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EDITORIAL

The seeds of success

The days are getting longer, the tulips are in bloom, and serried ranks of chocolate bunnies have sprouted in the shops — spring is in the air! The growing season has begun, and in parks and fields, woodlands and window boxes across the EU, plants are determined to get on with it.

A pretty sight, and also a promising one, for example for research and development efforts exploring the potential of various energy crops. The 'Bioenergy chains' project set out to increase the use of biomass by evaluating the technical, socioeconomic and environmental feasibility of the entire bioenergy chain in southern Europe, from biomass production to thermo-chemical conversion. The energy section leads with a short presentation of the project's work, which notably aimed to eliminate seasonal variation in supply. The team focused on perennial crops, such as reeds, miscanthus and switchgrass, to ensure year-round availability of raw material through successive harvesting.

And of course, plant power is just one of many topics recently featured on the Technology Marketplace. Our selection from the latest coverage begins with the biology and medicine section, which opens with fertile research into aspects of iron overload disorders, and more specifically the potential impact of normal dietary intake on the risk of heart disease in patients with hereditary haemochromatosis. The environment section sets out with an overview of a particularly fruitful outreach activity launched as part of the EuroStrataForm project in order to get schoolchildren involved in earth and ocean science. The IT and telecommunications section leads with an article from the ICT Results service, which hints that building home and office networks may soon become a do-it-yourself job, and a great deal cheaper than it is today, in the wake of the POF-ALL project's research into the potential of plastic optical fibres. And finally, the industrial technologies section features several articles on modelling approaches and techniques designed by EU-funded projects to reduce flow instabilities and optimise production processes for polymers.

As usual, all the articles presented this month were freshly picked from the Technology Marketplace and the ICT Results service. To check for more news, read up on other projects or submit information on your own work, please access these CORDIS services online at: http://cordis.europa.eu/marketplace and http://cordis.europa.eu/ictresults

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The editorial team

Frequent acronyms

ERA	European research area
FP5/6/7	Fifth/Sixth/Seventh Framework Programme of the European Community for research, technological development and demonstration activities
ICT	information and communication technologies
IST	information society technologies
R & D	research and development
SMEs	small and medium-sized enterprises

TABLE OF CONTENTS

Studying the role of iron in heart disease

The 'Nutrient iron toxicity' project investigated the impact of normal dietary iron in patients with homozygous hereditary haemochromatosis, particularly the risk of coronary heart disease in women.

Hereditary haemochromatosis is a chronic iron overload disorder where patients absorb too much iron that leads to increased levels of toxic non-transferrin bound iron (NTBI) in plasma. This disorder is quite common in European countries, with one tenth of the population at risk of developing cerebral and cardiac atherosclerotic complications.

With the aim of shedding more light on this disorder, the 'Nutrient iron toxicity' project focused on exploring the adverse effects of iron in haemochromatosis. One of the primary objectives was the specification of the mechanism of NTBI toxicity as well as its effects on the vascular endothelium, which notably include arteriosclerosis, and on the liver.

An important aspect of the project's work involved investigation of the relation of the dietary haem iron intake with coronary heart disease risk in a large population-based group of middle-aged women. The cohort involved women aged between 49 and 70 years at recruitment between 1993 and 1997.

The study was completed in January 2000 with follow-up research that resulted in the documentation of 252 newly diagnosed cases of coronary heart disease. Data stratification included additional cardiovascular risk factors, menstrual periods, and antioxidant intake to investigate the possibility of effect modification.

Having taken into account cardiovascular and nutritional risk factors, high dietary haem iron intake was found to be responsible for a 65 % increase in coronary heart disease risk. The data showed that middle-aged women with a relatively high haem iron intake are susceptible to the presentation of symptoms of coronary heart disease. Therefore, there is a significant need for middle-aged women to follow an appropriate diet and lifestyle to prevent this.

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New therapeutics for iron overload disorders

Within the context of the 'Nutrient iron toxicity' project, novel iron-binding polymers were designed for hereditary haemochromatosis disorder.

Haemochromatosis is a hereditary disorder that involves abnormal dietary iron metabolism causing iron overload in a number of body tissues. This disorder eventually leads to hyper-absorption of iron from a diet. Typically, after a period of 30 years, the accumulated iron levels become toxic, resulting in adverse cardiac, endocrine or liver symptoms. It is estimated that one tenth of the European population with hereditary markers for haemochromatosis are potentially subject to cerebral and cardiac atherosclerotic complications.

The 'Nutrient iron toxicity' project focused on developing new diagnostic tests and non-absorbable iron chelators for easy therapy and prevention of iron overload. One of the key project results involved the design of new iron polymers for avoiding the accumulation of body iron. The biocompatible polymers may be introduced in a diet when they demonstrate selective binding to iron in order to prevent its absorption. A set of synthesised polymers was successfully tested which may be incorporated into clinical studies.

One of the active iron-binding polymers designed presented an increased capacity to suppress iron absorption in the gastrointestinal system. A Swiss pharmaceutical company showed interest in this development for future collaboration. All these project results can significantly contribute to the minimisation of the high morbidity and mortality rates, providing a better quality of life for iron overload patients and their families.

Iron overload and liver fibrosis

Iron overload, as a result of dietary excess or inherited conditions, has serious consequences. Scientists have investigated the role of hepatic stellate cells (HSCs) on a common symptom of excess iron, fibrosis of the liver.

Iron is a very important dietary component and its deficiency symptoms are well known. On the other hand, its excess can be equally if not more devastating, potentially causing organ damage and the formation of excess fibrous tissue in the affected organ. Haemochromatosis (HC) is an inherited disease where normal dietary iron causes liver damage and atherosclerosis by the absorption of excessive iron.

The 'Nutrient iron toxicity' project therefore aimed to investigate the intricate metabolic pathways behind overload damage. Partners at Modena University refined this line of research and focused on HSCs. These cells are the main culprits involved in liver fibrosis. The research team discovered that hepatocytes in individuals with a certain type of HC fail to produce hepcidin. This is a hormone produced in the liver that controls secretion of iron from macrophages. These are the 'big eaters' of the immune system which engulf invaders.

This is particularly relevant for the specialised macrophages that recycle iron from old red blood cells. The consequent iron

Microbubbles for ultrasound interpretation

Ultrasound scanning is an effective means of detecting symptoms associated with strokes. Researchers have developed a new contrast agent to improve and extend diagnoses from the scanning process.

Ultrasound scanning is an effective means of obtaining information about blood perfusion, or nutritive flow, and perfusion defects within tissue. This method is non-invasive and can give an early diagnosis and a chance for effective monitoring and consequent recovery.

The UMEDS project aimed to develop enhanced techniques of ultrasound scanning in order to achieve these goals. Project partners at Bracco Research S.A. specifically researched the refinement of ultrasound contrast agents. Ultrasound images can be improved by using a contrast agent. To date, the blood pool agents utilised have only given information about vascular compartments through derived parameters like blood flow.

An alternative way of doing this is to use an agent which consists of millions of tiny air bubbles, each with a size of less than 10 μm. Each of these microbubbles will reflect the sound wave to produce an image. Using this targeted microbubble technique, medical staff can detect lesions, assess their size and their importance, and monitor the efficacy of treatments for the affected area.

The novel microbubbles were targeted to human platelets, and researchers found that use of these increased the ultrasonic detection of human thrombi or clots. Further experiments revealed the possibility of using the microbubbles for therapeutic thrombolysis to disperse the clot.
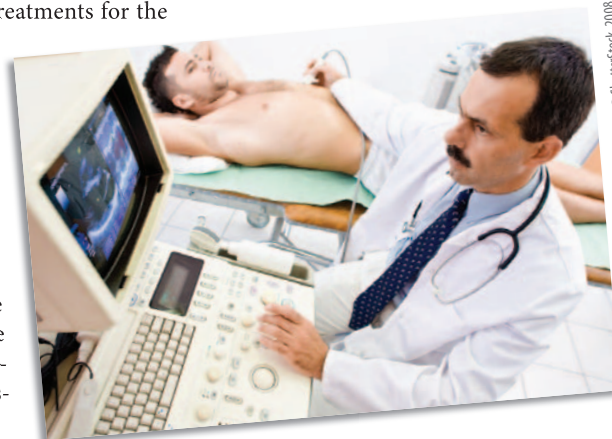
Alternative imaging techniques such as magnetic resonance imaging or computed tomography are expensive. It is foreseen that the use of microbubbles may be an efficient cost-effective alternative that has the added advantage of being readily transportable.

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B cells make specific monoclonal antibodies

The improvement of vaccination techniques is one of the keys to tackling diseases like hepatitis and cancer. Researchers have devised a method to produce monoclonal antibodies against a virus using human immune memory cells.

Human monoclonal antibodies have become an important tool in medicine, pharmaceuticals and molecular biology. If monoclonal antibodies are present for any cell or substance, the antibodies can serve to detect and purify those entities. Monoclonal antibodies have been produced to treat viral infections, cardiovascular diseases and inflammatory disease, to name but a few.

The overall objective of the European project Memovax was to investigate the nature of immunological memory to provide a rational approach to immunisation against diseases. Immunisation strategy could therefore be based on an improved understanding of the complex pathways involved. As an integral part of this, scientists at the Institute for Research in Biomedicine in Switzerland developed a novel method to produce human monoclonal antibodies from memory B cells. Memory B cells are formed from B lymphocytes and they 'remember' the invader for faster production of antibodies in the wake of a future infection by the same pathogen.

The team produced monoclonal antibodies from an individual who had recovered from severe acute respiratory syndrome coronavirus (SARS-CoV). With the informed consent of the patient, peripheral blood was collected and a specific type of B memory cell was isolated. After two weeks and after culture with the Epstein Barr virus using a newly developed method, the B cells were purified and screened for specific antibodies. After several purification steps, stable specific clones producing monoclonal antibodies were isolated.

It is expected that further R & D in this field will yield novel efficient methods of disease prevention. These are most likely to be based on the complex molecular biology involved including new vaccines refined for specific purposes.

excess then starts the cascade of events toward liver damage. The resultant oxidative stress triggers activation of those HSCs that cause the liver fibrosis. On a positive note, the team also discovered that during active fibrogenesis, iron chelators could be used for fibrosis prevention and therefore stop HSC activation.

As HC is the most common hereditary disease in Europe and iron excess has such detrimental effects on health, this research is crucial. It can provide the basis for more effective therapy for iron overload sufferers and the means by which preventive measures can be taken in those with excess dietary iron.

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Stem cells transformed to make dopamine

A European team of scientists has researched the molecular protocol for differentiation of stem cells into dopaminergic cells for the treatment of Parkinson's disease.

Parkinson's disease is typified by a pronounced tremor of the extremities, usually the hands or lips. It is the source of difficulty of movement and exacts a high cost in terms of health care. The disease is a result of the progressive destruction of dopamine-producing cells in an area of the midbrain, the substantia nigra. Dopamine is a neurotransmitter and has many functions including that involved in motor activity, hence the array of symptoms that constitute Parkinson's disease.

Accordingly, the aim of the DANCE project was to develop dopaminergic (DA) neural cell lines for transplants. A multidisciplinary consortium investigated DA cell development from human neural precursor cells. As part of this line of research, workers at the Molecular Neurobiology Lab in Stockholm researched some of the molecular pathways responsible for the differentiation of these dopamine-producing cells.

Their focus was the role of a family of glycoproteins, the Wnts. The Wnts, first investigated in the fruit fly, have a wide range of functions and are present throughout the animal kingdom. In humans, they are responsible for physiological processes including cell division and differentiation, the key to this piece of research. The researchers investigated several members of this family and they found that they are key regulators of proliferation and differentiation of the DA precursors. Moreover, they found evidence that individual Wnts play very different roles. In particular, Wnt-5a could directly stimulate the differentiation of stem cells into the DA neurons.

Parkinson's disease affects more than a million people in Europe alone. Thus, using Wnt-5a as part of the molecular cocktail, efficient production of DA neurons may be achieved for the effective treatment of this distressing condition.

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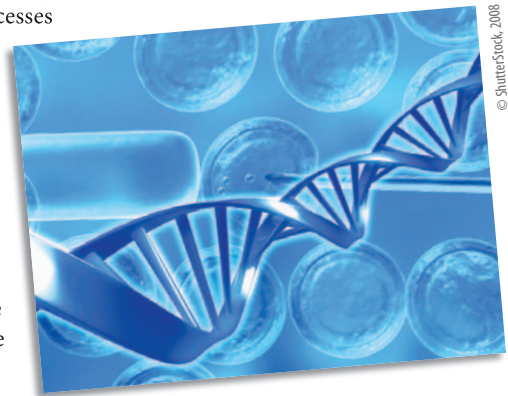
Reasons for leaving the nursing profession

The NEXT study contributed to sustaining future health care provision in ageing societies. This was achieved through investigating the reasons behind the loss of trained staff from the nursing profession.

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Maintaining a sufficient pool of active nurses in Europe will be a major challenge in the forthcoming decades. Demographic changes will lead to an increasing demand in the future and most countries within the EU already face a shortage. At present, the vast majority of nursing staff leave the profession prior to the normal retirement age.

The NEXT study used the work ability index (WAI) to investigate the reasons behind premature departure. The WAI evaluates the link between an individual's perceived personal resources and the self-evaluation of one's own working conditions. It also provides empirical evidence of the relationship between work ability, age and intention to leave nursing. This relationship was evaluated using a representative sample of 26 000 qualified nurses from 10 European countries.

In all 10 countries, WAI scores were significantly lower among older nurses than in younger staff. Furthermore, in all countries there was a significant association between low WAI scores and the declared 'intention to leave nursing'. This was especially true among younger nurses, since they are offered more employment opportunities to improve their working and personal conditions. Poor leadership and staff's social relationships were the main factors affecting the perceived working ability of nurses across Europe. Indeed, workload and the availability of good information in order to accomplish tasks heavily depend on such factors.

