Protecting nature through technology

The focus of this issue is man’s interaction with nature and technology. The image of gushing springs and roaring waterfalls symbolises the challenges we face in respect of energy, the environment and prudent resource management.
Energy, the environment and technology

The theme of the world’s fair EXPO 2000 in Hanover, Germany, is “Humankind – Nature – Technology”. The Norwegian Pavilion focuses special emphasis on energy and the environment, two fields of great importance that have long traditions in Norway.

The Research Council of Norway has devoted this special issue of Tell’Us to presenting some of the most outstanding contemporary Norwegian research projects that fall within the relatively broad parameters of the overall theme of the world’s fair. The editorial board has slanted its selection of articles to accord with Norway’s approach to the Hannover theme.

The Norwegian pavilion at EXPO 2000 has three separate areas for communicating with visitors:

The falls – a replica of the raging Steindal Falls, symbolising a powerful, clean, natural and renewable source of energy. The waterfall is 15 metres high, and features a water flow of 450 litres per second, adding up to 38 million litres per day. This is an invaluable source of renewable energy, reminiscent of Norway’s abundant hydropower resources that provide power for industry as well as panoramic beauty for tourists.

The second area features an artistic installation created by the internationally renowned Norwegian artist Marianne Heske. Besides being a large work of art, the room itself is a product of high-tech Norwegian innovation. The walls, measuring 15 metres across and 15 metres high, are covered by abstract natural patterns. The images have been burned into more than 600 specially-treated aluminium sheets which were produced by hydropower. The overall effect imparts a very special feeling about man’s role in the scheme of things.

Heske’s point of departure for this digital image processing is a digitised picture from a small power-producing mountain village on the west coast of Norway, Tafjord, magnified more than two million times. The installation aspires to communicate the wish that humankind hold technology in high esteem.

The third area, the in-depth room, is intended to give visitors the opportunity to learn a little more about some of the research and development being conducted in Norway. All major industrial enterprises agree that research is crucial to product development. Accordingly, it seems natural for Norway to present examples from some of its leading research facilities, both those operated by private enterprises and those within scientific institutions.

The Research Council would like to project an image of Norway as a country which assigns high priority to research, and which has made considerable progress in key fields of research. The presentations are all under the same roof, which, by the way, is held in place by huge Norwegian glulam (glue laminated timber) girders, developed as a result of advanced research that opens whole new horizons for numerous types of constructions.

If you are lucky enough to visit EXPO – let these myriad impressions flow over you! If you are reading Tell’Us without having experienced the wonders of EXPO, you can look forward to learning more about a wide range of incredibly exciting research projects. In fact, the magazine contains more comprehensive and in-depth information than what we can possibly present at the Norwegian pavilion!

Paul Alme
Executive Director
The Research Council of Norway
Norway EXPO 2000 Board Member
The electric car TH!NK is the first fully fledged automobile Norway has ever created on its own. It was approved pursuant to EU standards in 1998, and the car is made of a solid, colour-modelled thermoplastic polyethylenek shell, supported by a steel understructure and a welded aluminium space frame. The idea behind TH!NK is based on three principles: 1) environment-friendly production – including painting; 2) environment-friendly operation – electric; 3) environment-friendly disposal – simple to disassemble, easy to recycle. Based on materials never before used before to produce the car, the TH!NK cars are made using innovative new assembly technology, specially developed to keep costs down and assemble the car in one day and a special factory layout. TH!NK is manufactured in Norway by TH!NK Nordic AS, which is in the process of building up an international centre of knowledge and expertise about light, ultramodern cars. The idea is for Norway to be the centre for R&D and technological developments in the field of energy efficiency, drive systems, materials and building and process technology, while the car will be assembled in the field, i.e., in the individual user’s home. TH!NK Nordic is engaged in continuous R&D in respect of the various models of TH!NK, co-operating with other R&D institutions in a national and international arena.

The initial idea for the TH!NK project was conceived in 1973, and a development company under the name Pivco AS was founded in 1980. The enterprise has received substantial state support through the Research Council of Norway and the State Industrial and Regional Development Fund. The project was awarded EUREKA (European network for market-oriented R&D) status in 1993. In 1993, the Ford Motor Company acquired 51 per cent of the enterprise and changed the name to TH!NK Nordic AS. At the beginning of this year Ford Motor Company acquired the rest of the shares. The cars are being produced at Aurskog, approximately 50 km East of Oslo. The plant has the capacity to produce 5000 vehicles per year. Norway has been the site of numerous measures designed to promote the use of electric cars, ranging from reducing automotive registration fees, annual licence fees and scrapping fee, to offering free passage on toll roads and free on public parking.

Website: www.think.no
Mona Gravningen Rygh

TH!NK of a car
“Do we face an ethical dilemma if fish can actually feel pain, and is their suffering, if it does exist, of independent moral importance?” asks Senior Lecturer Andreas Føllesdal of the Faculty of Arts at the University of Oslo (UiO). He is heading a research project entitled “Can salmon suffer?” which is part of the Research Council’s “Salmon production” programme. The project will determine whether fish can suffer in the sense referred to in regulations concerning experiments on animals and in general ethical reflections. The project calls upon the expertise of theologians, philosophers, biologists and fish physiologists.

Fish farming is Norway’s second most important source of export revenues. In the fisheries industry, reference is made to production-related suffering which involves pushing a species’ biology beyond the limits of what is natural, in the strictest sense. Such pragmatic considerations put a fine but urgent point on the question of animal welfare and fishing industry management. Why are we less concerned about fish welfare than mammal welfare?

“Our perception of animals is anthropocentric, that is, it is based on man being the centre of the universe. We see animals either with the callousness of the hunter or the scientist, or with caring, compassion and empathy”, contends dr.med.vet. Bergljot Borresen, author of “The Lonely Ape.” According to her, we do this because people are equipped with a toggle switch in their brains that allows them to turn on and off their ability to get emotionally involved with other species. For example, a hunter views an animal exclusively as prey, ‘turning off’ his sense of compassion during the hunt. Then he carries his prey home, lights the fireplace and ‘turns on’ the emotional toggle switch to cuddle with his dog. Fish, on the other hand, do not exchange contact signals with people, nor do they signal pain, meaning they do not arouse any feelings of empathy in people. In plain English, their ‘Bambi factor’ is too low.

Yet the concept of ‘pain’ can be interpreted in different ways. According to Trond Brattelid from the School of Veterinary Science in Oslo, fish receive pain signals through pain receptors located in the tail, fins and around the mouth and eyes. The signals are transmitted through the neural system to the cortex of the brain, where they are processed and possibly interpreted as pain.

“Fish have a small cortex, and they are not equipped with a neocortex, which some would contend is a prerequisite for feeling pain. There is therefore considerable uncertainty about whether fish actually experience what we define as pain”, Brattelid points out. “Yet fish have a telencephalon or endbrain, and it may play a part in fear, suffering and learning. In any event, it will be up to the salmon researchers or fish farmers to interpret piscine pain signals based on fish behaviour.” Brattelid adds that attempts to escape, changes in pigmentation and similar behaviour may all be indicative of pain.

BIG SALMON: Do we face an ethical dilemma if fish feel pain?

(Photo: Samfoto)
1983 was a watershed year for the Internet. It marked the very first meeting convened to discuss the idea of a global network, and the meeting was held in Oslo. The main players from Norway were Pål Spilling, then of the Norwegian Defence Research Establishment, now a professor at the University of Oslo, and Rolf Nordhagen, then EDP manager, also now at the University of Oslo. The two are considered the ‘fathers’ of the Internet in Norway.

Yet the real history of the Internet dates back to the University of California in 1969: Two computers were linked together for the first time to form the Internet’s predecessor, the US national network called Arpanet. In 1973, Norway became the first country outside the USA to be linked to the Arpanet. Spilling was working at the Norwegian Defence Research Establishment in 1974 when he was invited to take part in Arpanet, a collaborative project that made Norway a pioneer in Internet development outside the USA.

THE BIRTH OF THE INTERNET: In 1983, Oslo’s Holmenkollen Park Hotel was the venue for the very first meeting convened to consider establishing a global computer network. (Photo: Pippip)

As time passed, Norwegian universities began developing a system that eventually became the academic computer network Uninet. In the early 1980s, there were still just two countries outside the USA trying to implement a national computer network: Great Britain with Janet and Norway with Uninet. Somewhat later, the Nordic countries began collaborating, resulting in the Nordunet, and making the Nordic region a major power in European network cooperation.

