but they will deplete the diversity of Norwegian research...'. It was also suggested that the selection of the 13 centres was governed by regional and industrial policy, and that too much importance was being attached to applied research and relevance criteria. Others complained because all the CoE directors are men.

Criticism from the research communities questioned the professional quality of the CoE selection process itself, but the Research Council strongly refuted such comments.

Christian Hambro (Photo: Eva Brænd)

A transparent process

"The selection of the 13 CoEs represents the most thorough process of ranking priorities ever conducted in the history of Norwegian research", states Director General Christian Hambro. "The process was conducted with complete transparency and the criteria were cleared with all key bodies in advance. Internationally respected scientists handled the quality assurance."

The grounds for ranking application priorities were announced in the call for proposals: "The main criterion is scientific quality at a high level by international standards. This criterion applies to planned research as well as to the centre's key scientific personnel. The utility value for industry or society-at-large is a supplementary criterion."

Pursuant to the Ministry of Education and Research's comments regarding the establishment of the scheme, importance was attached to including the four national target areas listed in the above-mentioned White Paper: medicine and health, ICT, marine research and research in the interface between energy and the environment.

More to come

The 13 centres represent only about ten per cent of the original applications, so it is obvious that many good applications were not successful. Given the high quality of the applications and the positive experience engendered by the process, the Executive Board of the Research Council voted to increase the annual budgetary parameters of the CoE scheme from MNOK 140 to MNOK 155. The Executive Board also adopted a statement of intention to expand the scheme by 5 to 10 new CoEs within budgetary parameters of roughly MNOK 100, based on a call for proposals in 2005/06.

THE DESIGNATION PROCESS IN SHORT

- In response to the first call for proposals for the Norwegian CoE scheme in February 2001, 129 applications were submitted for pre-qualification. The quality of the applications was generally high.
- Following a comprehensive evaluation process, 40 of the 129 applicants were invited to move on to the second and final round of applications.
- As in the pre-qualification round, the scientific merit of each applicant was assessed by at least four international scientific experts, independently of each other.
- In the light of those expert recommendations and its own assessments, an international scientific committee (consisting of 11 prominent foreign scientists representing a wide variety of subjects and disciplines) ranked the priority of the applications based on scientific merit and quality.
- In addition, the Research Council's Research Boards made evaluations based on the centres' commercial or social utility value.
- A separate Selection Committee was appointed to undertake the final selection based on the recommendations of the Expert Committee and the Research Boards. The committee consisted of four members of the Research Council's Executive Board and three independent experts. The Selection Committee was headed by the then Chair of the Executive Board, Frøydis Langmark, Chief Physician of the Cancer Registry.
- The Selection Committee adopted a decision regarding which centres should be given Centre of Excellence status and allocations. The decision was made public on 12 June 2002.
- The contracts with the 13 CoEs call for detailed research plans, which will be essential input when the centres are evaluated after 3.5 years of operation.

For more information, please see:
www.forskningsradet.no/fag/andre/sff/english/

A year later, the Minister of Research considers the CoE scheme highly successful, and has now announced that the Norwegian government plans to extend it from 2007 (see page 34). The Research Council's ambition is that Norway will eventually have about 30 CoEs.

Kari Kveseth (Photo: Eva Brænd)