NEXT was the first study to use the WAI from a cross-cultural perspective. This proved to be an effective tool for predicting an intention to leave the nursing profession. Therefore, work ability is an important organisational resource. Human resources managers should recognise examples of good practice and promote working conditions that support work ability. This in turn will help to reduce the desire to leave nursing as a result of burnout, disability or other reasons causing poor health.

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New insights on fish disease

Ensuring that fish populations across the EU remain healthy and disease-free is not only a matter of environmental protection, but also of economic necessity.

One of the most prevalent pathogens affecting Mediterranean fish cultures in particular is *Myxidium leei* (*Myxozoa*). *Sparus aurata* (commonly known as the gilthead bream) was the point of focus for the EU-funded MyxFishControl project, which sought to enrich the knowledge base on myxidiosis.

Project partners studied the epidemiological aspects of the disease as well as mechanisms of transmission, pathogenesis and immune responses. The Israeli National Center for Mariculture carried out a series of surveys examining the spread of the disease across wild fish populations in 10 sites in the Mediterranean Sea and the Red Sea. Participating countries included France, Greece, Israel, Italy and Spain.

A total of 2 260 fish was examined, and 55 individual fish were found to be positive for myxidiosis. The geographic proximity of infected fish near fish cultures implies that feral fish could act as infection reservoirs. This information could have an important impact on the development of prophylactic measures to ensure the health and well-being of wild and cultured fish in the Mediterranean region.

Salmon stress levels from sea lice

Farmed fish are particularly prone to disease and infection. Research has been carried out to ascertain which levels of the parasite Lepeophtheirus salmonis (L. salmonis) *induce physiological stress in the fish.*

Sound and sustainable management of farmed fish stocks is crucial for many reasons. Perhaps the most obvious is to fill the gap in the market for consumer favourites such as salmon and help to preserve wild populations. Equally important, farmed fish stocks constitute a valuable portion of the local economy for angling activities and farming income in peripheral north-western areas of Europe.

As a broad objective, Sumbaws, an EU-funded project, investigated the interactions between wild and farmed salmonids. The scope of this project also included research by workers at St Andrews University in Scotland on the effects of the sea louse (*L. salmonis*) on farmed fish. The life cycle of this unwelcome visitor includes stages where the parasite is attached to the fish, followed by motile stages when the majority of the harm is done to the host.

The scientists conducted trials to determine the level of sea lice infestation that was sufficient to cause physiological stress in the fish. Experimental conditions were set up to simulate realistic environmental conditions. Physiological parameters that indicated stress included decreases in haematocrit, red blood cell count, and increases in chloride and glucose lactate in plasma. Results overall concluded that infestation of more than 20 lice per fish caused the onset of physiological stress symptoms.

Recommendations regarding this important threshold for sea lice burden have been published for the benefit of both the aquaculture and wild fish industries. This will provide valuable information for the formulation of policy development in fish stock management.

Model for sea lice infection of salmonids

The protection of wild salmon populations is of prime importance. EU scientists have devised a multivariate model to predict their predisposition to sea lice infection within regions of a fjord.

The prospect of the establishment of a new fish farm involves many decisions. Choice of site is crucial and an array of factors can be significant. Productivity can be affected by climate, water source and quality, land topography, soil, and available infrastructure. Environmental factors include pollution and sensitive ecological niches.

Partners in the Sumbaws project have investigated one of the factors pertinent to wild salmonids, namely the risk of infection by sea lice in different areas of a fjord. Indirectly this is applicable to the farmed fish because the model can also be used to predict risk of infection in the aquacultural situation. The preparatory research for this was the study of temporal and spatial distribution of post-smolt salmonids in a Norwegian fjord system by the country's Institute for Nature Research.

Uses of the model include evaluation of levels of salmonid infestation by lice and a safety gauge to judge whether wild salmonids will be harmed. It can also be used to predict the chances of lice infection in smolts at specific sites in the waterway. The model can therefore assess the effects of the establishment of a new farm on the wild populations of salmonids. Potential negative effects can be evaluated and a fully informed decision be made about the location of a new farm.

Thus, using this model, the possible phenomenon of farmed fish being a pool of infection for this parasite can be kept to a minimum. Furthermore, the two systems can coexist for the maximum safety and conservation of salmonid fish stocks.

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Improving welfare in fish farms

The Fishcal project studied the production and receptor distribution of one of the key fish hormones, melatonin.

Efficient fish farming techniques are directly related to appropriate feeding and husbandry standards in order to improve fish welfare. Shedding light on the importance of calcium in fish culture, the Fishcal project studied different sources of calcium during fish development, growth and reproduction. As calcium also plays a significant role in proper skeleton formation, the project work is directly related to the issue of skeleton abnormalities in fish.

Additionally, the project researched calcium homeostasis during early life and normal growth in addition to the effects of parathyroid hormone-related protein (PTHrP) on homeostasis. Moreover, the molecular mechanisms underpinning bone formation in fish and the way in which PTHrP regulates this process were also explored. Part of the project work involved the study of melatonin, a hormone found in all living organisms from algae to humans.

Melatonin is found at different levels during the daily cycle and is considered to be a powerful antioxidant protecting the nuclear and mitochondrial DNA. Researchers gained a better insight into melatonin concentration levels dependent on the daily light-dark cycle for different age populations and tissues. The profile of melatonin production and receptor distribution constitutes a valuable tool for studying the hormone's interaction with PTHrP, which is related to calcium transfer.

Methods for evaluating and modelling fisheries

A generic software framework for fisheries modelling and the evaluation of management strategies has been developed.

Fishery systems and interaction among management, exploitation, environment and biology are complex in nature. Thus responses to management actions are not always easy to predict. The 'Framework for the evaluation of management strategies' (FEMS) project has proposed a computer simulation framework which allows evaluations of the performance of management strategies. These strategies are based on current and improved biological knowledge and management procedures.

Under these auspices, the software framework 'Fisheries library in R' (FLR) was designed. It allows simulation models to be created. These can be stipulated on an array of stock and fleet assumptions in which current and alternative management strategies can be assessed. The R in FLR is a free, open-source, multi-platform software environment for statistical computing and graphics. It provides a multitude of software tools and can also include packages such as libraries.

All users have access to the code, allowing numerous developers from various projects, bodies or institutes with different objectives to collaborate on coding. Hence, users can learn from each other and the process can be accelerated. The framework can include various processes and model uncertainty regarding knowledge of fisheries systems dynamics, their response to management and the ability to monitor, assess and control them.

The framework is currently used to produce bio-economic models, multi-annual management plans and fishery-independent assessment methods inside numerous EU projects. The FLR 'Concurrent versions system' (CVS) project can be found online at http://sourceforge.net/cvs/?group_id= 108356. All modules are available for browsing via the CVS tree.

Recommendations for aquaculture and game angling

A summary which focused on economic impact analyses of the aquaculture and game angling industries in Ireland, Norway and Scotland has been produced, complete with recommendations.

The Sumbaws project has examined the decrease of wild salmonid populations in north-western Europe as well as aspects of the migratory behaviour and physiological responses of young salmonids. Furthermore, it has provided current appraisals and modelling of the socioeconomic significance and interaction of the aquaculture and game angling industries in remote regions of north-western Europe.

A multidisciplinary approach was taken during the research. Academic and applied scientists, an SME consultancy as well as an industrial pharmaceutical company joined efforts to quantify the lice infestation levels causing physiological stress on host fish. They also assessed the possibilities of maintaining and enhancing small amounts of salmonid stock in a sustainable context with only little management intervention.

Following this, a summary was produced which highlighted an economic impact analysis of the aquaculture and game angling industries in Ireland, Norway and Scotland. It showed that both angling and aquaculture are important sources of employment, usually in remote rural regions. Furthermore, it became evident that treating wild smolts against sea lice infection has fallen short as an adequate management or conservation strategy.

Eliminating ovigerous (egg-bearing) lice on farms was found to be too costly, both in economical and in environmental terms. Therefore, a lower threshold of lice levels in both the wild and farmed fish sectors needs to be considered as acceptable. In order to continue obtaining scientific data on the health and performance of wild stocks, monitoring of these stocks should be given the highest priority.

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Muscle decline and physical training in the elderly

Musculoskeletal frailty is the limiting factor for the mobility, balance and endurance of elderly people. Therefore, a major effort to understand and mitigate the phenomenon of frailty appears necessary for maintaining quality of life.

The Better-ageing project researched the causes of frailty and evaluated the benefits of a training programme for the very old. The project evaluated neuromuscular function in older individuals, since one of the characteristics of ageing is a decrease in muscle mass and strength.

The decline in neuromuscular function and performance with ageing can be estimated by the measure of the maximal voluntary contraction (MVC) torque. However, this impairment of strength is muscle group dependent. The project investigated the effects of a six-month strength-training programme on the major muscle groups around the ankle. Although a training programme in old age is highly effective in recovering strength, it does not appear to improve the reflex activity of the muscles. These were found to decline in older adults, suggesting that this change could be linked to degenerative phenomena.

The plasticity of muscle elastic properties in older individuals was also evaluated following a strength-training programme. The first study determined stiffness during planar flexion in young and older people. This was similar between the age groups, suggesting an adaptive mechanism. The second study examined differences between older women and older men. Greater stiffness in women may be due to disparities in the muscle tissue, explaining in part their greater frequency of falling. The third study investigated the degree of recovery of motor function following a six-month strength-training programme. The reduced stiffness may be due to structural and neural adaptations, counterbalancing some of the effects of the neuromuscular ageing.

Research of this nature into the possible reversal of the effects of ageing can only improve quality of life for elderly people. Musculoskeletal frailty is the main factor affecting independent living until death. Social exclusion can therefore be avoided by maintaining mobility and postural stability as well as the ability for self-care and preventing falls.

Anti-ageing treatment for T cells

Conditions associated with an ageing and compromised immune system include cancer and increased risk of infection. Scientists have researched the potential anti-senescent effects of various treatments on human T cells.

The discovery of agents that will delay ageing or senescence in cells is an attractive lure. Not only will it be very profitable, but it will revolutionise the lives of elderly or frail individuals. Ageing will hopefully be free of diseases that are the result of senescing and malfunctioning cells.

The EU-funded 'T cell immunity and ageing' (T-CIA) project concentrated its efforts on ageing in T cells. These cells are highly important in the human immune system and become specific for a molecular target or antigen once they have been exposed to the invader. They therefore form part of the adaptive system of immunity and are important in dealing with cancer cells and viruses.

The project team from Nottingham Trent University conducted trials for various treatment strategies for ageing or senescence in T cells that were cultured *in vitro*. Variables or indicators of senescence measured were DNA damage levels, lifespan in culture and the ability to divide or proliferate.

Reduced oxygen tension and the addition of an antioxidant, superoxide dismutase induced the same effects on the cultured cells. In both cases, lifespan and the ability to proliferate were reduced. Furthermore, DNA damage was reduced in both trials.

It has been speculated that these data are a result of an effect of an overall change in redox balance in the cell. This may affect reactive oxygen species (ROS) mediated cell pathways. One of these is the mitogen-activated protein kinase (MAPK) pathway, which is responsible for the activation of cell division.

The project partners planned further research based on these findings to verify these results. The ultimate aim is to offer therapies for ageing at a cellular level.

Genetic damage in elderly immune systems

Susceptibility to infectious disease and cancer are two major effects of an ageing immune system — although some people appear to be far less affected than others. Researchers have investigated the molecular mechanisms that help to keep some of us healthy well into old age.

Cell ageing receives a lot of media and scientific attention. It is not only the realm of the cosmetics and nutraceutical industries. Pharmaceutical therapy is a potentially massive area as cell ageing is responsible for many of the degenerative diseases all too evident in the elderly population. The ageing process is multifaceted, and the ageing of the immune system is one important aspect. Without the disabling effects of diseases like cancer, often a result of a compromised immune system, the ageing process would not necessarily mean such a reduction in life quality.

Partners in the 'T cell immunity and ageing' (T-CIA) project researched the genetic basis of ageing in human T lymphocytes, one of the main agents of the adaptive defence system. The team at Nottingham Trent University investigated genetic damage in human T cells and their capacity to repair these errors as they were aged *in vitro*.

T cell clones (TCCs) were studied from three main groups aged 26, 45, and 80 and over. The clones were observed in culture until they underwent apoptosis, i.e. programmed cell death. The cells were also subjected to various chemical DNA-damaging agents as well as ultraviolet irradiation.

Two repair systems were under scrutiny. These were poly (ADP-ribose) polymerase (PARP), an enzyme which activates and recruits DNA repair enzymes, and the mismatch repair

High-density gene map for the fruit fly

The fruit fly **Drosophila (D.) melanogaster***, so commonly used in genetic studies, has proved its usefulness yet again. Researchers have produced a new high-speed, state-of-the-art mapping technique to facilitate the study of new mutations.*

Unravelling the human genome relies heavily on functional genomic studies in *Drosophila*. Partners in the FlySNP project focused on the production of a fine-resolution genome map to facilitate the assignment of functions to any given gene. Single nucleotide polymorphisms (SNPs), or genetic variants that are different in respect of one nucleotide only, occur very frequently in *D. melanogaster*. Due to their high incidence and their phenotypic expression, they are highly suitable for use as markers for mutations. These mutations, once located, can then be cloned for further study.

A team at the Austrian Academy of Sciences in Austria created a high-density SNP map with over 2 000 markers. Importantly, these are widely and evenly spaced throughout the genome. Construction of the SNP map was achieved in three phases, working from an initial low density to a medium density and then to the high-density map. To achieve this, the team utilised the *Drosophila* genetic database FlyBase for comparison of the SNPs that were selected, sequenced and amplified. Automatic SNP detection by the PolyBayes software package was followed by the application of quality criteria and then visual inspection of the alignments to increase reliability.