Larry Landweber of the University of Wisconsin, the man in charge of the American CSNet, took the initiative for the historic meeting convened to consider establishing a global research network. A dozen representatives from various walks of life and different countries attended the meeting. At a hotel with a panoramic view of Oslo and the vast forests, fjords and mountains in and around the city, the participants managed to find common ground and a common pioneer spirit, despite the fact that there was some disagreement about technological solutions. The Oslo meeting was the first in a series of events that preceded the first official international conference of the Internet Society in 1991. Rumour has it that back in the summer of 1983, the founding fathers’ discussion continued in Nordhagen’s garden into the wee small hours of the morning, waiting for the darkness that never came in the Land of the Midnight Sun.

Mona Gravningen Rygh

Human beings are not the only ones fond of the taste of that much sought-after delicacy, the scallop. Edible crabs like them too. What is more, the edible crab, also known as the brown crab, prefers cultivated scallops to wild scallops of the same size and age. In a project under the auspices of the Research Council’s programme “Farmed marine species”, researchers at the Institute of Marine Research, Centre for Aquaculture, have now shown that 30 cm high steel plates erected like fences on the seabed are an effective means of keeping edible crabs on the right side of the fence to prevent them from feasting on beds of vulnerable farmed scallops.

“We are testing the system in collaboration with some industrial players. With a few modifications to the methods and equipment, this looks as though it may be a cost-effective way of protecting farmed scallops destined for human dinner tables”, comments Øivind Strand, a researcher at the Institute of Marine Research.

“Scallops are delicious, I love them! As do most people. I have yet to meet anyone who doesn’t like scallops that have been prepared correctly”, adds Strand. Since 1996, he has been working on how to cultivate scallops on the seabed. More research will be necessary to develop scallop farming methods that are sufficiently commercial to take advantage of the huge export market demand that exists. More than 50 000 metric tonnes of scallops are sold each year in France alone.

Anita K. L. Thorølvsen
Arctic sea ice is a sensitive indicator of climatic change, and climate models predict that global warming due to the greenhouse effect will have a stronger impact on the areas around the North Pole than other places. Accordingly, it created quite a sensation when oceanographer Ola M. Johannessen and two of his colleagues recently used satellite observations to determine that multi-year Arctic ice has been reduced by a whopping 14 per cent over the past two decades. Earlier research results, including results produced by Johannessen’s own group, indicated that the total ice cover had been reduced by about 6 per cent during the same period. The new results indicate that the Arctic ice is melting twice as fast as previously believed. No wonder Johannessen has been contacted by so many people from all over the world since the results were published recently in Science, the prestigious US research journal.

NO ICE IN 50 TO 100 YEARS

“In 1995, we published an article in Nature, confirming that the total Arctic ice cap had been reduced by 3 per cent per decade from 1978 to 1995. This time round, we’ve had a look at multi-year ice, which is thicker than first ice, so it creates more volume and mass. We were surprised to ascertain that the area covered by multi-year ice has diminished by 14 per cent, the equivalent of 7 per cent per decade. These results are highly significant since they indicate that the entire relationship between first ice and multi-year ice is in the process of changing.”

The latest results indicate that the Arctic ice cap is melting twice as fast as previously expected. Should this trend continue, the entire Arctic could be sans summer snow and ice just 50 to 100 years from now.

BY BJARNE RØSJØ

The Arctic ice is melting twice as fast as previously expected. Should this trend continue, the entire Arctic could be sans summer snow and ice just 50 to 100 years from now.
FIRST ICE AND MULTI-YEAR ICE: The total amount of ice in the seas surrounding the North pole (left on map) consists in reality of multi-year ice.

The atmosphere contains about 50 times more CO2 than the ocean. At present, the oceans are absorbing 80% of incident sunlight, with effects on ocean and atmospheric circulation extending into mid-latitudes,” said the polar researcher John Walsh of the University of Illinois to Kerr.

This new information has been gleaned from studies of data transmitted by US satellites that have measured passive radiation levels from the ice in the microwave range: “We have had access to a 20-year series of measurements which began with the Nimbus 7 satellite in 1978. These very high-quality data are based on the principle that first ice and multi-year ice, that is, ice which has survived the first summer, have different radiation levels. This is because Arctic ice is formed from seawater with a salinity of 35 parts per thousand. During the first winter, the salinity level of the ice is reduced to 3 or 4 parts per thousand, which has an effect on radiation levels”, continues Johannessen.

“Multi-year ice is comprised of water which is virtually fresh, since it continues to desalinate. However, it is only possible to distinguish first-year from multi-year ice if the snow cover is dry, meaning the distinction cannot be made in the summer when the snow is wet”.

ABSORBING MORE CO2

“At this point in the interview, it was time for a few words of comfort. "I have no desire to be a prophet of doom, so I must add that this emerging trend may also have positive effects. A reduction in Arctic ice might make it easier to operate fish farms and to open shipping lanes through these areas. It is also very important to bear in mind that ocean water levels will not rise as Arctic ice melts”, he points out.

A NORWEGIAN RESPONSIBILITY

Johannessen observes that, on the down side, melting would produce huge volumes of freshwater, which could have tremendous consequences. The ocean’s thermohaline circulation (affected by temperature and salinity) is largely determined by deepwater formation in the polar areas, and that would be disrupted if large quantities of freshwater were introduced at the surface. Less deepwater formation would raise havoc, with ocean circulation, and could even have a mitigating effect on the Gulf Stream, which carries warm water from the Gulf of Mexico to northern Europe.

"Granted, there is a huge gap between the Russian and American measurements, but whether the results are one-half cm or four cm, the depletion is disquieting. We need to take a closer look at the discrepancy between the measurements. Gratifyingly speaking, it is not too great to measure ice thickness over vast areas. More attention should be devoted to this in future.”

CORROBORATING EVIDENCE

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Fjords - food factories of the future?

According to calculations performed by an interdisciplinary group of researchers associated with the University of Bergen (UiB), it may some day be possible to make the fjords along the west coast of Norway into veritable food factories. The researchers have used the university’s supercomputer to verify that their theory is valid, and now it is about to be tested in practice.

BY BÅRD AMUNSEN

S\nacing insidiously into the west coast of the country, Norway’s fjords were formed by glacial action and are more than 1000 metres deep. The idea of turning the fjords into food factories is based on these extreme depths and on the fact that the rivers at the heads of the fjords create a constant supply of fresh water.

Tremendous quantities of waste are produced in seas, oceans and fjords. The waste breaks down and acts as a sort of natural fertiliser to make oceans and fjords into seemingly inexhaustible reservoirs of nutrients. The problem is that most of these nutrients are never used. They simply fade away as they sink, disappearing to depths at which they are transported into nothing more than putrefaction gases. Generally speaking, sunlight penetrates only about 50 metres (the euphotic zone), leaving the deeper strata of the oceanic province and the Norwegian fjords pitch-dark watery wastelands. A very small part of the total area covered by oceans, mainly the areas along coastlines and in shallow fish-bearing grounds, accounts for almost all the production of fish and other marine foods harvested by man.

SIMPLE AND CHEAP

It was Professor Arne F. holdvik of the Geophysics Institute at the University of Bergen, who conceived the idea of capitalising on the vast amounts of nutrients that normally turn into ooze at the bottom of the deep fjords. He proposed enclosing the two to five kilometres of the river at the head of a fjord in a pipe, then directing the river water down towards the bed of the fjord. So doing would stimulate circulation in the seawater, stirring up the vast quantities of nutrients from the fjord floor and bringing them up into the euphotic zone.

The same currents would also help to bring new, natural fresh water into the fjord from the ocean outside it. The freshwater current would typically act as a catalyst for a process through which the influx of new nutrients would initially fertilise the phytoplankton in the fjords. The phytoplankton would then be eaten by the zooplankton, which would in turn be eaten by fish or shellfish, which would ultimately be eaten by humans.

Professor Jarle Berntsen of the Department of Applied Mathematics in Bergen undertook the task of translating Professor Holdvik’s into a huge archetypal problem. Berntsen was quick to realise that he needed large amounts of heavy-duty computer power to calculate and quantify the effects of currents, factoring in seawater, nutrient salts and other biological variables. Accordingly, he fed his problem into UiB’s Cray Origin 2000 supercomputer, which is capable of performing more than 50 billion calculations per second.