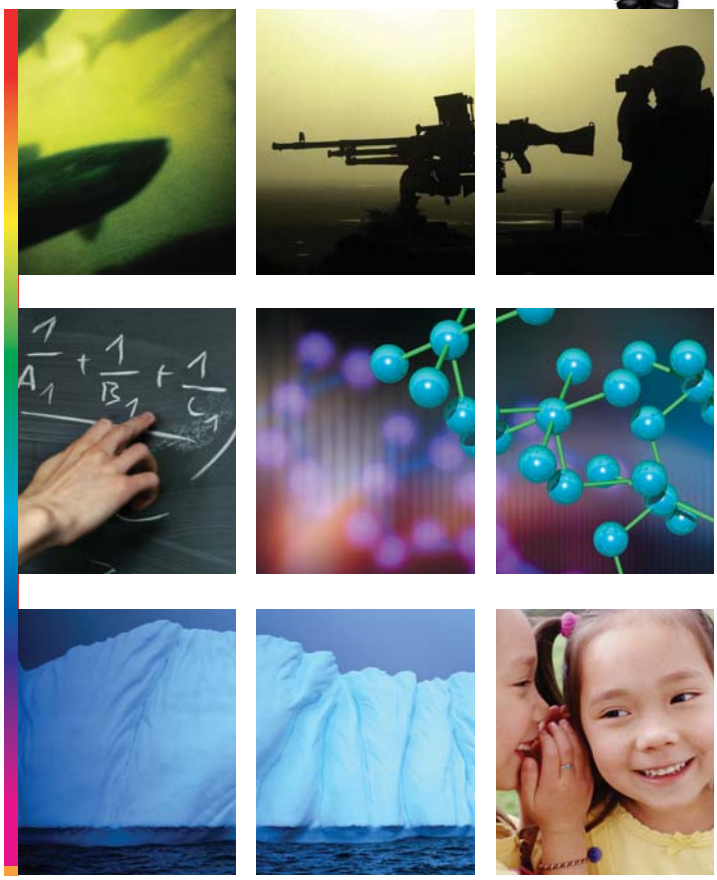
Interaction and internationalisation

"The Research Council has conducted several broad-based subject and discipline evaluations that have shown that Norwegian research communities are generally too small. More concentration is therefore an important policy instrument for promoting quality", points out Kari Kveseth, Executive Director, Strategy. "The others are more funding, more competition, more interaction and – not least – more internationalisation.

"The CoE scheme will not impoverish research in Norway. The challenge lies in striking a balance between specialisation and breadth. The CoE scheme accounts for no more than three to four per cent of our overall budget. Although we would like to make more resources available to the CoEs, the point is that we have to have enough funding to explore a wide range of subjects at any given time. After all, that diversity is the spawning ground for the CoEs of tomorrow!

"The CoEs open opportunities for more researchers to work together towards the same vision under the superstructure of a common plan, and under stable long-term operating conditions. There will be more concentration, and Norway's PhD programmes will be improved. Drawing up good research plans is a demanding task for research groups, and research management is no less demanding. It is precisely these qualities that are highlighted in the CoEs, and that are the basis of our expectations.

"The CoEs signal the advent of a new era. It is 'legal' to aspire to be the best, and we know the best way to achieve that is by working together rather than by standing alone", she says. "We have consulted the most prominent experts in the world to advise us in the process of designating the Norwegian CoEs. The centres will undoubtedly make their mark on the future of Norwegian research, and we expect them to have an impact in the international arena as well." □



(Photos: Digital Vision, Image Bank, Scanpix and PRIO)

Boundless ambition

Kristin Clemet (Photo:Scanpix)

THE NORWEGIAN GOVERNMENT'S ambition is for Norway to be in the forefront in terms of knowledge, expertise and new technology. This calls for quality improvement throughout the entire educational and research system. While it has become increasingly clear that Norway needs to enhance the quality of its research, there are numerous examples of Norwegian researchers who perform at a high international level, not least in connection with the EU framework programmes for research. Recent evaluations have also given Norwegian research groups top scores in fields such as neuroscience, climate research, mathematics and ICT.

"If we want to develop more international-calibre research groups, we have to focus far more intently and systematically on quality than what we have been in the habit of doing in Norway."

If we are to develop more international-calibre research groups, we have to focus far more intently and systematically on quality than what we have been in the habit of doing in Norway. My impression is that there is broad support for this new approach to Norwegian research. The enthusiasm spawned by our new Centres of Excellence (CoE) scheme is proof positive that it has become acceptable to focus on the best, most promising researchers. Great efforts are currently being invested by Norway's universities and university colleges as they implement the Quality Reform aimed at improving quality and promoting internationalisation. At the same time, the Norwegian government has increased allocations for the purchase of scientific equipment substantially and launched a new initiative to encourage outstanding young scientists.

Notwithstanding, the Centres of Excellence scheme is the most important single measure designed to improve the quality of Norwegian research. Although only a year has passed since the first 13 centres were created, the scheme has already had a favourable impact. The call for applications inspired innovation and engendered exciting new co-operation constellations across subject and institutional boundaries. All 40 candidates that made it to the second round of applications were considered highly qualified. The Norwegian government is eager to build further on the favourable experience gleaned from the first call for proposals.

Accordingly, the CoE scheme will be extended by creating more centres already from 2007, based on a call for proposals to be issued in 2005.

"European research co-operation currently attaches considerable importance to creating networks between countries' centres of excellence. Norway aspires to participate actively."

One important objective of the Centres of Excellence is that they are to make extensive contributions to international knowledge development. European research co-operation currently attaches considerable importance to creating networks between countries' Centres of Excellence. Norway aspires to participate actively in this co-operation, and will therefore strive to develop research groups of the highest international calibre. The CoEs are also expected to maintain an international profile within their organisations, e.g. by recruiting foreign researchers.

Outstanding research cannot be achieved through stopgap measures, but only through patient, systematic efforts over time. The new CoEs will have the time and resources they need to conduct long-term research in their respective fields. They will not be required to produce immediate results. In the long term, however, their ambition should be to perform research of Nobel Prize calibre. □

Kristin Clemet
Norwegian Minister of Education and Research