For interested users, the SNP map is shown via the project database (see http://flysnp. imp.ac.at/flysnpdb.php). This site provides an introduction to the project, a user guide, methods and links to important relevant sites. Information downloadable from the website on specified regions includes the alleles, position in the genome (arm region and position), flanking sequences and details of the amplification primers. There is also a direct link through GBrowse that gives a pictorial version of sequences.

The work achieved by the team has developed the SNP mapping technique which has cut the onerous task of mapping from years, in some cases, to a matter of a few months. This allows researchers to concentrate their valuable time on further analysis of the genes and location of new mutations.

Intranasal flu vaccines

Researchers have organised clinical trials for a variety of influenza strains to test the efficacy of mucosal vaccines for intranasal application.

Human trials for highly infective agents like avian flu need to be carefully monitored and controlled. A clinical trial under the auspices of the European MUCADJ project was conducted at the University of Leicester in the United Kingdom. All of the 84 volunteers were carefully monitored for possible side-effects. An air courier service was used to deliver blood and secretion samples the same day for cell-mediated immunity monitoring. A clinical database in Amsterdam was used to record the data and produce a full clinical study report.

Vaccines were applied, both intranasally for the experimental group and intramuscularly in the control volunteers. The flu virus is notorious for the development of new strains. Consequently, combinations of different strains were tested, including avian and swine flu variants. Vaccines were applied using a non-toxic enterotoxin as an adjuvant. An adjuvant is an agent that modifies the action of another agent and is used to enhance the immune action of the vaccine.

Results were both encouraging and informative inasmuch as they provided a base for amendments to current vaccination strategies. Most notably, a trivalent vaccine produced a systemic response against the swine flu (virus A) and influenza strain B, albeit a reduced response. There were two main recommendations. Firstly, for effective immunisation against avian flu, H5N3, it was suggested that a stronger adjuvant be used, probably another *Escherichia coli* mutant. Also, cell-mediated immunity studies suggested that there should be a longer period between the two immunisations to allow the development of immunological memory.

The vaccinology in this project has real potential in the development of safe, efficacious vaccines against important diseases. Mucosal vaccinology and parenteral (needle-free) vaccination generally are areas with great potential for pain- and discomfort-free application.

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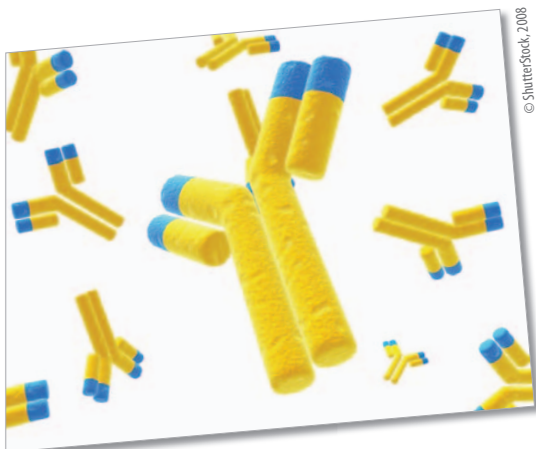
(MMR) systems. Both mechanisms were impaired during cell ageing in the two more youthful samples, but in the 80-year old cell, they appeared to be more efficient.

Furthermore, older donors appeared to have intact DNA in the area of the telomere, according to a new fluorescent *in situ* hybridisation (FISH) technique. The telomere is found at the end of chromosomes and tends to disintegrate with every cell division. The theory is that this region protects valuable DNA further down the chromosome and disorganising it causes the dividing cell to make genetic mistakes.

Further research will help to uncover the genetic and molecular mechanisms as to why some people age with more ease and comfort than others. From the point of view of resistance to disease and cancer, the ageing of the immune system no doubt holds some important clues.

See also page 16 (offer 3638)

Improving ruminant diets

Improving the dietary status of farm animals, including ruminants, forms an important policy area for the European Commission. As such, the reduction of antibiotic and chemical additive intake is a priority topic in this agenda.

The EU-funded Rumen-up project focused on the development of new plants and plant extracts that would reduce lactic acidosis, bloating, methane production and nitrogen secretions. The overall aim was to improve animal welfare and also protect the environment.

Under normal conditions, nitrogen is retained poorly by the digestive tract of ruminants, and it is excreted via the urinary tract. The low rates of nitrogen retention have shown to be a financial loss as well as a cause of stress for the animal and a source of environmental pollution.

Therefore, decreasing the rate of protein breakdown to ammonia could be of great value to different stakeholders. The way to reduce this proteolysis process could be via the ingestion of appropriate plant materials, containing natural proteolytic inhibitors. These plants and extracts include plant materials from *Helianthemum canum, Arctostaphylos uva-ursi, Epilobium montanum, Knautia arvensis* and *Peltiphyllum peltatum*.

It is therefore possible to modify the long-term metabolic status of ruminants by replacing chemical additives with plant extracts, thereby improving their environmental record and improving animal welfare. These results could be of value to biotechnology companies involved in animal nutrition as well as academic institutions with similar research projects.

Funded under the FP5 programme IST
(User-friendly information society).

Collaboration sought: information exchange/training.

Offer ID: 3599

Using plants to decrease methane emissions

Plant-based solutions have been developed to alleviate methane emissions caused by imbalances in digestion in ruminants.

Bloat and acidosis are distressing disorders for ruminants. They are caused by a malfunction of microbial digestion in the rumen. Methane, a potent greenhouse gas, and ammonia are a result of normal rumen fermentation.

As a way to alleviate these problems, the Rumen-up project has created plant-based sustainable solutions. This has been achieved through the development of new plants or plant extracts as dietary supplements in place of chemical additives and antibiotics. Plant materials were obtained from botanical and industrial collections and then assessed for their potential to lessen nutritional stress in ruminants. It is also a way to decrease pollution since methane formation is prevented and nitrogen excretions are decreased.

This advancement in organic farming is beneficial for the EU's biotech and agricultural industries and can also increase crop diversity.

Funded under the FP5 programme 'Life quality'
(Quality of life and management of living resources).

Collaboration sought: further research or development support.

Offer ID: 3660

Meadow plants reduce unwanted protozoa

Scientists, as part of the EU-funded Rumen-up project, investigated the effects of protozoa in ruminants on the efficiency of protein utilisation.

Ruminants are notoriously inefficient when it comes to nitrogen utilisation. This has a knock-on effect on the environment because of nitrogen excretion in the urine and faeces. Consequently, there will also be a reduced protein content in livestock products, meat and milk.

The extent to which the grazer will assimilate nitrogen from the food is partly dependent on the contents of its rumen. This first chamber in the alimentary canal is a seething mass of microbes, predominantly bacteria and single-cell animals (protozoa). It is a dynamic ecosystem in its own right and this delicate balance is inevitably affected by the diet of the animal.

Scientists at the Rowett Research Institute in Scotland investigated the effects of the protozoan population on nitrogen retention in the rumen. They established that a reduction in the numbers of protozoa would increase the efficiency of nitrogen utilisation. This is due to the fact that these single-cell marauders consume vast quantities of the bacterial fauna in the rumen. As the microbes digest and ferment the fodder, reduction in the population size of the bacteria can reduce the yield of protein from microbial action.

The team discovered that this can be remedied by administration of extracts of meadow plants in the livestock drinking water. These plants, once a natural feature of old grazing pastures, are all too often missing from modern intensive feeding regimes. They include the daisy (*B. perennis*), pussy willow with its furry flower structures (*Salix caprea*) and the stinging nettle (*Urtica diocia*).

It would perhaps be impractical to reintroduce the farming conditions prevalent prior to large-scale mechanisation. Indeed, certain meadow plants, for example groundsel, are toxic to ruminants. Careful management, however, combined with biotechnological know-how, can yield a highly productive regime, with limited damage to the environment.

Funded under the FP5 programme 'Life quality'
(Quality of life and management of living resources).

Collaboration sought: licence agreement.

Offer ID: 3623

Mapping for mastitis resistance

Milk production accounts for 18 % of the EU's agricultural production. Researchers have investigated the genetics of resistance to mastitis, a disease that causes severe losses throughout the dairy industry.

Mastitis — inflammation of the udder in cattle — causes loss of milk quality and lost milking days while the animal is being treated. Treatments for mastitis include antibiotics, which are becoming increasingly unpopular within Europe. Improved hygiene, husbandry and selection for resistance are alternative strategies. To date, however, breeding programmes have largely neglected the inclusion of resistance to mastitis because the degree of heritability is relatively low.

The partners in the 'Mastitis resistance' project aimed to address this omission in conventional breeding programmes. They concentrated their research on providing breeding tools to improve the genetic resistance to this distressing disease. To do this, they set about fine-mapping the chromosomes of cattle to determine the proximity of resistance genes to marker traits that can be easily identified. Marker-assisted selection (MAS) in a breeding programme could then be employed.

Chromosome mapping can be performed using linkage studies. The principle depends on the probability of separation of the genes on formation of the gametes when the chromosomes break and recombine at certain points. Generally speaking, if the probability of recombination is high, it follows the genes are far apart because there will be more breaks. The converse is, of course, also true. The closer they are, the fewer times they will be split apart from each other.

Mapping using this so-called linkage disequilibrium (LD) technique demands a lot of information. Therefore, the team at the Animal Genetics and Genomics Centre at Lelystad in the Netherlands used a vast amount of historical data. This mapping method has been used very successfully on the human genome, with a high degree of resolution achieved.

In refining this technique, the team developed methods to calculate the identical by descent (IBD) probability, taking into account the families and breeds in the study. An IBD matrix that required verification was then constructed. Comparing all founder haplotypes (statistically associated genetic variants) with the resulting matrix was then undertaken. Because of the vast numbers of haplotypes to be compared, the group programmed several ways to cluster these variants.

Due to the huge quantity of information used as input, future fine-mapping using LD linkage analysis will require more computer resources. These results, however, have undoubtedly paved the way towards control of the disease using breeding by the selection of identifiable markers associated with mastitis resistance polymorphisms.

Dendritic cells fight foot-and-mouth disease

The foot-and-mouth disease virus (FMDV) still poses a constant threat to livestock health in Europe. The most efficient means of stimulating protective responses against this disease have been investigated.

Foot-and-mouth disease is devastating to livestock for several reasons. It is highly infectious, and the acute phase is followed by a time where there are no symptoms. Carrier animals can therefore pose a significant risk to healthy stock. Moreover, the virus can persist in straw and hay for up to 20 weeks.

The 'FMD tropism' project set about trying to unravel the complex molecular biology surrounding viral movement and persistence in the host. This, the team hoped, would lead to the prevention or cure of this dangerous carrier state. Scientists at the Institute of Virology in Switzerland investigated the role of dendritic cells (DCs) in the shaping of the immune response.

First, they investigated the way in which FMDV interacts with DCs. These cells are important players in the mammalian immune response, and they control lymphocytes that respond to specific antigens. Two variants of the virus were studied. The results indicated that there was a more efficient uptake and binding of the virus if it was the heparan sulfate-binding variant. It was also confirmed that uptake and retention of the virus are essential for the induction of lymphocyte activity.

Secondly, they focused on the interaction of FMDV with natural interferon-producing cells (NIPCs), also a type of DC. They discovered that interferon production was only induced when live FMDV was complexed with immune immunoglobulin G, the most common type of antibody found in the system. Encouragingly, the presence of NIPCs and therefore interferon could constitute a form of innate or natural immunity.

This could confer defence against the virus before the acquired immunity of antibody production was fully developed.

These findings constitute important factors in the possible development of new vaccination strategies. Efficient activation of specific immune defences may well provide the key to the eradication or effective control of this disease.

BIOLOGY AND MEDICINE

Research network for chromosome imbalances

Current gene analysis techniques and database technology have facilitated the storage, exchange, analysis and access to genetic information. The Ecaruca project has collected medical data on chromosomal aberrations and set up a database for optimum information retrieval.

The human genome consists of approximately three billion base pairs. The number of mutations possible is therefore very large indeed, and the pace of discovery is advancing at an exponential rate. Types of mutation include alterations in one gene only, and changes on a bigger scale that involve the whole or part of a chromosome. Project partners in Ecaruca have focused their attention on smaller chromosomal changes. These include microdeletions, where a small part of the genome is missing, and microduplications, where a tiny, also submicroscopic region is duplicated.

Clinical geneticists at the Radboud University Nijmegen Centre in the Netherlands have set up a microdeletion research network that consists of seven scientific groups. These are distributed throughout Europe and are all working in cooperation on chromosomal microdeletions. Their efforts centre on the identification of the mutation and the genes involved. Information is disseminated primarily through the project website: http://www.Ecaruca.net

Massive jumps in technology as regards DNA analysis mean that geneticists can identify previously unrecognisable microdeletions and duplications and link these with associated syndromes. The analyses used by the project groups include microarray-based comparative genomic hybridisation (array CGH) and multiplex ligation-dependent probe amplification (MLPA).

The aim of the website is to make the database easily accessible to all participants and to encourage the exchange of information and technical knowledge. In order to further facilitate communication, a network of national coordinators has been set up, one in each participating country of the European Cytogenetics Association. They will submit new cases, cytogenetic information and clinical data to the Ecaruca database. Access to this database can help doctors and medical care workers to improve the care provided to affected individuals and their families.

Throwing light on chromosomal disorders

A website has been set up as a dedicated information point to inform both experts and patients about rare chromosomal disorders.

Finding information about rare chromosomal aberrations can be difficult both for patients and doctors. It is a vast subject area, and geneticists are now working with new techniques for detecting abnormalities, which means that the number of identified abnormalities will rise. The Ecaruca website was launched as a way of clarifying and organising information about the subject. The Ecaruca project allows everyone who has an interest in chromosomal abnormalities to access current information about the subject and connect with others including patients, their families and professionals.

The Ecaruca website has both public and private pages that users can access. Public pages, which can be accessed by the general public, give details about the project's objectives and general downloadable information about chromosomal disorders. The private pages, which can only be accessed with password protection by registered account holders, contain patients' personal data, lists of participating centres, a case-of-the-month study and a search facility organised by chromosomal aberration. There are also restricted pages for children's cases that can be accessed by their parents, who can then send follow-up information to the database managers. Information updates are disseminated regularly by means of a newsletter.