Notwithstanding its incredible capacity, the Cray used several days to work its way through the problem. Ultimately, however, the answer was clear. The Norwegian fjords should be able to convert enormous amounts of unexploited nutrients into a veritable marine feast.

THE FIRST TEST

Researchers in Bergen have been given a green light to test whether the whole concept is feasible in practice. The test will be run in the Samsanger Fjord, south-east of Bergen. The experiments should show whether, for example, the influx of new nutrients will support large populations of sea trout. Or perhaps the production of shellfish in the larger fjords could be increased by 500 to 1000 per cent.

Professor Berntsen underscores that the point is not to introduce artificial nutrients from an external source, as in the case with ordinary fish farming. Instead, the project is based on using existing nutrients for genuinely new food production. On paper, it looks as though this type of production has far more potential than salmon farming, even though salmon farming in Norway is second only to petroleum as an export product.

The supercomputer in Bergen tells us that the project is possible in theory. Soon we will know whether it will work in actual practice.

Crunching problems by crunching numbers

Powerful computers, also referred to as supercomputers, currently play a key role in a number of fields of research. The supercomputers at the universities of Bergen, Tromsø and Oslo have brought Norwegian research many small, but a few giant, steps forward.

Over the past four years, the Research Council of Norway has channelled more than NOK 100 million through the Computational Science Programme to finance the three supercomputers and their operation. The investment has enabled a large number of Norwegian researchers to leap up with the work done by their colleagues abroad, and it has put a few researchers at the forefront of developments in their chosen subject areas. The outstanding research done on supercomputers at the University of Tromsø is a startling example of this.

10,000 PROJECTS

Supercomputers have become as indispensable as lab equipment in fields such as chemistry, physics and geophysics. Mathematicians and pharmacists are also turning their attention to computational science, and subjects such as biology, economics and medicine are likely to account for important applications in future.

The Computational Science Programme has received a total of 168 postgraduate students and 149 graduate students by going them on the three supercomputers. In one way or another, more than 1000 research projects have benefited from the computational resources provided.

STILL GOING STRONG

One rule of thumb in the computer world is that you will get twice as much data capacity for your money in 18 months. Accordingly, when an expensive supercomputer rolls through the gates of a university, it is essential to get it up and running as soon as possible.

When the Cray Origin 2000 was installed at the University of Bergen in autumn 1996, it was the first of its kind in Europe, a short-lived distinction. The computer had a computational capacity that was almost unparalleled, allowing researchers performing calculations hardly anyone had been able to make earlier.

The “Computational Science Programme 1999-2003” will carry the Research Council of Norway’s efforts in the field of supercomputing forward in the years ahead.

WEATHER FORECASTING is one of the most demanding computational operations done today. Without the supercomputer at the University of Tromsø, Norwegian weather forecasting would hardly have been possible at its current level of detail.

CLIMATE RESEARCH is a field in rapid growth. One important part of climate research involves studying the extent to which man influences the climate. Climate researchers are high-volume users of supercomputers.

AIR POLLUTION in cities such as Oslo and Bergen is a serious problem in the winter months. Ordinary monitoring stations can report pollution levels at any given time, but it takes supercomputers to forecast urban pollution levels a day in advance.

OCEAN CURRENTS in the North Sea have been charted in more detail than ever before by a graduate student at the University of Tromsø has taken an impressive leap forward by making new discoveries about the factors that impede superconductors.

Number crunching for pharmaceuticals, pollution and the climate

PHARMACEUTICAL RESEARCH calls for the investment of tremendous resources. A research group at the University of Tromsø has taken an impressive leap forward by making new discoveries about the factors that impede superconductors.

Fjord food factories: The Geiranger fjord and the other beautiful fjords along the west coast of Norway are among the country’s foremost tourist attractions. In future, they may also be making important contributions to the world food supply. (Photo: Sjursen)
Super sophisticated ultrasound technology is revolutionising medical diagnostics and treatments, opening up exciting new horizons: Imagine, 3D images of the heart and circulatory system as seen from the inside, virtual brain operations and full overviews of organ development in foetuses as tiny as nine millimetres in size while still in the womb.

BY MONA GRAVINEN RYGH

In 1895, the picture of the X-rayed hand of Wilhelm Conrad Roentgen’s wife Bertha created quite a stir, and the X-ray image with the ring on the finger is widely known. Today, large parts of the world have become so blasé when it comes to technology that many people may not even be surprised by a 3D image of the hand of a living foetus. The latest developments in ultrasound instrumentation, digital image processing and visualisation techniques entail that 3D images of the inside of the body can be used for several applications, including diagnostics, research and non-invasive surgery.

The technique involves converting ultrasound images into 3D volumes. It facilitates the imaging and analysis of structures and pathologies with complex geometries. Ultrasound, an enterprise located in the small Norwegian town of Horten, has been actively engaged in research on ultrasound visualisation since 1985, focusing strongly on 3D ultrasound images since 1990. The company has established unique cooperation with many research institutions in the area of IT and image processing, as well as with clinical communities. These efforts have put Ultrasound in the vanguard of technical and clinical testing in respect of this exciting imaging modality.

ADVANCED TECHNOLOGY

"Vingmed's main expertise is cardiology," explains Research Director Bjørn Olstad. He himself has played a key part in designing the algorithms for the type of image processing with which the company works. He was appointed professor at the Norwegian University of Science and Technology in 1995 at the age of just 29, with image processing as his specialty.

The university's collaboration with Ultrasound subsequently led him to accept an offer to become the company's director of research.

"The three-dimensional ultrasound recordings of the heart are accomplished by guiding a mechanical or electronic ultrasound probe through a spatial search pattern. A computer follows the movements, automatically taking numerous pictures from every position, synchronised with the heart rate. The huge set of original pictures is then converted into a set of volumes", he explains.

"After this spatial conversion, the computer can be used to simulate the placement of the probe. This allows us to use "virtual probes" which can be placed completely independently of where the physical probe was placed originally. In addition, a set of sophisticated image processing algorithms has been developed, making it possible for spatial data to be visualised as an image. The user can choose the calculation method best suited for the clinical problem being treated (surface visualisation or spatial visualisation). This technique has great potential for further applications for ultrasound as a medical imaging modality, both in respect of new applications (for example real-time support during heart operations) and in providing more reliable diagnoses in difficult clinical cases," says Olstad.

FROM THREE TO FOUR DIMENSIONS

The next generation of ultrasound systems from Vingmed will be based on digital technology and computer architecture. Applications rendered possible today by post-processing on a computer will be integrated with the scanner, meaning that some computer processing can take place in virtually real-time. That is, the imaging is four-dimensional, the fourth dimension being time.

"We are also directing research efforts at fields other than ultrasound techniques per se. Among them are data processing techniques, image processing, production techniques and functionality," remarks Olstad, emphasising the importance of the company's interdisciplinary collaboration with a variety of Norwegian research institutions.

It takes tremendous computing power to convert ultrasound signals. To manage it, the company has developed its own specialised computer, known as System Five.

3D WITHOUT MECHANICAL MOVEMENTS

Three-dimensional work is performed in collaboration with a group of researchers from the Department of Informatics at the University of Oslo. In the journal Diagnostic Imaging, in 1998, the group's work was described as "Some of the most advanced academic work being done in this field."

"The goal is to develop the technology needed for real-time data collection and visualisation", explains Professor Sverre Holm, head of the group. "Almost all ultrasound requires that the ultrasound probe be rotated, tipped or moved. It is this movement that facilitates the capture of the third dimension. The unique aspect of our project is that we are testing considerably more sophisticated ultrasound probes which can guide an ultrasound beam over a volume without any mechanical movement. This also calls for a considerably more complicated ultrasound scanner, but we believe that it will be a reality within a few years, thanks to advances in microelectronics."