Ecaruca is currently being visited by more than 300 people per week. Over 500 professionals in the field of clinical cytogenetics have accounts and access the site regularly. The website is proving successful for connecting patients with chromosomal disorders, their families, doctors, scientists and all others involved in the area of chromosomal aberrations. It is hoped that Ecaruca will become an international forum for clinical cytogenetics.

Health supplements from fungi

The production of health supplements using biotechnology rather than industrial means is a rapidly expanding area. As part of a European project, scientists researched the production of ubiquinone, an important respiratory enzyme, from fungal species.

Coenzyme Q, or ubiquinone, is a familiar name on the vitamins and supplements shelf — with good reason. It is a strong antioxidant and therefore protects against those scavenging free radicals. Research has shown that it can reduce blood pressure and be used in the treatment of certain cancers. It occurs naturally in the body, mainly in the heart, but unfortunately its concentration in tissues can decrease from about the age of 35.

Scientists in the EU-funded 'Fungal carotenoids' project investigated the production of carotenoids by different fungal species. Carotenoids share a chemical relationship with coenzyme Q in that they are part of the large group of terpenoids. Project partners at the University of Seville focused their research skills on the coenzyme and its production pathways in the fungal group Zygomycetes.

Using radioactive tracer molecules, they followed the production of coenzyme Q and other target compounds, for example carotene. They found that these fungal cells

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were made up of the equivalent of production departments in a factory. Each sub-cellular compartment produced its own

Reproductive health of young Lithuanian men

There has been an increasing incidence of male reproductive health disorders across Europe. As part of a wider EU study, tests were carried out on the reproductive health of a sample of young Lithuanian men.

Over the last 50 years, there has been dramatic change for the worse with regard to male reproductive health. A number of countries have reported a decline in average sperm counts. During this period, the incidence of testicular cancer has increased, and it is now the most common type of cancer in young males. However, there are marked geographic differences across Europe. It has also been found that there are differences in sperm counts between selected EU countries. The prevalence of other disorders of the male reproductive tract also appears to be increasing. These include conditions such as hypospadias (the misplacement of the urethral opening) and cryptorchidism (the absence of testes).

Poor reproductive health leading to illness or childlessness obviously has an impact on the quality of life of the affected individual. There may also be a large social impact, with changes in the age composition of European populations over the next 20 to 30 years. The increased knowledge obtained during the 'Envir. reprod. health' project may help to identify the causes of these adverse trends.

Studies were carried out on the reproductive function of young men in Lithuania, using military conscripts as subjects. Researchers recorded their physical appearance and testis volume, which was measured using an orchidometer and ultrasound. Semen quality (sperm concentration, motility and morphology) and reproductive hormone levels in blood samples were also measured.

The findings have also taken into account information on lifestyle, antenatal and childhood exposure as well as previous or current diseases. The data will be compared with findings from other EU countries. Additional information is being provided from the Baltic area to the centralised European database on male reproductive health.

Software approach for understanding mitogen-activated protein kinase

The mitogen-activated protein kinase (MAPK) is perhaps the most important signalling pathway at the cellular level, involved in a myriad of biological processes from growth and development through to pathogenesis.

The EU-funded 'MAPK signalling' project set out to elucidate the spatio-temporal organisation of the pathway and how that organisation impacts function. In other words, even though scientists are now aware of the pathway's set-up, little is known regarding the pathway's involvement in all the different processes.

The Beatson Institute for Cancer Research, a project partner, focused on the development of the appropriate tools for the processing of protein and gene expression data. These tools form an essential part of research efforts within the framework of the project, given the amount of information that needs to be processed and interpreted.

Researchers tried to identify proteins that can be used for protein expression studies using 2-dimensional (2D) gels. The overall aim was to model the MAPK pathway using these high-throughput proteomic data. Part of that goal was reached through the development of a specific portal used to manage 2D gel data and delineating protein-protein interactions.

The online database was designed on the .NET platform and querying the database can be achieved through a variety of means. These include third-party software and a set of standard queries built into the database.
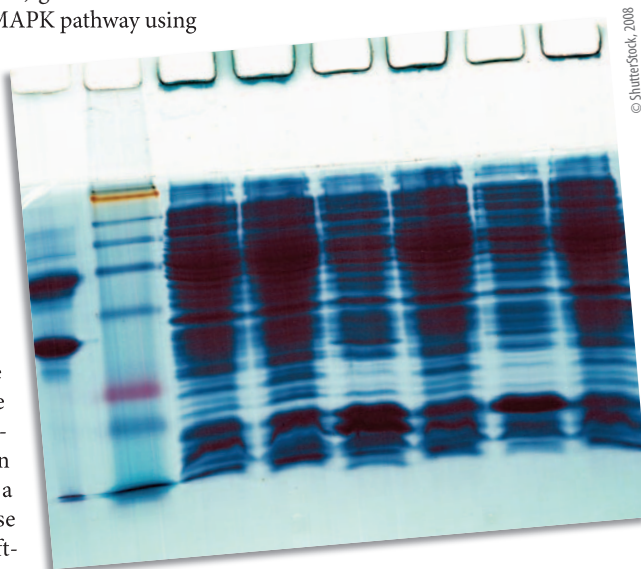
end-product and possessed its own pool of metabolites or raw materials.

With commercial production in mind, the scientists also investigated how production of ubiquinone varies with environmental conditions. The presence of carotene or illumination had no effect. By contrast though, leucine and acetate as carbon sources both caused upregulation of ubiquinone. Moreover, they found that fungal genus or the source of the coenzyme is sometimes important. The antibiotic oligomycin increases production in *Phycomeces*, but not *Blakeslea*.

This work could act as a platform for further research projects for these microbial production lines. The health of the consumer, food, pharmaceutical and biotechnology industries all stand to benefit from this line of research.

BIOLOGY AND MEDICINE

Disc cells under pressure

Back pain exacts a very high price, both in terms of health costs and suffering for the individual concerned. Scientists in the Eurodisc project researched the effects of physical and hydrostatic stresses on the potential self-regeneration powers of intervertebral disc cells.

The fact that intervertebral disc injuries are among the largest contributors to lost time at work is old news. However, it remains that the cost in terms of pain, disability and percentage GNP lost in Europe is very large. Degeneration of these cartilaginous cushions between the vertebrae is a result of ageing, genetics and life style. Researchers at the Demokritos Research Centre in Athens

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specifically investigated the effect of a range of stress situations on the discs.

Parameters tested were twofold. First, autocrine activity was measured, that is the ability to stimulate self-proliferation by the cells themselves. Discs have no blood supply, so the team reasoned that maintenance, or homeostasis, should therefore be reliant on factors secreted by the disc cells themselves. Secondly, paracrine or chemical effects on neighbouring cells were estimated.

The team subjected bovine and human disc cell cultures to hydrostatic pressure and a variety of physical stresses. These included low levels of glucose, low pH and oxygen tension and high osmolarity. High osmolarity occurs when the concentration of certain molecules externally is sufficient

to cause the lowering of the water content within the cells. The results suggested that these homeostatic responses were strongly inhibited in cells under the stressful conditions imposed.

The scientists also investigated the biochemical pathways responsible for regeneration and discovered several possibilities which could prove significant in the search for efficacious disc degeneration therapy.

This research could have important implications with regard to the signalling pathways in intervertebral disc cells. Moreover, it could well be an important clue to the reasons behind the degenerative pathway to disability that affects such a large part of the population. For information on the project, please visit: http://www.physiol.ox.ac.uk/EURODISC

The backbone of spine degeneration

Back pain affects the sufferer's quality of life and also represents a serious financial burden on health services. The Eurodisc project has researched the reasons behind senescence in intervertebral discs as a potential key to effective therapy.

The human spine is a complex and dynamic structure. It can bear the weight of the head and yet offers the flexibility to sit, dance or lift loads. Until, that is, degeneration occurs. This can happen all too early in life and then can lead to a path of disc herniation, pain and chronic disability, particularly in elderly individuals.

Partners in the Eurodisc project investigated the links between ageing, the environment and genetic factors that contribute to this unfortunate spiral of decline. Cell senescence is a phenomenon that has been linked to degenerative diseases in other tissues. This is when a cell is no longer able to successfully divide to produce fresh daughter cells. A team of scientists at the Robert Jones and Agnes Hunt Hospital in Shropshire has therefore specifically investigated if this process, characteristic of ageing, occurs in different tissues of the spinal disc.

The degree of senescence was assessed by means of two criteria. Firstly, a biomarker associated with senescence in tissues and secondly, the number of cells in a cluster which increases directly with the amount of ageing. The researchers found that the degree of senescence varied according to the type of degeneration. For example,

herniated discs displayed the greatest percentage of aged cells as compared with other degenerative diseases. Moreover, the tissue type within the disc was important. Each disc is composed of a soft middle, the nucleus pulposus, surrounded by rings of connective tissue. Senescence was more commonly associated with the soft nucleus where cell clusters were seen to occur.

These results have important implications for the development of back ailments and their treatment. Firstly, tissue engineering is a real possibility for disc therapy whereby replacement tissue is supplied. It appears then that cells from degenerative tissue would be unsuitable for use. Secondly, the presence of senescent cells is generally associated with abnormal behaviour in tissues and therefore may prove to be the root cause of spinal degeneration.

These results have been posted on the project website (http://www.physiol.ox.ac.uk/EURODISC). The project results are well explained here for both the public and interested academics in the field. They have

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been further disseminated through peer meetings, journals and conferences.

Grasslands grow as energy source

The search for bioenergy and its related source fuels has kindled research into different biomass products that could proffer the best results for pyrolysis-based systems. In the context of the 'Bioenergy chains' project, perennial grasses have notably proven to be of interest for a research group at Aston University in Birmingham.

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The university's Bioenergy Research Group (BERG) intends to provide renewable and sustainable biomass resources to address tomorrow's energy needs. As such, it applies chemical engineering science and technology to utilise the chemical energy of biomass.

In this regard, BERG has set out to evaluate the feasibility of the entire bioenergy chain. It found that perennial grasses with low alkali metal content would provide similar pyrolysis yields as those obtained from clean wood feedstock. The environmental viability of this finding holds great promise, as grasslands are one of the major biomes of the world.

Since it was found that alkali metal presence lowers pyrolysis yields, alkali volume needs to be reliably controlled. One of the ways to ensure this is to wash the grass in clean water. The obstacle remaining here is to determine the financial and technical difficulties involved, and of course, to ensure the availability of clean water supplies.

One other factor found during the research was that even without washing and with low pyrolysis liquid yields of 40 to 50 %, the oil could have potential uses. Although it would be of poor quality, it could still prove suitable for applications such as industrial fuels or space heating. This would also be dependent upon whether or not the oil could be suitably stored, for example through blending with other biofuels such as bioethanol or biodiesel.

While the research does not yet present a cheap biofuel process solution, it contributes towards a more effective understanding of suitable sources of energy, generating an understanding as to the best available options.

Leading to sustainable bioenergy

Aiming to exploit biomass as an energy resource, the 'Bioenergy chains' project studied the performance of combustion tests of four selected perennial crops.

Biomass encompasses any organic material coming from plants or animals, with resources including agricultural and forestry residues as well as municipal solid and industrial wastes. The 'Bioenergy chains' project studied the complete bioenergy chain from biomass production to thermo-chemical conversion for a number of perennial crops, evaluating the chain's technical, socioeconomic and environmental feasibility aspects.

The selected perennial crops were *Arundo donax* (giant reed), *Cynara cardunculus* (cardoon), *Miscanthus x giganteus* (miscanthus) and *Panicum virgatum* (switchgrass). These are found in large field cultivations in southern Europe and are successively harvested, with year-round availability of raw material.

All four perennial crops were subject to combustion tests at a laboratory-scale fixed-bed reactor as well as in a pilot-scale fixed-bed combustion plant. Investigations also involved identification of possible operation problems. Examples of such problems included fuel feeding, ash melting on the grate and in the furnace, ash transport systems as well as emissions (including nitrogen oxides, sulphur oxides and particulates).

Each crop was fully characterised and subjected to a comprehensive combustion test programme. Test runs showed that the combustion characteristics and the problems occurring during combustion were similar for all four perennial crops. Due to its extremely high potassium, silicon and chlorine content, cardoon was found unsuitable for combustion.

The tests provided valuable information on various aspects of combustion for the design of an optimised combustion plant. Issues such as suitable fuel feeding and ash removal systems were also addressed, as was handling the problem of bottom ash formation. These results are expected to contribute to increasing the share of biomass in the energy production resources.

Database for energy insight into low-income rural housing

A database containing country reports, country overviews and information regarding the field of energy has been created.

The EU-funded Spark-Net project consists of a network of knowledge that operates as a virtual community meeting and publishing through the Internet and e-mail. It has brought stakeholders together from eight countries in southern and eastern Africa and three from the EU on the topic of energy in low-income rural households.

The network began by drawing comparisons and contrasts between common current energy situations in rural households in each country. This helped to reveal policy alternatives and innovation opportunities. A knowledge bank containing fundamental participants and projects was then created. This can determine the results of policies already in use and foster debate regarding the best practices and alternative approaches. On this basis, policy options were created, and two international Internet conferences took place to help distribute the findings. Included in this dissemination is the database which was created. This database can be accessed by the public at: http://www.sparknet.info/home.php

Rethinking silicon wafer technology

A new reactor employing liquid phase epitaxy (LPE) technology built by the University of Konstanz will help to make photovoltaic (PV) technology less expensive.

The PV industry in Europe has been growing rapidly, so much so that the necessary raw materials are in short supply. This is not only slowing PV adoption, but also driving up the price of the technology. The EESD programme funded the Treasure project to reverse this worrisome trend by investigating alternative sources of silicon.

Physicists with the University of Konstanz in Germany contributed their experience in PV manufacturing to the Treasure consortium. During the project, they developed a reactor to create wafers from metallurgical silicon using LPE, which enables extremely thin but uniform silicon deposition.

After successful laboratory trials, the German physicists assessed the potential benefits of expanding to industrial-scale production. By combining several reactors in parallel, they estimated that enough wafers could be produced in one year to provide 6 MW of power. The cost per wafer is less than 10 cents and energy payback periods are very attractive, in the order of just a few days.

Further to these encouraging results, the University of Konstanz is seeking patent protection for its new reactor. Driving down the cost per watt will provide impetus to the PV market and assist Europe in meeting the challenging goals set for electricity production from solar power.

Thermally stable adhesive for vacuum applications

A discovery by a German company specialising in the production of very thin films will make energy-efficient glass coatings easier to manufacture.

The use of glass in building architecture has become increasingly popular. Depending on the local climate, the glass can be treated in order to optimise its thermal behaviour. Specifically, extremely thin metallic layers are deposited using a technique called large area magnetron sputtering to reduce the emissivity of the glass.

The '3rd Genlac' project consortium received FP5 funding to develop new, thermally stable low-emissivity coatings. Heraeus Thin Film Materials GmbH, a '3rd Genlac' partner, contributed to the project objectives by making advances in magnetron sputtering with ceramic rotatable targets.

To overcome long-standing difficulties related to the different rates of thermal expansion of the metal and ceramic components, a special adhesive was required to secure the targets to the cylindrical backing tube. Unfortunately, conventional adhesives do not fare well in the vacuum environment that is necessary for sputtering. Further to an extensive investigation, the German material scientists managed to develop a suitable adhesive with the requisite thermal stability.

Heraeus Thin Film Materials GmbH has applied for patent protection for its discovery and is looking to establish a strategic partnership to proceed to the manufacturing phase.

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Magnetron sputtering with real-time thickness control

A feat of German engineering facilitates homogeneous deposition of thin films via magnetron sputtering. The result is improved product quality and increased production with less system downtime.

The Fraunhofer Institute for Surface Engineering and Thin Films (Fraunhofer IST) coordinated a three-year multimillion euro research project entitled '3rd Genlac' with the aim of producing the next generation of optical coatings.

Fraunhofer IST is an expert in all kinds of thin-film applications, including the use of large-area magnetron sputtering. One problem that arises from the use of ceramic targets in magnetron sputtering is their erosion over time, which can lead to inhomogeneous deposition rates. This can be addressed by frequent calibration, but it results in lost production time.

The German engineers came up with a novel solution that measures and adjusts for the rate of target erosion in real time. Specifically, Fraunhofer IST uses x-ray fluorescence (XRF) to measure target loss in a secondary planar direct current sputtering cathode filled with argon. A constant XRF signal indicates uniform output from the main cylindrical rotatable sputtering source.

The new set-up is suitable for architectural glazing applications where standards are extremely high regarding the homogeneity of film thickness, such as low-emissivity windows.

Semiconductor waste makes highly efficient solar cells

The EESD programme funded a unique research project to recycle semiconductor waste into raw materials for highly efficient solar cells.

The available stores of high-quality silicon have been declining as the popularity of solar cell applications continues to rise. The NESSI project was conceived to investigate the feasibility of alternative sources of lower-grade silicon, such as waste products from the semiconductor industry.

The Solar Energy division of the Energy Research Centre of the Netherlands was charged with modifying cell process technology to convert low-quality multicrystalline silicon (mc-Si) into n-type wafers. The challenge was to cut costs without sacrificing performance.

Using new sequences for surface passivation, Solar Energy was able to achieve high levels of cell efficiency. Extensive testing during NESSI led to the refinement of an industrial-scale process with multi-megawatt annual production capacity. The encouraging results of an economic feasibility study will help to drive further investment.

The NESSI project results will help Europe to attain the ambitious goals it has set regarding electricity production from renewable energy sources such as solar power.

Designing durability into large rotor blades

A new report from the 'Optimat blades' project provides practical advice to wind turbine manufacturers on ways to improve the durability of their rotor blades.

European funding has been earmarked to help the wind energy industry meet the increasing demand for carbon-free energy production from renewable energy sources like the wind. Plans to build bigger systems must first be preceded by research programmes to ensure reliability throughout the system's lifetime.

The 'Optimat blades' project brought together 17 wind turbine manufacturers, academic institutions and research institutes from eight EU Member States. Over four years of research culminated in a comprehensive report with nearly 40 specific design recommendations for blade manufacturers.

The report's author, Det Norske Veritas (DNV), summarised the results of more than 3 000 tests performed during 'Optimat blades'. Various blade designs using advanced materials such as glass fibre reinforced polyester (GFRP) were evaluated for their strength, stiffness and a number of other characteristics. The results were compiled in the OptiDAT database.

Current industry practice regarding issues such as repairs, strain rate effects, variable amplitude loading, complex stress states and constant life diagrams is reviewed in detail. Subsequently, proposals are made based on the 'Optimat blades' results. DNV and its partner Germanischer Lloyd intend to incorporate these recommendations in their future design guidelines.

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Bigger, stronger wind turbine blades

To build bigger wind turbine blades, one first has to think small since minute cracks can grow over time and eventually cause blade failure. The Risoe National Laboratory (RNL) in Denmark has developed validated modelling tools to assist in this process.

The demand for larger wind turbines is growing and will continue to grow as European Member States look to comply with increasingly stringent carbon dioxide emission targets. Blade manufacturers are turning to advanced polymer composite materials in order to reduce blade weight while retaining the necessary strength to withstand the increased blade loading.

FP5 supported relevant research in this field through the 'Optimat blades' project. The RNL, an 'Optimat blades' partner heavily involved in research into alternative energy sources, investigated the issues of component fatigue and breakage.

RNL's work relied on the use of finite element methods (FEM) and Monte Carlo simulations to model stresses and strains on very small scales. These techniques enabled the calculation of the theoretical internal state variable (ISV). Conversely, measurements of the ISV were made in a laboratory setting for different damage mechanisms (e.g. progressive fibre fracture).

Interpretation and comparison of the modelled and measured ISV was used to fine-tune the micro-scale mechanics modelling approach. RNL has applied for copyright protection of its 'Optimat blades' research, which can be utilised by blade manufacturers to resolve design flaws and material limitations during the prototyping phase.

Outreach for oceans

Scientists have completed a very successful EU-backed project that inspired schoolchildren worldwide to develop an interest in the wonders of ocean and earth science.

The objectives of the EuroStrataForm project involved the study of marine ecosystems from a biological, physical and geochemical viewpoint. One ambitious part of this initiative originated at the Oceanographic Department of the University of Southampton, one of the project partners. At the inception of the project, a website was established (http://www.soc.soton.ac.uk/CHD/EuroStrataForm). The site provided access to data, project forms and research resources for purely academic purposes. Nonetheless, it was the basis of an outreach programme that achieved a remarkable degree of success with schoolchildren.

This success was linked to the project's Classroom@sea outreach activity, accessible through a link from the EuroStrataForm homepage, which encouraged schoolchildren to become involved in the project's work. While such outreach activities are not new in themselves, the key to Classroom@sea's success was possibly the use of specially equipped research vessels including the royal research ship *RRS Darwin*. Owned by the Natural Environment Research Council (NERC) in the United Kingdom, each ship carries its own highly trained staff. Selected teachers are then invited to take part in the environmental cruises that usually set sail twice a year.

The cruises study the oceans at various locations around the world. One cruise studied the canyons on the ocean floor off the coast of Portugal. These are up to 5 km deep and span the same distance.

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The teachers onboard sent back daily reports, video clips and stories to be posted on the website. Further publicity was very effective. The project sponsored four posters that depicted various aspects of ocean and earth science. There were competitions, BBC radio programmes, workshops at the Southampton Oceanographic Centre and local press reports. Fun and education proved to be completely compatible.

The project partners aimed to continue the scheme beyond the lifetime of EuroStrataForm. This has become a reality. The daily cruise blogs and news are still posted on the web together with an interactive questions forum. Cruises are ongoing and continue to open the window to the exploration of the ocean floor and its ecosystems for schoolchildren worldwide.

Canopy processes in terrestrial ecosystem models

The United Kingdom's Met Office led an effort to improve the way in which modellers extrapolate from processes involving a single leaf to entire canopies in order to improve the performance of terrestrial ecosystem models (TEMs).

The global carbon cycle is a complex symphony of fluxes of carbon between various sources and sinks in the atmosphere, oceans, biosphere and soil. Measuring these fluxes experimentally is possible, but only over small areas, so global flux estimations require numerical approaches.

The Met Office brought its considerable expertise in weather and climate prediction to Camels, an R & D project designed to resolve carbon dioxide savings from changes in land management practice. To achieve this objective, it was necessary to advance the state of the art in terrestrial ecosystem modelling.

Previous terrestrial ecosystem modelling studies identified weaknesses with canopy parameterisations resulting in over-prediction of the net ecosystem productivity (NEP). The Met Office examined alternatives to the traditional application of the Penman-Monteith energy combination equation at the leaf level. Specifically, more detailed descriptions of the canopy structure and the physical processes affecting the diurnal NEP cycle were assessed.

Through this work, the Camels consortium hopes to increase the accuracy of the global circulation models (GCMs) with which the TEMs are coupled. This in turn should improve confidence in global carbon cycle calculations and, consequently, in studies of the possible effects on the climate system.

Climate change and acid oceans

The NOCES project confirmed the important role that models can play in predicting the magnitude, geographic scope and timing of impacts related to increasing concentrations of greenhouse gases in the atmosphere.

As power plants, motor vehicles, forest fires and other anthropogenic and natural sources continue to belch large amounts of carbon dioxide (CO_2) into the atmosphere, it remains to be seen what effect this may have on the earth's oceans. The purpose of NOCES was to use computer-based models to simulate the complex biogeochemical processes involved in ocean-atmosphere interactions.

Le Laboratoire des sciences du climat et l'environnement of the Commissariat à l'énergie atomique (LSCE/CEA) in France led the NOCES consortium, which involved 12 different research institutes. Using the 'business as usual' scenario of the Intergovernmental Panel on Climate Change, LSCE/CEA and its partners predicted the expected changes in ocean pH using 13 different models.

They discovered that as atmospheric CO_2 concentrations continue to escalate, the dissolution of CO_2 in surface waters causes the pH to rise significantly. Why does this matter? It is alarming because today's sur-

Non-destructive tool for environmental analysis

A non-destructive analytical tool using neutron technology has been developed for use in environmental monitoring and assessment. The new device enables the rapid detection of metals and other elements.

The NuPulse project's main result is the pulse neutron detector tool (PNDT), which is capable of detecting fast and thermal neutrons, as well as photons of gamma radiation, to give a quantitative analysis of soils, rocks and water. It may be used for data logging and as a monitoring tool. Typical applications of the NuPulse device include environmental monitoring and assessment, as well as hydrocarbon and mineral exploration and processing. Further potential applications for the device extend beyond the remit of this project and include studies in materials science and the detection of explosives and narcotics.

Typical end-users of the tool are SMEs working in the environmental or mineral/hydrocarbon exploration and mining sectors. These companies either use the device for their own activities, or offer services based on the use of the tool to other companies, communities or organisations. A major innovation is that the same tool can be used to study both fast and thermal neutrons as well as gamma rays. The tool can measure soil, rock and water samples both on the surface and in drill holes. It is also able to detect elements and compounds using a real-time measurement display. An on-site display of results, automatic operation and data transmission will make the PNDT tool a very attractive alternative to many individual single-purpose devices.

The work of the project will be written up in peer-reviewed publications. This will help to increase awareness among the scientific community of the technology and methods developed by the project, further enhancing their development. It is also necessary for gaining general acceptance of the technology, since many organisations require scientific proof of its applications before accepting new technology and methods within their sphere of activities.

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Underwater recording of medusa dispersion

An efficient method of examining the structure and distribution of megaplankton organisms such as jellyfish through the use of an underwater camcorder has been developed.

Jellyplankton outbursts have a negative impact on fisheries, aquaculture, coastal tourism and industrial development. Furthermore, due to their aggregated distribution, it is difficult to explain the mechanisms causing such mass developments and to measure the ecological and socioeconomic consequences. The Eurogel project has risen to the challenge to do just that through a joint experimental and field-based effort involving nine European partners. Included in their study were the functional biology of key species, the mechanisms behind trophic interactions and the ways in which biotic factors govern survival, growth and reproduction.

To aid this process, a simple video recording system was developed to estimate the amount, dispersion and population composition of jellyfish in surface waters. In a shallow coastal lagoon in the south-east of Spain, an underwater camcorder was situated in a steel pyramidal structure filming towards the square base. The area was canvassed in a zigzag pattern and three species of medusas were evaluated. When the sampling was finished, the videotapes were digitalised. Values that were taken into account included the density of jellyfish within the sailed distance as well as the temperature and salinity averages. Groups of medusas were then assigned a position on distribution maps.

Population dynamics and the distribution were examined, exhibiting the relationships between the dispersion of the medusas and the characteristics of the water. The system was improved with more precision for future use and so that various positions of aggregation could be explored.

face waters are saturated with calcium carbonate ($CaCO_3$), one of the basic building blocks of coral and other species inhabiting the oceans. As the pH rises, $CaCO_3$-based minerals, such as aragonite, will go into a state of undersaturation. This could lead to degradation of the shells of marine animals. To illustrate this phenomenon, LCSE/CEA submerged pteropods in artificially undersaturated seawater, and considerable degradation of their aragonite shells was observed.

Analysis of the model output by LSCE/CEA revealed that acidification will be most prevalent in the Southern Ocean, but will soon spread to the subarctic Pacific Ocean. In contrast to previous studies, the NOCES research indicates that these effects will be felt within a few decades rather than the longer timescales once thought. A complete review of the modelling work and results has been published in a prominent scientific journal.