The advantage is that we can collect data more quickly, thus achieving a more rapid updating rate on the images. This is what makes it possible to monitor the movements of the heart, for example: Holm adds that this is an EU project in collaboration with Vingmed and Thomson Microsonics of France. In addition, the Research Council of Norway is funding a doctoral fellowship.
CARDIOVASCULAR DISEASE

The use of ultrasound for diagnosing cardiovascular diseases spares patients from invasive procedures and considerable discomfort. Using Vinmed’s current system, the Norwegian cardiologist professor Liv Hatle, ably assisted by the doctors and engineers who worked with her in Tromsø, laid the foundation for ultrasound diagnostics based on blood flow measurement. The method is invaluable to modern medicine for diagnosing heart disease as well as diseases of other organs. Hatle is internationally recognised for her research (see Tell’s no. 299).

Ultrasound machines that measure blood flow velocities are based on a phenomenon known as Doppler effect which takes advantage of the fact that sound frequencies are altered when sound is reflected on a body in motion. Liv Hatle demonstrated how the Doppler effect could be used to diagnose heart abnormalities and to assess pressure conditions in the heart. The genius of it is that she made it possible to perform these examinations non-invasively. The doctor simply placed a sensor on the skin, and the results can be seen instantly on a screen.

STRESS ECHO

“For the past three years, we have been working on a Research Council project to develop a new technique for stress echos, an ultrasound tech- nique used for diagnosis and risk assessment of patients with known or suspected coronary disease. Interpretation is based on a visual compari- son of the heart’s movements at rest and during stress. We have now developed automatic, objective measur- ing techniques, and the results indicate that we have achieved a high level of quality assurance for this type of examination,” reports Olaf. He adds that Liv Hatle, who is now working at the University Hospital at Leuven, Belgium, is a key figure in the clinical testing of the new technique.

Now techniques have been develop- ed for visualising blood flows, as have techniques for imaging the contraction of the cardiac muscle. Studies of patients indicate that the new techniques will increase the sensitivity of early diagnoses, pro- viding an important new tool for cardiologists.

FOetal DIAGNOSTICS

Embryology used to be based on aborted foetuses, but now these soon-to-be people can be studied in vivo, that is, while they are still in the womb. Norway is on the cutting edge when it comes to using this new technology for embryonic research, so-called sono-embryo- logic. This represents yet another important new application for Vinmed’s technology. Three-dimensional ultrasound images of foetuses down to seven weeks of age have been developed by the National Centre for Foetal Imaging at the University Hospital in Tromsø. The foetuses are a mere four to 40 millimetres long.

With “good 3D images, the doc- tors can learn more about fetal anomalies, and make presentations of organs while they are developing incorrectly,” says Professor Sturla Eik Nilsen, a specialist in foetal medi- cine and head of the centre. He explains that these new opportunities are a result of interdisciplinary col- laboration among doctors and com- puter engineers, while Vinmed is responsible for making the machine. Vinmed has set up a special team to work in close contact with the National Centre for Foetal Medicine.

VIRTUAL BRAIN SURGERY

Brain surgeons will soon be able to operate while their eyes are fixed on a computer screen rather than on the patient’s brain. Using new ultra- sound technology, surgeons can now get 3D images of the brain during an operation. “Virtual reality” technology will make it possible for sur- geons to be “present” inside the body, making it easier to navigate through complex structures.

The method is now the object of intensive research and development at the University Hospital in Tromsø, the Norwegian University of Science and Technology and the research institute SINTEF, in collaboration with commercialisa- tion partner Mison, with support from the Research Council of Nor- way, among others, and based on equipment from Vinmed.

Traditionally, the surgeon locates the area on which he or she will operate using magnetic resonance images (MRI). They are of excellent quality, but cannot be updated dur- ing the operation. The general man- ager of Mison, Age Grunngåsper, explains that brain surgery usually entails shifts and changes in the brain, meaning the MRI images become outdated very quickly. Using ultrasound, it is possible to record 3D images in just minutes, keeping up to date with changes as they occur. It is also possible to record live, 2D images at any time during an operation. Ordinarily, the surgeon will make a tiny additional hole in the cranium to get good pic- tures of the brain, while the proce- dure itself is performed through another hole. The surgical instru- ments can be guided using the ultra- sound images”, expands Grunngåsper.

BETTER QUALITY OF LIFE

Professor Geirmund Unsgård of the Centre for Foetal Medicine at the University Hospital in Tromsø is a pioneer when it comes to using ultrasound for brain surgery. “Once the equipment is commercially avail- able, it will be possible to improve the quality and safety of brain surgery. What is more, it will be pos- sible to operate on some patients who are inoperable today. We also expect that the technique will improve the quality of life for many of our patients, reducing hospitalisa- tion and recovery time. For many patients, the technique will lead to more radical surgery of malignant brain tumours, thus increasing their expected survival time”, reports Unsgård.

Vinmed

GE Vinmed Ultrasound is an international supplier of ultrasound hardware and software for medical pur- poses. The company is a European market leader in the field of advanced ultrasound equipment for cardiology examinations based on measuring blood flow in the heart. The company’s research and development efforts are being directed towards eliminating the time lag engendered by acquisition and data processing.

Since it was founded in 1985, Vinmed has co- operated closely with the Department of Physics and Biomedical Engineering at the Norwegian University of Science and Technology in Tromsø. The company today has its own research institute, the Vingmed Research Centre, as well as a research department with a staff of five in Oslo, where it collaborates with a number of other research institutions. Over the past 10 years, Vinmed has spent more than 10% of its turnover on research and development. Thus far, more than 50 doctoral theses based on Vinmed’s technol- ogy have been written at the field of medicine, natural sci- ence and technology. The Research Council has supported Vinmed every step of the way, not least through MÆGOT, The Research Council’s ICT product commercialisation programme.

Vinmed was acquired by General Electric in 1998. Most of the enterprise’s 170 employees are located at the main office in Horten, Norway, from where the company serves a global market. Of the company’s aggregate sales of about MNOK 750 in 1999, approxi- mately 60% went to Europe, 15% to the USA and 25% to the USA. Sales in the USA were growing rapidly, largely as a result of becoming part of the General Electric Corporation.

In 1995, Vinmed won the EU Commission’s ITEA (Information Technology European Award), Gold Prize for System Five. The enterprise was one of three winners in a competition that included 650 entrys from European technology enterprises. The prize, a gold trophy and ECU 200,000, is awarded to companies that have successfully used modern information technology to develop commercial products.
Runes and Christianity

• The runes are a Germanic alphabet believed to have originated at about the time of Christ’s birth. The older runic alphabet consisted of 24 signs and is called “the elder Futhark,” after the first six letters in the alphabet (“f” was one letter).
• In about 700, the aboriginal Nordic alphabet was replaced by a new one, the younger Futhark, with just 16 letters.
• The Viking expeditions ended in approximately 1050. As about the same time, Norway was united into a single kingdom, and Christianity was introduced. The Latin alphabet was introduced via England, accompanying Christianity. Runes ceased to be used in writing.

ORIENTEERING INTO THE PAST. A contour map of the area of the Kuli Stone shows how the inscription look like elevations on an orienteering map.

Lasers and micro-surveying equipment

The Kuli Stone, a rune stone manufactured about 1000 years ago and discovered on the island of Smøla in the 1860s, has taken its own sweet time to divulge its story. Mentioned in the writings of a Norwegian minister in the 1860s, the stone seems subsequently to have sunk into oblivion. Even when the stone was turned over to the Norwegian Museum of Science in 1913, no one showed any particular interest in the inscription. Then in 1956, the stone was “rediscovered” by a man named Asla, Linnes.

The researcher’s astonishment was great when he realized the stone actually represented the oldest known occurrence of the country name “Norway” in writing.

The 1956 examination declared that Christianity had been in Norway for twelve winters when the stone was erected, and the inscription stated explicitly that it had been erected by Tore and Hallvard. Years passed. Then one mild evening in 1998, the Kuli Stone divulged another secret. Runologist Jan O.H. Swantesson turned to a physical geographer who had laser and micro-surveying equipment. Dr. Jan Swantesson. As a physical geographer employed by Karlstad College, Dr. Swantesson has spent a tremendous amount of time trudging about in Swedish bogs with his home-made equipment which consists of a frame equipped with a laser, an electronic control unit, and a laptop computer.

One gets an idea of the accuracy of this system when hearing that Dr. Swantesson intended to survey ancient inscriptions etched into rune stones a millennium ago.

“Of course! No, that can’t be right. There are fine runes, but they can’t mean life or Uniket. ‘Should we cross him off our list, Dr.’” asks Swantesson.

HAGLAND LETS THE FACTS SINK IN

“An interpretation of line B appears to justify a significant change in linguistic content. The crux of the matter is the reading of runes that indicate otherwise. ‘Twelve winters had Christianity been in Norway.’ However, deep in one of the valleys, Hagland finds runes that indicate otherwise. The reading of what’s called line B appears to justify a significant change in linguistic content. ‘Twelve winters had Christianity been in Norway.’” Then doubt rears its ugly head; earlier readings have interpreted the whole sentence to read: ‘Twelve winters had Christianity been in Norway.’ However, deep in one of the valleys, Hagland finds runes that indicate otherwise.

MTN4UR A MILLIMETRE HIGH

One gets an idea of the accuracy of this system when hearing that Dr. Swantesson intended to survey ancient inscriptions etched into rune stones a millennium ago.

“The Kuli Stone…’The Kuli Stone was erected by Tore and Hallvard on the island of Smøla nearly 1000 years ago. (Illustration: Jan O.H. Swantesson)”

You can’t get blood out of a stone, can you?
The sludge and sediments along the path of the Gulf Stream and in the fjords along the west coast of Norway contain detailed information about past climatic changes. In summer 1999, researchers took a large number of samples from the seabed. Over the next two years, examinations of the samples are expected to shed some new light on the climatic changes the world is experiencing today.

Thanks to technology carried by the French research ship, the Marion Dufresne, sediments can be used as a chronological archive of climate-related information, facilitating the reconstruction of climatic trends over several thousand years. Today’s researchers are able to detect temperature variations of as little as plus/minus one degree through several ice ages (several hundred thousand years).

“To be able to say anything about climatic change today, we need to know as much as possible about the reasons for earlier temperature fluctuations. We now know that rapid, natural changes in average temperatures have occurred previously, with fluctuations of as much as five to ten degrees in as little as a decade”, explains Eystein Jansen, professor of paleoclimatology at the University of Bergen. Along with Professor Laurent Labeyrie of the French university Paris-Sud, Orsay, Jansen co-headed part of the Marion Dufresne expedition along the Gulf Stream from the Caribbean to the coast of northern Norway.

BLESSED BY THE GULF STREAM

The climate along the coast of Norway is exceptionally mild, considering its proximity to the Arctic. The reason is the Gulf Stream, which carries warm water from the Gulf of Mexico to the Norwegian coast, making it possible for people to enjoy a dip in the briny deep at latitudes which otherwise lend themselves best to icebergs. That being said, over time, temperature and climate are determined by a more complex global network of variables, and even the Gulf Stream is influenced by the atmosphere and the location of high and low pressure systems.

“We don’t know what it would take to disrupt the Gulf Stream, but it is part of an extremely sensitive system. We have recorded small temperature fluctuations in recent years. However, we don’t know whether they are due to natural climate fluctuations or are harbingers of lasting changes. It is still too early to tell”, says Jansen.

Many wonder whether today’s unstable climate is anthropogenic, that is, caused by man, or whether it is due to the whims of Mother Nature. Scientists may find some of the answers to that question on the seabed where organic and inorganic residue builds up layers of sludge year by year. In stable sea areas, the layers can be traced thousands of years back in time.
In this sense, the waters off the Norwegian coast are a key area for learning more about fluctuation patterns in the climate and ocean currents. “Here, it is possible to study the Gulf Stream’s transport of heat. The sediments on the fjord floors and on the slope of the Continental Margin are particularly good places for studying these phenomena,” comments Jansen, who expects the research expeditions to produce a detailed new picture of how the oceans affect climatic change.

ATYPICAL TIES

“In the long term, we hope to collect enough data to form a solid foundation for saying something about whether today’s climatic changes are natural, man-made, or both,” says the professor from Bergen.

The debate regarding the reasons for today’s unstable climate has revolved around the greenhouse effect, the influence of ignots, cosmic radiation, major volcanic eruptions, etc. Several researchers have recently questioned whether or not most of the blame should be attributed to man-made pollution. Jansen is of the opinion that there are indications that our current climatic situation is different from those of earlier times. Using climate data, it is possible to make a graph showing temperature trends over past millennia. Against that type of requirement line, our own era is “apparal”, continues the professor.

The Marion Dufresne is the only research ship in the world able to take continuous sediment core samples up to 60 metres long.

“The French have developed highly sophisticated sampling equipment. The field needs huge, stable vessels to collect samples that show sufficient detail,” adds Jansen.

MAKING THE RESULTS PUBLIC

Norwegian experts have been particularly active in analysing sediments from the fjords and the Continental Shelf. As a result, our groups are good teams which is helping to gain more knowledge about climatic fluctuations, not at least at the international level”, says Professor Labeyrie. Jansen’s palaeoclimatological research has attracted international attention, and his group has published its results in the prestigious scientific journal Nature on several occasions over the past few years. Professor Labeyrie managed to collect a kilometre of core samples. The scientific analyses will be performed on terra firma over the next two years. After that, all the sample material will be made available to the public.

Over the past century, average temperatures have risen in Norway and globally. Nonetheless, Norway is in a class of its own. While the 1990s was the warmest decade from 1860 to 1999 on the global level, average temperatures in northern Norway were just as high in the 1930s as at the end of the 20th century.

BY SINI ELLEN JACOBSEN

It is certain, there were clear differences between average global temperatures and those in Norway. Globally, for example, 1998 was the warmest year ever recorded using reliable temperature measurements, but it was a normal year in Norway. Here, nearly half the years since 1900 have had higher or equally high average annual temperatures as 1998.

“The annual mean temperature has increased by about 0.7 °C over the past 100 years on a global basis, and the annual mean temperature fluctuations between 0.5 and 1.0 °C in most parts of Norway. The special thing about Norway is that average temperatures in parts of northern Norway and on the Svalbard archipelago were as high in the 1930s as they are today”, observes climatologist Eirik Fortin and Inger Hanssen-Bauer at the Norwegian Meteorological Institute (DNMI) in Oslo. The field needs huge, stable vessels to collect samples that show sufficient detail”, adds Jansen.

REGIONAL CLIMATE MODELS

Norway is an exciting, but complex country in terms of climatology. The country’s varied topography means that the global climate models developed for international use are not particularly suitable for Norway’s climatic conditions. RegClm-climatologists are in the process of developing regional climate models that can predict something about Norway’s future climate, based on global climate models and regional meteorological data. It can be raining heavily for days on the west coast of Norway, while it is clear and sunny in Oslo in the eastern part of the country. Such varia - tions are captured by the large global climate models, which, among other things, do not have particularly good resolution. These models produce useful results on a large scale, but are not useful for forecasting climate changes in specific areas, for instance, Norway. However, by examining historical climate data, it is possible to find correlations between large-scale and local climates.

As the global climate changes, RegClm participants will be trying to predict the most likely regional climate development trends in Norway. It appears that temperatures in northern Norway and on Svalbard archipelago will rise throughout the year, and summer, while those in the southern part of the country have increased in the spring and autumn. The high annual temperature in the 1990s was the result of high temperatures in the winter, summer and autumn. In recent years, mild winters have been the main explanation for the rise in average annual temperatures.

IT’S RAINING, IT’S POURING …

Most places in Norway have noted a marked increase in precipitation levels over the past century, although the rate of increase differs considerably from one part of the country to the next. North-eastern Norway has seen the most significant increase. There are also pronounced regional differences in the seasons experiencing the increase: northern Norway has noted increases in the spring and summer, while southern Norway has recorded the greatest increases in the autumn. Winter precipitation has also increased significantly in most parts of northern Norway.

Altogether, Jansen and his group have published a number of studies over the past few years. The studies have, in fact, found that a large part of the change in temperature and precipitation is related to systematic fluctuations in the pattern of atmospheric circulation over northern Europe. These changes may be attributable to the growing severity of the greenhouse effect.

There is also pronounced regional variation in the precipitation patterns. This demonstrates that the global climate models developed for international use are not particularly suitable for Norway’s climatic conditions.

The increased precipitation may be the result of high temperatures in the south-west. They have, in fact, found that a large part of the change in temperature and precipitation is related to systematic fluctuations in the pattern of atmospheric circulation over northern Europe. These changes may be attributable to the growing severity of the greenhouse effect.