See also page 23 (offer 3753)

ENVIRONMENT

Tram travel crosses borders

Under the auspices of the Vivaldi project, a complex new tram system has been designed in Bremen, Germany, both to cross borders and make cost-effective use of neglected rail tracks.

A new cross-border tram system for the German city of Bremen is under construction, with the final opening scheduled for 2009. It is a complicated project because it requires much cooperation between different partners and the extension of the tramlines across the administrative borders of the city into the territory of Lower Saxony.

Part of the system, tramline 4, opened in December 2002 and is proving popular with passengers, attracting far higher numbers of people than were using the previous bus service. There are currently delays to the project. This is partly because of long debates over the proposed route of two lines and the initial rejecting of planning council recommendations by the local government. Increasing the acceptance of the scheme by residents and local politicians has been an important step. Agreement has been encouraged by holding round table cost-benefit analyses and discussions. Implementing a

tram system is very expensive and requires substantial state financing. Comprehensive information on all aspects of the system must be openly available, even if these lead to extended debates and delay.

Planned tram systems always arouse a lot of controversy, particularly on such issues as where the lines will be laid. An interesting facet of this project is that the planners decided to use existing rail tracks as part of the new tram routes. Using disused or underused rail tracks for a tram system is a very positive and cost-effective way of reviving a neglected resource. This is valid as long as access for passengers is easy and safe, so stations at convenient points along the routes were planned. Using existing track in this way also has the potential to be adopted in other cities.

Switching from a bus to a tram system is a very efficient way of improving public transport and developing or revitalising certain areas of a city. Figures show that despite delays and controversies, the majority of the city's citizens who will be affected are in support of the new tram.

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Integrating public transport information

The Intermodal Travel Information Centre (ITIC) in Bremen, Germany, is providing comprehensive information about public transportation services for old and new customers.

In order to optimise environmentally friendly means of travel, it is essential to have access to useful information regarding alternatives to private car use. The ITIC has set forth to do just that.

The ITIC, which opened in November 2002 and is run by the local public transport operator in the centre of Bremen, was originally used for transport ticket sales. It provides many services such as sales and distribution,

annual subscription, timetable and fare information all in the same place. Additionally, it delivers information about Cambio, the local car-sharing organisation. The existing intermodal Internet information platform has been upgraded to provide better passenger/customer information and is available from a self-service terminal as well.

The main target users of the ITIC are those citizens who are not likely public transport

customers. They are offered easy access to reliable public transport information. Overall, it is a prime example of providing relevant local and regional public transport information to the public in a central location. The knowledge obtained from Bremen's ITIC in the context of the Vivaldi project could be an example for implementation in other cities.

A fresh eye on public transport

A new, efficient, environmentally friendly transport system has been introduced in Nantes, France, increasing passenger numbers and reversing the previous decline in patronage.

One of the objectives of the Vivaldi project was to create a new and non-polluting public transport system to be fully operational in Nantes by the end of 2005. An overhaul of the city's bus system was timely as passenger numbers were decreasing, partly due to the old and run-down buses in operation and partly because of competition from Nantes' modern tram system. After the project finished, passenger bus numbers had increased by 15.7 %.

Citizens of Nantes are now the beneficiaries of a clean and efficient transport system with lower fuel emissions. Creating a newer, fresher and more environmentally friendly public transport system is a good way of encouraging people who do not use public transport to begin doing so. The new fleet in Nantes is now transporting 81 % of its passengers with compressed natural gas (CNG) fuel and comprises 125 standard CNG buses and 30 articulated CNG buses. Nearly 55 %

of the areas covered by the network are on clean fuel. There was a 4 % reduction in energy costs in 2004 using the new fleet, and the average age of the network's buses has been reduced from nine to five years. A real-time passenger information system at bus stops and on the Internet was introduced at the same time.

The project was driven by many factors including strong political support, financial support from the EU, a positive attitude from bus company staff and enthusiasm from passengers. The most important impetus to the project, however, was the neces-

Reproducing night-time warming and drought conditions

Italian ecologists have developed an innovative methodology for reproducing night-time warming and drought conditions like those forecast to affect Europe over the coming decades. The objective was to understand how local ecosystems will respond.

As greenhouse concentrations continue to rise in the earth's atmosphere, the temperature is expected to rise, not only during the day but also at night. Furthermore, rain is projected to fall less frequently, but more intensely, resulting in periods of drought followed by flash floods.

The question posed by the Vulcan project is how Europe's shrub ecosystems will cope with these changes. In order to answer this question, it was necessary to reproduce the expected warming and drought artificially in test plots.

Ecologists with the Università degli Studi della Tuscia developed the methodology applied at the six test sites in Denmark, Spain, Italy, Hungary, the Netherlands and the United Kingdom. The experimental set-up was designed for durability with a galvanised steel frame covered with aluminium-reinforced high-density polyethylene (HDPE), which is virtually impervious to long-wave radiation. The HDPE was replaced with a transparent polyethylene curtain for the drought plots to allow solar radiation through, but not rain, which was removed via special rain gutters.

Due to the length of the experimental campaign, the extension and retraction of the coverings was fully automated. Light sensors ensured that the HDPE curtains moved into place following sunset and withdrew at sunrise, acting as a blanket to raise the surface temperature during the night. Similarly, a rain sensor activated the retraction of the covering so that equivalent soil moisture content was maintained with the control plots. To prevent damage in case of high winds, both the night-time temperature and drought plots were outfitted with wind sensors that withdrew the curtains when wind speeds exceed 10 m/sec.

At each of the six test sites, three night-time and three drought plots, each covering 20 m², were created as well as several control plots. Similar steel frames were installed on the control plots to eliminate additional sources of variation. The experimental set-up enabled the Vulcan scientists to investigate the impact a warmer, drier climate may have upon important European ecosystems.

See also page 20 (offers 3689, 3700 and 3666)

Eco-friendly, low-cost prefabrication of buildings

Using waste raw material as a basis, the Inprowarm project resulted in the design and fabrication of inexpensive dwelling components.

The key objective was to produce innovative, modular, interlocking composite construction panels that would be easily assembled for low-cost housing. The project exploited waste raw materials that were consolidated within an innovative polymeric matrix. The reduced use of expensive polymers in combination with the application of secondary quarry products offers considerable cost reduction in building construction.

On the basis of extensive and detailed studies of different materials, complete drawings of separate panels and panel assemblies for a potential prefabricated structure were developed. These included technical specifications for their design and significant features to be applied in different types of lightweight panels. The panels designed for the construction of the potential unit dwelling also involved architectural studies that included door panel, corner, tee and crosses as well as wall and roof assembly.

Detailed descriptions of different participating materials included size and humidity specifications. Estimations for the average weights of the overall participating secondary materials and specific polymer per unit along with envisaged costs were provided. The properties of the structure were measured and tested against existing regulations and applications. These included structural norms, weather and fire resistance.

See also page 17 (offer 3609)

sity to encourage the use of alternative fuels and energy sources in every day life.

A prototype bus was designed and assembled in 2001; the first buses of the new fleet were delivered in August 2002 and were in operation during September 2002. There were some ratification and operational problems with the new buses which led to a hold-up in delivery. Despite this, Nantes City Council decided in June 2005 to continue to buy new CNG buses.

See also pages 40 (Crash warning for connected cars?) and 41 (offer 3741)

ENVIRONMENT

The leading 'edge': plastic fibre slashes network costs

Plans in the 1990s to bring ultra-high-speed telecom lines into every home foundered because the optical fibre infrastructure was just too expensive. But a new European project using plastic fibre and off-the-shelf components could make optical networking so cheap and simple that anyone could install it.

What happened to the dream of optical fibre in every home? While the core of the telecoms network, the long-distance trunk routes, uses optical fibre, the links from the exchange to individual homes remain almost entirely copper wire. Telecoms companies have been creative in pushing copper to its limit with ADSL broadband technology and leveraging existing television cable infrastructure (especially France and the Benelux), but only by taking optical fibre right into the home can they meet the demands for ever-faster connections.

The truth is, it's too expensive. Ambitious plans to rip out the copper and lay optical fibre were largely abandoned in 2001 when telecoms companies realised that they could not afford the mounting costs. Only a few countries, notably Japan, have pushed ahead on any scale.

'The cost was way too high to be sustainable,' says Alessandro Nocivelli, the founder and CEO of Luceat SpA, one of the partners in the EU-funded 'Paving the optical future with affordable lightning-fast links' (POF-ALL) project. 'There was no business model to support such an investment.'

The object of POF-ALL is to find a technical solution to this rising cost. The partners decided to focus on the cabling inside buildings, which would typically account for 30 % of the cost of laying an optical fibre from the exchange into the home. This last hundred metres or so is known as the 'edge' network.

'We realised that we could lower the cost of this edge installation by using a simpler technology,' Mr Nocivelli says. 'If we could employ a technology which is so simple to use that anyone can install it, that would relieve telecom companies of 30 % of the cost of the access network, which means up to several billion euro if you consider the European Union as a whole.'

The key to a simpler, cheaper edge network is optical fibre made of plastic rather than the more usual glass. It has several advantages. First of all, glass fibres use infrared laser light to transmit the signal. The light is invisible to the eye, yet can cause permanent damage or even blindness if someone looks down a live fibre.

'I have a two-year-old child,' Mr Nocivelli says, 'and I would never install a glass optical fibre in my own home, even though I have been working with glass optical fibres for many years.' In contrast, plastic fibres use harmless green or red light that is easily visible to the eye. Plastic fibres can be safely installed in a home without risk to inquisitive children.

A second advantage is their robustness. Plastic fibres are much thicker than glass fibres, a millimetre or more, and can be handled without special tools or techniques. 'You don't need to be trained to handle and install it. You just cut it with scissors, plug it in and it works. It's as easy as that.'

Of course there are drawbacks. Plastic fibres absorb light more than glass, which limits their useful length to a few hundred metres. They also have a lower data capacity than glass fibres. But that is fine for the cable that runs from a conventional glass fibre in the street into a house, or even for laying a network within a block of flats.

With six months of the project to run, POF-ALL is already producing results. The partners have built a system that uses green light to transmit 100 Mbit/s over a distance of 300 m, which is the speed telecom companies hope to offer their customers 5 to 10 years from now, and 50 times as fast as a typical ADSL broadband connection.

The second achievement, using red light, is to transmit 10 times faster still — 1 Gbit/s — over a 30 m fibre. By the end of the project, in June 2008, the partners expect to have extended that to 100 m.

'Then, of course, we will try to focus on longer distances,' Mr Nocivelli says. 'We have already demonstrated that plastic fibre would be future-proof not only for the next 10 years, but for the next 30 years. With that speed in your home, you could download a full DVD in 30 seconds.'

Remarkably, the POF-ALL members have not had to develop any novel technologies. They have built their systems using the latest off-the-shelf components and the ingenuity and skill of the 10 academic and industrial partners.

Two products are already coming to the market. Luceat is commercialising an optical Ethernet switch (a router) using plastic fibre technology, and the Fraunhofer Institute is looking for partners to market an integrated optical transceiver to work at 1 Gbit/s with plastic fibre.

Home and office networks could be rewired with plastic optical fibre so simply and cheaply it could be a do-it-yourself job. 'It's future-proof,' Mr Nocivelli confirms. 'You run at 100 Mbit/s today, 1 Gbit/s tomorrow and maybe 10 Gbit/s in the future.'

A follow-up project, POF-PLUS, is intended to further develop optoelectronic components for plastic fibre and is awaiting a final decision on EU funding.

The benefits for Europe of plastic optical fibre could be immense. Today, the market for optical network technology is dominated by American and Japanese firms, but Mr Nocivelli sees an opportunity for European companies to seize the initiative in the same way as they did for mobile phones. 'The GSM standard, which was developed in Europe, has been adopted almost worldwide. And, of course, this is the kind of success we are looking forward to.'

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Problem solving in mobile ad hoc networks

Inspired by nature, the BISON project developed the AntHocNet, an ant-based algorithm for adaptive routing in mesh and mobile ad hoc networks.

The ever-increasing complexity of network information systems has created new highly demanding needs for better deployment of systems. This complexity is due not only

to the increased number of interconnected users and devices, but also to the new forms of interactions among them. Under many circumstances, minor changes in this dynamic environment require manual intervention for the system's operation. Aiming at resolving this complexity explosion problem, the BISON project focused on developing self-organising and self-repairing robust network information systems.

Mimicking the behaviour of insect communities and immune networks, adaptation, self-organisation and robustness can be achieved without programming them into the individual artificial agents. Thereby, the global behaviour of large agent colonies may be adaptive and cooperative with arbitrary initial conditions, unforeseen scenarios and variations in the environment or presence of deviant agents.

One of the developed algorithms, the AntHocNet constitutes an example of this adaptive and robust behav-

iour with respect to network changes. Featuring a hybrid design, it involves a unique combination of reactivity and proactivity when anticipating and responding to sudden disruptive events in the most timely fashion. Based on adaptive learning mechanisms such as the Monte Carlo sampling and an information bootstrapping process, it allows continuous adaptation of nodes' routing tables. Aided by a number of metrics including delay, throughput and signal-to-noise ratio, the AntHocNet offers efficient optimisation of the set-up of multiple routing paths.

The innovative AntHocNet was tested and found to display superior performance under a number of open space and urban/structured scenarios of mobile ad hoc networks. Its hybrid and composite nature makes this algorithm suitable for use with various networks and network dynamics, as well as with several different modes or characteristics within the same heterogeneous network. For further information, please visit: http://www.cs.unibo.it/bison

Designing modern dynamic networks

PeerSim, a scalable simulation environment, was developed within the BISON project to deal with the scale and dynamism that characterise modern distributed information systems.

Peer-to-peer (P2P) networks gained a great deal of notoriety in the 1990s as a mechanism allowing users to share copyrighted material, in particular MP3-coded music files. Meanwhile, academic researchers began to focus on the benefits and possible application areas of this decentralised and highly fault-tolerant network structure.