The temperature increases noted in our area over the past 20 years are expected to continue in the future. Global Change (IGBP) centres on the international research programme Global Change (IGBP).

Norway’s future climate is expected to feature milder winters and wetter autumns, according to the first climate scenarios presented by Norwegian researchers. In December 1999, the researchers involved in RegClm presented their first forecasts for climatic and weather conditions in Norway in the decades ahead. Eirik J. Fortin and Eirik Nordeng emphasised that their calculations are still subject to a great deal of uncertainty, and that they expect the models to improve considerably. With that proviso, they presented the following main conclusions about the period from 2000 to 2050 in a newsletter from the Cicero Research Foundation:

• A significant concentration of greenhouse gases will increase, average annual temperatures in different parts of Norway are expected to rise by 0.2 to 0.7 °C per decade;• Temperature increases are expected to be most significant inland, and least along the coast;• All seasons will be warmer, but winters will see the most significant rise;• Snowfall and the Barents region will probably experience the greatest temperature increase;• Annual precipitation will rise in most parts of Norway, but most in the western part of the country;• The rise in precipitation will be most pronounced in the autumn, except in eastern Norway;• Eastern Norway will probably receive less precipitation in spring, while the greatest increase will be in winter.

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There is a 25-year-old girl from Bergen with cerebral palsy. She thinks, sees, hears and writes just as you and I, but, alas, she has no voice. And she would like to have one: “I want the voice of a young woman with a Bergen dialect. I want a computer that I can operate with my brain. A computer like that can even whisper, so my mother couldn’t hear. I have a lot to say and many opinions, but talking is a long-drawn out process for me.”

Few can envisage what it must be like not to have a voice of one’s own. Anger, grief, joy and laughter are not the same in writing. But the day is rapidly approaching when language technology should be able to make some of this young lady’s dreams come true. Over the next four years, the Research Council of Norway’s programme entitled “IT for the disabled” (IT-Funk) will be spending MNOK 25 on the development of user-friendly IT products and services for the disabled.

“As many people as possible should benefit from the progress being made in the field of information and communications technology,” says Tron Espeli, an adviser with the Research Council.

**UNDEMANDED-OF-OPTIMISMS**

Voice recognition software is already on the market, as are a variety of speech synthesis programs. Navigation systems for the sight-impaired are currently in the pipeline, and an electronic memory is being tested for individuals with acquired brain damage (ABD). Certain research groups have made major advances in the miniaturisation of electronics, while others are working on miniature communications equipment that is batteryless and battery powered. Such advances will open up new horizons for the disabled. Many have feared that IT will isolate and alienate vulnerable social groups. This has been a very real concern for the disabled and, justifiably so, since they have usually been at the end of the queue when it comes to the development and adaptation of new technologies and services. “The goal should be as far as possible to benefit from the technological advances being achieved in the field of information technology. This should be what drives product development forward for those of us who are concerned about access to user-friendly IT products and services for the disabled,” points out Maja Aarestad, project manager for the Research Council of Norway’s “IT-Funk”, a programme designed to promote IT for the disabled.

**TALKING MAPS**

The first global positioning systems (GPS) for vehicles appeared on the market years ago. They guide drivers along unfamiliar roads using maps and messages. Similar technology is now being developed for pedestrians, according to Ingibjorg Svagård of Sintef Telecom and Informatics. She is manager of a project aimed at developing a portable, speech-based system called “Speech Navigator”. The system is designed to help the blind and sight-impaired find their way around. Based on electronic maps and a compass, the system features speech-based interaction between the user and the system. Users can determine where they are at any given time, then get directions for the best way to reach their destination. In the digital world, this is known as getting “on-line, interactive information about position, direction and route.”

“Demo models have been made in both the US and the UK, but the technology was not good enough, so it undermined user confidence. We need to do something about that”, remarks Svagård.

One of the problems remaining to be solved is that GPS users have to be within five range of a GPS satellite. This can be a problem in big cities where skyscrapers can get in the way, sporadically leaving the sight-impaired user with no means of spatial orientation. Better digital maps are needed as well. Once the maps can provide more information on traffic lights and pedestrian crossings, in addition to road information, they will benefit more groups of people.

“As time passes, the system will lend itself to other applications, for example, on a hand-held PC or on a pair of computerised glasses that display a text screen in front of one eye.”

At the moment, this is no more than a vision of the future, but scien- tists are getting closer to applications all the time. Efforts are being made to set up a test service for speaking phones and textphones for the hearing-impaired. “Today, a hearing-impaired person who wants to speak to someone who has a regular phone has to ring a manual switchboard service where an operator "translates" text into speech. In future, it will be possible to translate automatically in both directions”, explains Georg Ottesen of Sintef Telecom and Informatics.

Speech synthesis takes place when text is keyed in by the hearing-impaired person, then translated into speech by the hearing-person’s receiver. This requires a voice recognition system with a relatively limited vocabulary, so that the voice of the hearing person appears as text on either a telephone or a PC.

“In addition to recognising speech, it would be a great advantage if it were possible to indicate the way in which words are spoken. For example, angry, laughter or sadness could be conveyed using colours, font, underlining and explanation points”, explains Ottesen.

**BRAIN IN A BOX**

In the not too distant future, people with cognitive disabilities such as concentration, memory and/or language problems will be able to get invaluable help from PCs equipped with the appropriate software. The EU’s TASC (Telecommunications Applications Supporting Cognition) project, aimed at developing such software, is already being tested by different groups of people in several countries. Groups in Northern Ireland, Denmark and Sweden have been asked to examine more closely the potential needs of and applications designed for the mentally handicapped. In Finland, efforts are focusing on patients suffering from senile dementia, and in Norway, people with acquired brain damage (ABD) will be trying out a variety of models. The software is based on daily schedules. Someone sets all the different tasks to be performed during the day in a chronological order on a PC. An alarm will then announce when it is time to start making dinner. For example, it is possible to receive messages in the form of text, sound, images, or a combination of the above.

“Mind you, memory problems are a double-edged sword”, states Stein Tornås at the Sunnaas Rehabilitation Hospital outside Oslo. The hospital is involved in an accident. What’s more, most of their facilies are in tact. Nonetheless, there are many things they can no longer do due to their cognitive problems. Most of them would like to help them plan and structure their everyday routines”, remarks Tornås.

Sunnaas Rehabilitation Hospital: info@sunnaas.no/akvea/English_frameset.htm

Sintef Telecom and Informatics: http://www.informet.no/itfunk
NANOENGINEERING: The computer chip being carried by this minuscule ant is just one of many examples of how far microtechnologies have already progressed. The picture was taken by researchers at Huddersfield University in the UK. (Photo: Reuters)

"Micro- and nanotechnology will become just as important in the years ahead as computer technology has been in recent years. This technology will take science to entirely new levels," remarks Project Director Anders Hanneborg of SINTEF Electronics and Cybernetics in Oslo.

Researchers at this SINTEF institute are currently developing machines so tiny that one needs a microscope to see how they are assembled. In fact, microtechnology is so small that it is based on a scale measured in micrometers, that is, thousandths of a millimetre. And today's researchers are diving ever deeper into the microcosmos by moving into nanotechnology, where accuracy is measured in nanometres, that is, thousandths of a micrometer.

The summer of 2000 will see the start of construction of a new NOK 200 million microtechnology laboratory in Oslo. The Research Council of Norway is targeting this field, and will be providing funds for 50 doctorates over the next five years in this very narrow speciality. "Every facet of society will be influenced by these minute machines. Norway's National Hospital is already cooperating with the University of Oslo and SINTEF to develop a tiny device to be implanted in the skull of patients suffering from hydrocephaly. When water pressure increases, the sensor will detect it, and release excess water through a drain," explains Hanneborg.

Researchers in a variety of fields are hard at work creating the technology needed to build a machine so small that it can be injected into a blood vessel using a syringe. There, the machine could perform tasks that currently call for surgical procedures, angioplasties, for instance, that is, the unblocking of clogged blood vessels.

The transport sector will also be totally changed. Several years ago, the Sensatec company developed a microsensor that detects collisions, instantly revealing an alert to protect the passengers. The next step will be sensors that communicate with components embedded in the roadway, so cars will navigate themselves, allowing drivers to read a newspaper or enjoy the scenery.

KEYBOARDLESS KEYBOARDING

Like all other technology, it will also be possible to use micro- and nanotechnology for more jaundiced applications. For example, it will be possible to make remote-controlled cameras systems and microphones the size of a grain of sand. And development will continue relentlessly, regardless of its potential adverse applications. The main challenge in respect of the new micromachines is enabling them to communicate with the world around them, which will open up an incredible number of potential applications. At the University of California at Berkeley, researchers are attempting to create 'smart dust' that can be attached to fingernails, for example, to detect your finger movements. That would make it possible to enter information into a computer without using a keyboard to enter words, you could send an email from wherever you might be at any given time without having access to your keyboard!
With its long coastline and numerous freshwater lakes, Norway has a huge potential for generating power. Surprisingly, research into how fresh and saltwater in contact with each other can result in a pressure that could be used to generate electricity, is currently in progress to determine how freshwater, in contact with saltwater, can result in competitive energy prices. Research suggests that salinity power plants could be an important contribution to Norway’s future energy production.

OSMOSIS: A salinity power plant would be fitted with a membrane enclosing a container. There would be currents on both sides of the membrane. Freshwater would be flowing on the one side, at the same time as it would be moving through the membrane to dilute the seawater flowing on the other side. Freshwater and seawater would subsequently be mixed in the seawater channel, creating osmotic pressure which would in turn drive a turbine and generate electricity.

For centuries, people have known that when saltwater and freshwater are divided into two distinct chambers separated by a semipermeable membrane, a biological membrane made from a pig’s bladder, for example, excess pressure will build up, causing the less concentrated solution (freshwater) to dilute the more concentrated one (saltwater) until the two are in equilibrium, that is, until they reach the same concentration. This process is based on a simple principle known as osmosis and the pressure is called osmotic pressure. Norwegian researchers would like to take advantage of this process on a rather grand scale by diverting water from a river into a power plant, where it would meet saltwater pumped up from the ocean. The excess pressure created in the saltwater would be diverted to a turbine and used to generate electricity.

According to the most optimistic calculations, if researchers succeed, the resultant energy prices could be pressed down towards a mere NOK 0.25 per kilowatt hour. Even better, this type of power generation creates no CO2 emissions. All in all, salt power could turn out to be a substantial energy resource. Calculations indicate that Norway could produce a total of 20–25 TWh of energy per year with the help of salt power. By comparison, the largest, most modern gas-fuelled power plant can produce three TWh per year.

THE MEMBRANE IS THE KEY

There are, of course, certain criteria which must be met before this type of power production will ever see a breakthrough. Researchers are working relentlessly to develop a membrane that will lend itself to salinity power plants. The membrane has to let the freshwater through easily, while keeping the saltwater contained on the other side. In a way, the membrane has to let the freshwater through easily, while keeping the saltwater contained on the other side.

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A MEDIUM-SIZED FOOTBALL STADIUM

For financial and practical reasons, a salinity power plant would have to be situated at the mouth of a river, or between the sea and a nearby lake. The project would call for three relatively large-scale water pipes, one for freshwater, one for saltwater and one for brackish water. Brackish water is what forms when freshwater and saltwater mix, and it would be discharged back into the sea again. A 50-megawatt facility would take up the same amount of space as a football stadium if it were built at ground level. “The environmental disadvantages are minimal compared with many other alternatives. This kind of facility would have no significant impact on large wilderness areas, and the method could be adapted to facilities of all sizes”, concludes Øyan.
Using technology that ensures record-low pollution levels and modest operating costs, Energos’ waste-to-energy facility has attracted considerable attention from environmentalists, investors and international energy companies.

BY INGAR MYKING AND BJARNE RØSJØ

In the shadow of the huge paper factory next door, a nondescript little building in Ranheim near Trondheim hides an environmental technology company that seems to be ‘burning out’ a niche for itself on the export market. This little village is where the energy enterprise Energos built its first, apparently low-key, waste-to-energy facility in 1997. A mere three years later, European energy companies are practically queuing up to sign co-operation agreements.

Energos achieved its international breakthrough in 1998, when the CEO signed a letter of intention to build a waste-to-energy facility in 1997. A groundbreaking event is Energos’ achievement of full-scale installations. A recycling company, Energos engenders double environmental dividends: it helps reduce the tip volume of waste and the environmental problems such waste entails in terms of methane emissions, etc. Energy based on fossil fuels will increasingly be replaced by various types of alternative energy sources. The Norwegian authorities wish to encourage this trend towards energy switching. The application of Energos’ waste-derived energy recovery technology is a prudent financial investment at the same time as its emissions are well within national and international pollution control limits.

Efficient, renewable energy technologies

The Research Council of Norway helped finance the project through the NYTEK programme which aims at supporting R&D on efficient, renewable energy technologies. The programme focuses on development up to prototype testing. For the purposes of the programme, the term ‘renewable energy’ chiefly refers to solar, bio-, wind, geothermal and wave energy. Other renewable energy sources such as ocean currents and salinity gradients, as well as micro hydropower plants, may also qualify for NYTEK. The programme is intended to concentrate on areas with commercial potential for Norwegian enterprises. Special emphasis is attached to high-risk projects and projects with major domestic wealth creation potential.

Operating a power plant that generates 10 MW of electricity calls for the incineration of about 30 000 tonnes of refuse.

There are approximately 400 million people living in western Europe. Each year, they produce a total of 200 million tonnes of combustible waste.
ENERGY TO BURN: There are tremendous amounts of energy in this garbage. The energy can be released through combustion, but that causes pollution. Hence it is necessary to control the incineration process. (Photo: Sanfoto)

THE ENERGY RECOVERY PROCESS:
1. The fuel is ground up and deposited in a silo.
2. The fuel is transported to the fuel magazine.
3. The fuel is added to the furnace in portions as needed.
4. The fuel is mechanically shovelled over a grid in the primary chamber of the furnace. Combustible gases are burned in the secondary chamber.
5. The flue gas is then channelled into a boiler where it is cooled down to steam.
7. The flue gas goes to a reactor where calcium and active carbon are added.
8. A filter removes dust particles, calcium and active carbon from the gas.
9. The cleaned flue gas is released from the smokestack into the air.
10. The entire process is controlled by an innovative new control and monitoring system so the facility operates optimally, satisfying all environmental requirements.
More health in every byte

Today, northern Norway is the world’s most sophisticated telemedicine laboratory. In a region where patients and medical experts are separated by vast geographical distances, regional disadvantages have been turned to advantages.

BY SIW ELLEN JAKOBSEN
IN EVERY BYTE usually take place in the presence of diagnoses aided by sound/image communications. This will form the basis of telemedicine, which is currently involved in a number of international projects. For several years, the Centre has co-operated with north-west Russia to find solutions that will work in a region the size of France, but with a population of 1.5 million inhabitants and extremely difficult infrastructure. The collaboration has led to a number of inquiries about co-operation, advisory services and training from countries in the Third World. The plans of the World Health Organisation (WHO) to make the Norwegian body a “collaborating centre” for telemedicine will lead to even broader international co-operation.

Not only are there organisational and financial barriers to the development of telemedicine, there is also some uncertainty attached the legal issues. What the state "saves" in terms of giving doctors permission to consult dermatologists about skin diseases by video conferencing or use of telemedicine for psychiatric consultations by video conferencing.

Telemedicine: What the state "saves" in terms of giving doctors permission to consult dermatologists about skin diseases by video conferencing or use of telemedicine for psychiatric consultations by video conferencing.

Teledermatology: Specialised consultations are required in cases of cutaneous malignancies. Hence, the dermatologist can learn to use the equipment via video conferencing. This is possible in northern Norway because the public health system is cost effective in most municipalities. Health economy is not the main interest of patients, since it will be easier to perform medical procedures in a situation where the size of France, but with a population of 1.5 million inhabitants and extremely difficult infrastructure. The collaboration has led to a number of inquiries about co-operation, advisory services and training from countries in the Third World. The plans of the World Health Organisation (WHO) to make the Norwegian body a "collaborating centre" for telemedicine will lead to even broader international co-operation.