Currently, P2P technologies used for file sharing are superseding older mechanisms, including the traditional file transfer protocol (FTP). P2P systems, such as BitTorrent, make efficient use of bandwidth for all broadband users and have been known to scale to over 100 000 users for a single file or data set.

PeerSim has been developed as an open-source simulation environment, which can potentially provide assurance for software developers when designing such P2P systems and testing network applications. Simulations do not suffer from the problems arising when experimenting with the P2P system itself or when adopting an analytical approach, requiring mathematical modelling of the P2P network.

As P2P systems can consist of a very large number of nodes, performing experiments with the actual system requires significant resources, in addition to being vulnerable to node failures. The cost of network communication simulations is less than that of large-scale experiments because fewer resources are necessary. Furthermore, the model can be less complex than a mathematical one.

PeerSim was specifically designed for epidemic protocols, such as OverStat and SG-1 among others, with high scalability and support for dynamism. The simulator structure is based on components, making it easy to quickly prototype a protocol by combining different pluggable building blocks. Every block can easily be replaced by another component implementing the same interface (i.e. the same functionality).

Two different simulation models are supported by PeerSim, a simplified cycle-based model and a more traditional event-driven model. The cycle-

based model allows the simulator to scale up to a large number of nodes, with some accuracy being lost in comparison with PeerSim's event-driven simulator engine.

Interested users will find tutorials and examples, along with detailed application programming interface (API) documentation on the project's website: http://www.cs.unibo.it/bison
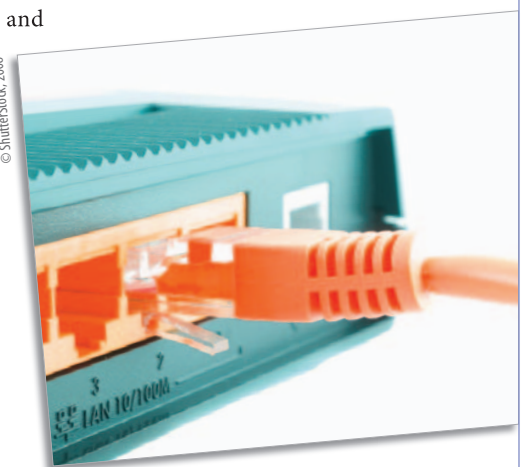
Sophisticated image segmentation

A faster, more efficient method of image segmentation with many applications has been designed.

Video can encompass temporal and spatial information about scenes. Despite this, the information is difficult to find and organise within the raw video data. Standard sequential frame-based representation of video data is sufficient for viewing in movie mode, but cannot handle quick access to much of the information that is needed in new applications.

In light of this, the VIBES project has developed the means for rapid video search, hyperlinking, re-animation and view synthesis. This can improve the content and enhance the experience of video sequences. A top-of-the-line data type that can be searched on the basis of content as well as annotated, hyperlinked and edited was created.

Methods of image segmentation separate the image into sections with coherent properties, which helps to distinguish objects and their parts. After this occurs, recognition, compression and information retrieval are much easier. However, current methods of segmentation do not always produce good results when tested on many types of natural images. This is largely due to the fact that coarse measurement for detecting properties cannot be detected through simple geometric averaging.

Thus fast multiscale image segmentation provides a highly sophisticated and non-trivial method through the use of computer algorithms. This can be beneficial for a wide variety of application systems including robotics, medical imaging, image retrieval and surveillance.

Managing IP network trust

The Pacwoman project aimed to build the tools needed to develop low-cost and secure wireless personal and access networks. Trust managers are now able to authenticate newly arrived devices, distribute state information and maintain the trusted presence of such devices under various modes of trust.

Trust management is gaining in importance for numerous types of Internet protocol (IP)-interconnected devices. Networked devices can form an Internet grid able to share services which benefits users. Some examples of such devices include sensors, mobile phones, media centres, home equipment, personal digital assistants and laptops. Ownership and trust between and within these groups is a critical issue, so much so that networks nowadays need to be based on trust instead on connectivity criteria.

A network of trust (NT) may include any group of IP-networked devices identified according to a certificate signed by an owner. The owner of an NT creates a root key pair of a public and private key and a root certificate, all of which is done offline. The owner then signs the certificates of the devices which make up the NT using the root private key which is stored in a secure place. Given this, an IP-networked device having a certificate signed by the root private key is owned by the issuer of the root certificate and belongs to an NT.

A set of IP-networked devices can help to distinguish the home NT, one or many foreign NTs as well as any number of untrusted devices. Untrusted devices include those that are not able to present a certificate signed either by the owner of the home NT or by a trusted owner of a foreign NT.

Web 3.0: user-generated networks?

European researchers took the concepts of Web 2.0, like user-generated content and social networking, into the real world. They hope to create user-generated physical networks so Internets could be set up by anyone, anytime. It's radical and, surprisingly, fairly realistic. Welcome to Web 3.0.

The Internet, Web 1.0, is so incredibly powerful that even now, almost 20 years later, we have only begun to explore its potential. Web 2.0, with its YouTube, Facebook, Flickr and blogs galore, is even younger and shows even more potential.

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Now, thanks to the work of the WIP project, we may be on the brink of a new Internet, a new World Wide Web. One where users can spontaneously create their own networks, in minutes, and with any kind of data device — mobile or fixed, handheld or deskbound. It means completely reinventing the Internet, retooling its underlying technology, creating new operating principles and defining wholly new communications protocols so that it all works with any technology.

'When the Internet first emerged, it assumed devices would be fixed in place and linked by wires,' remarks Marcelo Dias de Amorim, a researcher with the WIP project. 'But that's no longer true. A large number of devices are mobile and equipped with wireless communication capabilities.'

Many of the fundamental assumptions of the original Internet have been superseded and many other pillars of the web are simply ad hoc (even bootstrap) solutions to discrete problems. It all appears rather accidental.

WIP wants to change all that, reinventing the Internet and its underlying methods in what they cheerfully describe as disruptive technology. It is revolutionary, radical, but is it realistic?

'We're not looking to replace the Internet with the flick of a switch,' Mr Dias de Amorim warns. 'What we're proposing is a robust, flexible, optimised and above all user-friendly set of technologies and standards that will mean any user, anywhere, can identify and network with any nearby devices. Without any technical expertise whatsoever.'

Distributed control systems in industrial automation

A publicly available open communication system has been designed within the OCEAN project to enable the reuse of control systems software and infrastructure. Offered without licence fees, it can even form the basis for the development of small companies' controls for automation systems.

Control technologies play a key role in modern production systems, ensuring high productivity levels. Nevertheless, the individuality of products is constantly increasing, and with state-of-the-art controllers it is almost impossible to fulfil these demands. To help overcome current controllers' lack of flexibility, the OCEAN project sought to develop a real-time capable communication platform for distributed control applications.

The distributed control system real-time framework (DCRF) was designed to enable dynamic integration of numerical control components in distributed open platforms. More specifically, a flexible and application-specific configuration of control systems was the ultimate aim of the OCEAN project. For this purpose, a modular-based philosophy was opted for, which evolved from the basic concepts of the open system architecture for controls within automation systems (OSACA) standard.

The main task of the real-time capable communication platform DCRF is to support the efficient exchange of data between control components. Therefore, besides a real-time operating system, an appropriate communication middleware was necessary as the imple-

mentation base for the realisation of the DCRF platform. TAO was found to be the most suitable CORBA object request broker and RTAI the preferred Linux real-time extension.

The common object request broker architecture (CORBA) allows software objects to communicate with each other, even when running different processes on different hardware platforms. On the other hand, RTAI supports real-time processes running simultaneously in kernel and user space and, just as importantly, the use of various standard operating systems functionalities in real-time applications.

One further aim of the DCRF developers was to have numerical control components from different vendors interoperating within the same communication framework. Hardware abstractions were investigated and evaluated so that an exchange of components will be feasible and easy. Moreover, suitable transport mechanisms were added, as it is mandatory for real-time components that their communication channels meet their time constraints.

Based on publicly available open and vendor-independent source software, the DCRF communication platform is also offered as open-source software. For more information about the DCRF communication platform, please visit the OCEAN project website: http://ocean.itia.cnr.it

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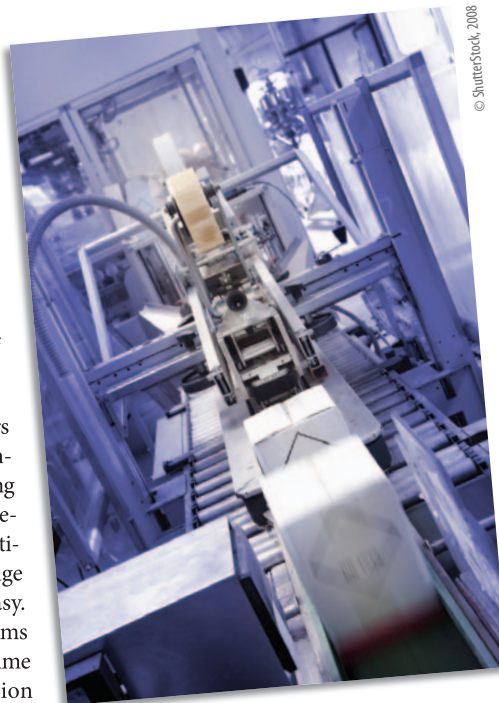
An example helps to illustrate the concept. You live in an apartment building. You find the neighbours' wifi connections and invite them to join a new 'building network' with a few clicks. Now you can share and communicate with everyone.

You all have Internet connections via an Internet service provider, ranging from 1, 2 and 5 Mbit/s. You decide to pool your money and rent a fibre-optic line that handles voice, data and television for the whole building. Suddenly you all have 10 Mbit/s connections.

Another scenario. You go to a gig with some friends, set up an ad hoc network, and you can all communicate via text, voice or image for the rest of the day, all for free.

It's a radical concept that must overcome some major design flaws of the current Internet. One simple example: an IP address governs the routing of information and the identity of the recipient. 'That works fine

in wired networks, but what happens if the user moves? Their address has changed, not the identity,' Mr Dias de Amorim reveals. 'But if separate values are used for identity and routing, then this isn't a problem, even if the user is walking through a park. We've successfully separated the two functions.'

That is just one of dozens of challenges the WIP project has responded to during its research. It is a radical rethink of the current state of the art, but can it replace the Internet? 'That's not what we're saying,' Mr Dias de Amorim says. 'It does address the basis of networking, but it can happily plug into the Internet itself ... That said, if everybody, or even the majority, is using WIP to create Internets, then WIP is the Internet!'

The project is not quite there yet, but it has made enormous progress. The project split the multitude of technical challenges into three grand strands: user applications and interface, routing protocols, and physical technology innovations. They fit hand in

glove to allow users to set up the network, allow the protocols to communicate with any device, and allow the devices to keep up with requirements. It is plug-and-play networking for grown-up applications.

Remarkably, WIP is already in testing phase, using laboratories especially set up for the task, with many of the components of the system. Over the next year, it will finalise some elements and integrate them all together. Finally, it hopes to seed the technology in promising communities to kickstart its adoption.

And then we may see the beginnings of Web 3.0.

IT AND TELECOMMUNICATIONS

Raising awareness of IPv6 within the scientific community

Internet Protocol version 6 (IPv6) stands ready to revitalise the growth and use of networking and the Internet as a platform for research, education and general information sharing.

The current version of the Internet protocol (IP version 4) has several shortcomings which complicate, and in some cases present a barrier to, the further development of the Internet. The 32-bits of address space are limiting, while the development of a new IP version (IPv6) promises to provide a feature-rich environment for the future of global networking.

The deployment of IPv6 in Europe has recently been boosted by the framework programmes of the European Commission. Funding was granted for the 6NET project that focused on gaining practical, operational experience of IPv6 deployment and testing migration strategies from existing IPv4-based networks. A pan-European native IPv6 network connecting 16 countries was built to extensively test a variety of new IPv6 services and applications, as well as interoperability with legacy applications.

While IPv6 has additional features to IPv4, such as mobility and security support, these were not attractive enough to motivate a significant number of companies to develop IPv6 implementations. On the other hand, academic networks, being keen on new technologies and not strictly interested in immediate profit, provided it to their users for experimentation.

The Westfälische Wilhelms-Universität in Münster was assigned the task to prepare for the deployment of IPv6 in the production environment of the Gigabit-Wissenschafts-netz (G-WiN). This is the national part of the German research network, which is under the responsibility of Deutsches Forschungsnetz e.V., and the 'heart of the Internet for science in Germany'.

Within the 6NET project, the Deutsche Forschungsnetz had another German partner. The Fraunhofer Institute Fokus worked on providing a technical solution that not only enables mobile and session initiation protocol services in IPv6 networks, but also in heterogeneous environments.

The success of this IPv6 test bed spurred the existing GÉANT networks to move to dual-stack operation earlier than anticipated. Moreover, other national research and education networks (NRENs) were encouraged to offer production IPv6 services.

Technological advantages of IPv6

The new Internet protocol version, in development since the early 1990s, has now matured to the state where initial deployments are being made and early commercial products are being delivered.

Among the primary benefits Internet protocol version 6 (IPv6) brings to Internet users are scalable services based on peer-to-peer signalling and network convergence, combined with the ability to restore end-to-end communications. Besides this, IPv6 eases the deployment of advanced network concepts and services such as security, mobility and quality of service (QoS).