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The growing internationalisation of the Norwegian petroleum sector entails new challenges in terms of research on culture, politics and the social sciences, as well as in the economic sphere. One of the imperative objectives of these international challenges is the need to link technological and social science research in the petroleum sector. In response, the Research Council of Norway has launched a research programme which focuses on the challenges imposed by the internationalisation process. Among other things, the programme will be exploring the demands internationalisation places on the petroleum industry, the organisation of marketing efforts, forms of corporate co-operation, national and general international conditions, and other factors which affect corporate strategies and competitiveness. Additionally, the programme has put human rights and democracy building on the agenda in terms of the problems involved in trading with regimes that violate human rights. Thirteen research communities located in Bergen, Stavanger, Trondheim and Oslo, respectively, are participating in the Petropol programme.

"By linking technology research to more and better research on organisational, social and political issues related to oil and gas research in the petroleum sector, it may be possible to gain essential new insight and identify new strategies," comments Bridge Whitt, chairman of the Programme Committee for the Petropol programme.

http://www.sol.no/forskningsradet/programmeforskningsradet/programmet/petropol

Amie K. L. Thallstrøm

CHALLENGE: The internationalisation of Norway’s petroleum sector calls for research into its potential economic, political and organisational consequences (Photo: Ocean Drilling Programme)


ew new stethoscopes talk to computer

The good old stethoscope has seen little change since it became a common tool among physicians nearly 180 years ago. The last stethoscope-related innovation was in the 1950s, when someone discovered the wisdom of placing microphones in the most sophisticated instruments to magnify the sound. Since then, changes have mainly involved improved ergonomics and micro-technology.

The Norwegian company Medtron AS now intends to revolutionise the concept of what a stethoscope is: introducing sensor-based, electronic instruments. As a result of inter-disciplinary product development, Medtron has created an entirely new concept: stethoscopes equipped to listen to, store and retrieve, or present sound files for specialists, when so required. The system captures and reproduces sounds at the same time as the patented sensor and distributed memory. It is also possible to add a diagnostic tool to blood flow – in humans and animals alike. It is also possible to add a diagnostic tool to blood flow – in humans and animals alike.

The stethoscopes can also be used to listen to other sounds, from breathing to blood flow – in humans and animals alike. It is also possible to add a diagnostic tool to blood flow – in humans and animals alike.

The stethoscope systems is that the listening device extracts more information than ordinary stethoscopes. The answer is no. Immigrants find it very difficult to be treated in a sanitary and professional way.

The scientists did field work among immigrants in Oslo in 1998 and 1999 to determine whether the Council’s Day celebrations accentuate the exclusively “Norwegian” in a way that excludes Norway’s new residents. “The answer is no. Immigrants generally participate in 17th of May celebrations and views the day as a holiday,” comments researcher Anne Kristoffersen. “For them, the day commemorates universal values such as independence, democracy, stability and freedom from oppression. At the same time, they see the day as being very pleasant and fun for children, a day filled with life and vitality. There are signs of change in public opinion. Following a bomb threat in the 1980s, immigrants gained a clearly more legitimate place in the national ritual. Today, they are the ones who are being very pleasant and fun for children, a day filled with life and vitality. There are signs of change in public opinion. Following a bomb threat in the 1980s, immigrants gained a clearly more legitimate place in the national ritual. Today, they are the ones who are

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The age of enlightenment

A salve is rubbed on the patch of skin affected by cancer, then a special light is directed at the area. The cancer cells become overly sensitive to the light and die, while the healthy cells tolerate the light without any problem. Known as photochemotherapy (PCT) or photodynamic therapy (PDT), the method is based on photosensitising substances which turn toxic in the presence of light.

A group at the Norwegian Cancer Hospital has specialised in the use of a derivative of 5-amino lavulinic acid, ALA, which can be blended into a salve and rubbed directly on a patch of cancerous skin. A few hours later, the area is subjected to light from a halogen bulb.

More than 90 per cent of the patients suffering from basal cell carcinomas, a very common variety of skin cancer, are permanently cured by this treatment. In addition to obtaining excellent cosmetic results, the method has few side effects and is far less expensive than conventional cancer treatments.

Methods are currently being developed for using photochemotherapy to treat carcinomas in the buccal cavity (mouth), respiratory tract, oesophagus, stomach, colon and bladder. Such cures would involve shining the light from inside the patient, which would be facilitated by an endoscope. The beauty of the method is that photochemotherapy can be used to cure cancer without resorting to the removal of all or part of the organ in question.

Researchers at the Norwegian Cancer Hospital are currently cooperating with colleagues in China. In the Henan Province, along the Yellow River, the incidence of oesophageal cancer is 200 times as high as it is on average in Norway. Under the auspices of a joint research project, the patients selected for photochemotherapy are in an early stage of cancer, meaning there is time to test the treatment. The first follow up showed a cure rate of about 50 per cent, and scientists expect that about half those not cured after the first treatment will respond to a second treatment, which translates into a success rate of at least 75 per cent. However, the patients will have to be followed up for quite some time since there is a strong chance of relapse.

While clinicians are testing how to optimise the treatment itself, another group is continuing to pursue pioneering basic research first started in the 1970s. They are now working on derivatives of ALA which are so promising that a separate company, PhotoCure, has been set up to handle the business aspects of the patent applications currently pending in more than 30 countries. A group of investors is now involved in the company, along with the Norwegian Industrial and Regional Development Fund and the Research Council of Norway.

Mona Gravningen Rygh
New anti-bacterial substance from the sea

Norwegian scientists recently discovered an enzyme in the Iceland scallop, *Chlamys islandica*, which kills bacteria in human beings and fish. The substance is now being produced in such large quantities that commercialisation is a distinct possibility.

BY SIW ELLEN JAKOBSEN

Decades of antibiotic use have led to new strains of infectious bacteria which are resistant to drugs. Over the past few years, several different groups of researchers have found that marine organisms may be a source of a variety of potential new pharmaceutical compounds. Researchers at the Norwegian Institute of Fisheries and Aquaculture Ltd. (Fiskeriforskning) in Tromsø have discovered a substance in Iceland scallops – chlamysin – that appears to have an anti-bacterial effect on disease-producing bacteria in humans and animals. The scientists now know the gene that codes the production of this substance, meaning it is possible to reproduce it recombinantly, that is, in yeast cells. The substance occurs in Iceland scallops in such small amounts that it would have been neither practical nor financially feasible to extract it from scallops alone, but now it is possible to manufacture such large quantities of the enzyme that commercialisation is a distinct possibility.

GOURMET: The muscle in the Iceland scallop, *Chlamys islandica*, has long been a gourmet favourite, and now researchers have discovered a substance in the mollusc that may be able to prevent or cure diseases in humans. (Photo: Frank Gregersen, Fiskeriforskning)

Until recently, this research was shrouded in considerable mystery, but now that the patent is pending, scientists are free to talk about the properties of the substance. Their results were published in *FEBS Letters*, the journal of the Federation of European Biochemical Societies this past December.

**UNIQUE**

“The enzyme we’ve discovered is entirely unique in a scientific context”, observes Bjørnar Myrnes, the researcher in charge of the Institute’s work with marine enzymes in cold-water habitats. “We found the substance in the crystalline style, an organ found only in the digestive gland of molluscs. It appears that the enzyme plays a dual role in the mollusc, being involved in both the disease defence system and the digestion of bacteria”.

Myrnes explains that the structure of chlamysin is similar to lysozym, an enzyme derived from a scallop found off the coast of Japan. There is a great deal of lysozym in spit and tears. In fact, it is this enzyme that keeps bacteria at bay in these body fluids. Although lysozym and chlamysin have similarities, they work differently.

To date, researchers have discovered four different anti-microbial substances in the Iceland scallop. However, chlamysin is the only substance shown thus far to have an effect on disease-producing bacteria, including *Listeria* which causes disease in human beings.

**MARINE POTENTIAL**

For quite some time, scientists have speculated that Arctic marine organisms must possess some very special qualities to survive in the cold waters of the north. They live at constant low temperatures, ranging from -1° C. to +4° C. The organisms’ enzyme activity levels are actually high at low temperatures, and they rarely tolerate much heat. However, chlamysin is an exception to that rule.

“Thirty days at room temperature or being heated to 70° C. for 15 minutes does not lower the enzyme activity level. Now that is unique”, explains Myrnes. “The discovery of this enzyme is indicative of the tremendous potential inherent in Arctic organisms. Norway has focused almost exclusively on oil for a long time, but now we have to begin taking a closer look at our other marine resources. They represent undreamed-of possibilities.”