The Euro6IX project was the largest research project funded by the European IST programme aiming to support the rapid introduction of IPv6 in Europe. A total of 17 partners from the telecommunications, industrial and academic sector combined their research efforts to build a native IPv6 backbone of eight traffic exchanges established in major European cities.
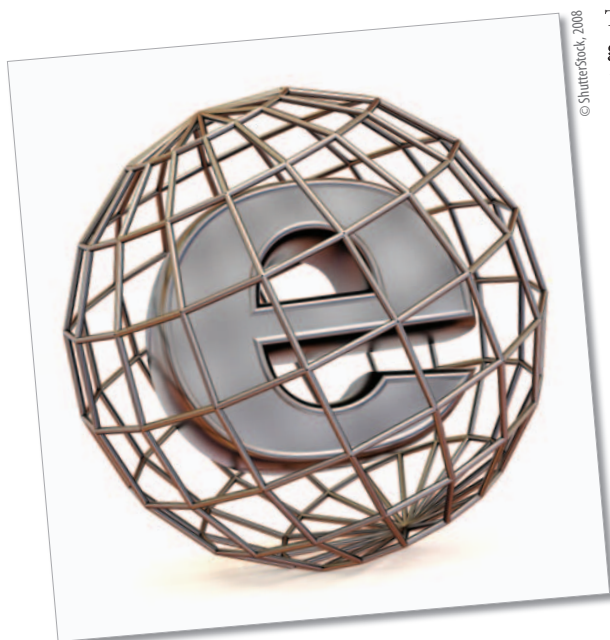
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The Euro6IX backbone gradually became a place where network management applications and user trials focused on finding out how new services could be deployed to benefit all Internet stakeholders. As part of the Euro6IX architecture, a user-initiated end-to-end bandwidth service was specified with all the protocols and functionalities of a voice over IP (VoIP) carrier.

Service providers and business customers are specifically interested in these value-added services that could be a realistic replacement for standard public switched telephone network (PSTN) services. However, for VoIP to offer users an acceptable level of voice quality, the carrier QoS architecture must ensure that voice packets are given priority over other kinds of network traffic.

Urged by this need for high-performance packet routing, the carrier QoS architecture selected was DiffServ with static resource assignment and no state maintenance required by the backbone routers. Although the preferential treatment that voice packets require was guaranteed by on-demand QoS, access to this service should furthermore be authorised and consumption of resources tightly controlled by the network.

This functionality could be provided by network-edge routers, while the network core supports bare DiffServ QoS features. To deploy this architecture model, Euro6IX project partners proposed end-system-based admission control (EAC) relying on end-to-end network resource measurements.

The overall on-demand QoS architecture can be implemented stepwise, starting with a simple scenario involving only trusted users and, finally, resulting in a commercial service-like environment.

Developing ontology-based software

Within the next generation of the web, information will no longer be intended only for human readers, but also for processing by machines that would enable intelligent information services.

Like the current version of the web, the emerging semantic web will be distributed and heterogeneous. Data will therefore have to be expressed in the framework of ontologies in order to contribute to the integration of the resources that compose it. However, available ontologies are themselves also a source of heterogeneity.

Semantic interoperability can be based on finding relationships between concepts belonging to different ontologies, which is commonly referred to as ontology reconciliation. The web ontology language (OWL) has been originally designed to represent information about categories of objects and how these are interrelated, and importantly, about the objects themselves.

This ontology language represents the meanings of terms in vocabularies and the relationships between those terms in a way that is suitable for processing by software. A common application infrastructure has been proposed by the Wonderweb project partners to pave the way for easy access to, and integration of ontology management systems.

Designed to facilitate the manipulation of OWL ontologies for use by editors, reasoners and other tools, the application programming interface (API) has provided the foundation for popular tools. These include the Protégé, Swoop and Ontotrack editors, in addition to patching and versioning services, through to inference services such as explanation and debugging.

The API is primarily targeted at developers who wish to work with the OWL description logics (DL) language fragment. It provides a level of abstraction above the extensible mark-up language (XML) syntax for the resource description framework (RDF) that is widely used for exchange.

The API for manipulating OWL ontologies is available from Source Forge at: http://sourceforge.net/projects/owlapi

The future of the web is semantic

For successful information exchange among people and machines in complex environments like the web, conceptual structures defining a variety of formal ontologies have been proposed within the Wonderweb project.

A main issue in the deployment of the new generation of the World Wide Web, the semantic web, is its basic infrastructure. To provide for a wide range of intelligent services such as information brokers, search agents and information filters, ontologies are to act as shared vocabularies. Defining the semantics of objects and their interrelationships explicitly and formally, they will have a pivotal role to play in enabling content-based access, interoperability and communication across the web.

The European project Wonderweb aimed to address a crucial question arising as the community of users evolves: 'What kind of ontologies will be needed?' Moreover, the need to establish precise agreements on the meaning of terms becomes crucial as multicultural and multilingual communities start to exchange data and services. To this end, the research work on which the Wonderweb project partners focused involved the development of a library of foundational ontologies.

For ontologies related to each other in a way that would make rationales and alternatives underlying different ontological choices as explicit as possible, a framework of engineering methodologies was developed. Researchers at the Istituto di Scienze e Tecnologie della Cognizione in Italy sought, firstly, to clarify the general attitudes towards ontological analysis. In other words, they sought to distinguish motivations and constraints that drive our conceptualisation of the world before including crucial distinctions in reference modules for the construction of new ontologies.

On the other hand, the management and organisation of data and documents already available on the web requires domain-specific ontologies. The next step in this line of research was therefore to identify methods to reengineer, align and merge knowledge organisation systems (KOSes). Containing metadata in vocabularies, taxonomies and directories, KOSes support document tagging and information retrieval, but they are characterised by informality and heterogeneity.

In the context of a concrete case study, principles that can be adopted when reengineering semi-structured KOSes into formal ontologi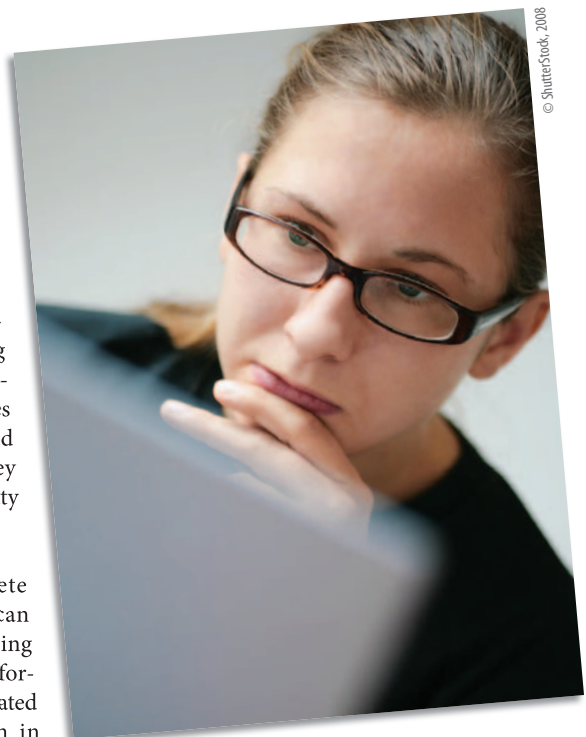es were demonstrated for information integration in a specific domain. Such a library of ontological systems would contribute to making computers commit to common ontological agreements, which seems more effective than enforcing interoperability.

See also page 32 (offer 3654)

IT AND TELECOMMUNICATIONS

Ambient intelligence: snowboarding to the new frontier

Think how many lives could be saved if emergency services were alerted the moment a pedestrian is run over. Think how much more fun snowboarding could be if you could emote your feelings electronically to ski-buddies. Breakthroughs in capturing and transmitting ambient intelligence could make these scenarios a reality.

The My Space/Facebook phenomenon has shown how we love to share personal information. But will we take the next step and share our feelings and emotions across the ether?

Whether it is sensors on our skin, in our clothing or embedded in the environment, research into ambient intelligence is advancing in leaps and bounds. We could soon be using technology in a whole new, human-centric way.

But before we can fully interact in a responsive electronic environment, a number of obstacles need to be overcome. For example, the development of miniaturised, unobtrusive hardware, clever interfaces, data-secure systems, autonomous and flexible network protocols, and more efficient wireless infrastructures.

There are already diverse applications using ambient technology on the market, but one crucial sticking point is that few of them are fully integrated into wireless communication systems. European researchers have been addressing this outstanding issue.

'The idea is to integrate sensor networks into wireless communication systems and to "capture" the user's environment, perhaps using a mobile phone as a gateway, and then transmit this context to a service platform to deliver a personalised service and act on situations,' says Laurent Hérault, project coordinator of a research scheme developing new ways of capturing ambient intelligence in post-3G mobile communication systems through wireless sensor networks.

The context captured can be an environmental one, such as location, but also the subject's emotional context — what is known as the 'physiological state'.

'We capture physiological parameters, such as temperature, heart rate and skin conductance levels [measuring sweat gland activity],' says Mr Hérault, who heads the e-Sense project. 'We analyse the evolution of these signals and the function of emotional input. For instance, we show [people] films and we analyse their reaction via sensors. We can determine if a person is afraid, happy, sad …'

The potential for applications is vast: it goes from entertainment to e-health, safety, and industrial applications, such as remote asset monitoring. The consortium behind this, which includes a number of European universities, research institutes and companies such as Telefónica, IBM, Fujitsu, Thales, Nokia Siemens Networks, EADS and Mitsubishi, has developed 26 scenarios and 16 audiovisual showcases demonstrating the use of sensor networks to capture ambient intelligence and use it in mobile communications.

Perhaps the most obvious scenarios focus on emergency situations, with systems contributing to improving the response of emergency services to car crashes and other accidents. Other applications also include leisure and sport. 'We can measure the feelings you experience while skiing, such as acceleration, speed and happiness. This can be useful if you want to share your experiences with friends,' Mr Hérault says.

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The EU-funded e-Sense project also carried out studies on the acceptance of such technologies and their societal impact. Most of these were positive, with the best results coming from Nordic countries on health care, sport and entertainment applications.

The project has also achieved a number of technical breakthroughs with wider impact on the development of ambient intelligence. E-Sense focused on developing radio components, which are known to be the power consumption bottleneck in wireless sensor networks. So it has developed very small sensor nodes that consume up to 10 times less power than the current state-of-the-art systems.

'We have developed an ultra-low-powered implementation of the ZigBee system and achieved our aim of 20 nanojoules per transmitted bit, which is significantly better than the energy efficiency of any chip on the market today,' Mr Hérault says.

E-Sense has also defined an architecture which is adaptable to every module and every scenario, increasing the versatility and efficiency of communications. 'We have developed an end-to-end system architecture which we call "e-stack", a very generic protocol stack with different subsystems: a connectivity subsystem, a middleware subsystem, an application subsystem and a management subsystem,' Mr Hérault explains.

'All subsystems are compatible and e-Stack is effectively a bit like Lego. It is a toolbox of protocol elements which can easily be connected to other elements, in order to have the most efficient protocol stack for your specific application, in terms of energy consumption and bit rate. The defined architecture also extends to beyond-3G systems and platforms, specifying an innovative interface and middleware solution.'

The e-Sense project, backed by FP6, concluded at the end of 2007. But a new project under FP7, called Sensei, will take research a step further by integrating the powerful network islands made up of different protocol elements into the web. 'We believe that, in the future, most requests on the Internet will be to obtain information originating from sensors,' Mr Hérault confirms.

The consortium of 20 new partners behind Sensei, which includes Nokia, Ericsson and SAP, also intends to create a new industrial standardisation group, under the guidance of the European Telecommunications Standards Institute, with the aim of creating a European standard for wireless sensor networks.

All this could mean that in the not-so-distant future, you could use the Internet to keep in touch with friends and family 24/7, detecting where they are, what they are doing and, crucially, how they feel. So, no need to rack your brains to come up with original Facebook status updates anymore.

Advanced programming for distributed and mobile systems

The Mikado project developed new formal models for the specification and programming of large-scale, highly distributed and mobile systems.

Challenged by the global computing initiative, the Mikado project focused on exceeding current limitations of common middleware and programming technologies. Such limitations include restricted interactions and view of components and objects as well as difficulties in proper and uniform support of mobility, predictability, security and fault tolerance. Another important aspect is system responsiveness to investigation for verification, validation and test purposes in the most accurate way.

Motivated by this, the project specified and developed prototypes of innovative models for specification and programming

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of highly distributed and mobile systems. The ultimate objective was to employ the new tools and techniques in order to improve the trustworthiness and safety of systems for solving dependability and security issues. A set of rigorous models and analysis techniques as well as software infrastructure and virtual machines were generated.

One of the new programming models, 'Un langage pour la mobilité' (A language for mobility / ULM) enables the user to move from functional programming resulting from mathematical functions to reactive programming, distribution and mobility. Embedded in the scheme multi-paradigm programming language that supports functional programming, it includes a compiler and a virtual machine for its implementation. For further information, please visit: http://mikado.di.fc.ul.pt

Inspired by distributed and mobile programming concepts

As the scope and computational power of global information infrastructures continue to grow, an innovative software framework supporting highly distributed computation aims to harvest their potential benefits.

Emerging computing paradigms, such as global computing and ambient intelligence, envision scenarios where a mixture of personal and public mobile devices can move across domains and network boundaries. A massive infrastructure composed of highly diverse and interconnected objects would support uniform services with variable guarantees for communication and mobility, in addition to resource usage and security.

The Mikado project, as part of the future emerging technologies initiative, sought to address inadequacies of current middleware and programming languages to meet the challenges posed by such an environment. In particular, these tend to provide for a limited range of interactions and have a limited view of components and objects. Importantly, they are not amenable to rigorous investigations for validation and test purposes.

The development of formal models for both the specification and programming of large-scale, distributed and mobile systems was among the primary aims of the Mikado project partners. In order to lay the foundation necessary to overcome current limitations in global programming, several models for explicit code and computation

distribution and migration were studied. They concentrated on models of computational domains with programmable membranes and attempted to unify different calculi in a core formal model for concurrent and object-oriented programming.

Specification and analysis techniques for the new programming model were then proposed, extending recent work on type systems for object-oriented languages and distributed process calculi. These ranged from type systems and static analysis techniques for expressing constraints on concurrency and resources access to proof techniques for assuring that mobile codes conform to predefined specifications. The latter required novel co-inductive techniques to compare the distributed behaviour of systems and new specification logics for expressing partial views of programming paradigms.

A common software framework to support the implementation of distributed process calculi could not restrain itself to a fixed set of communication
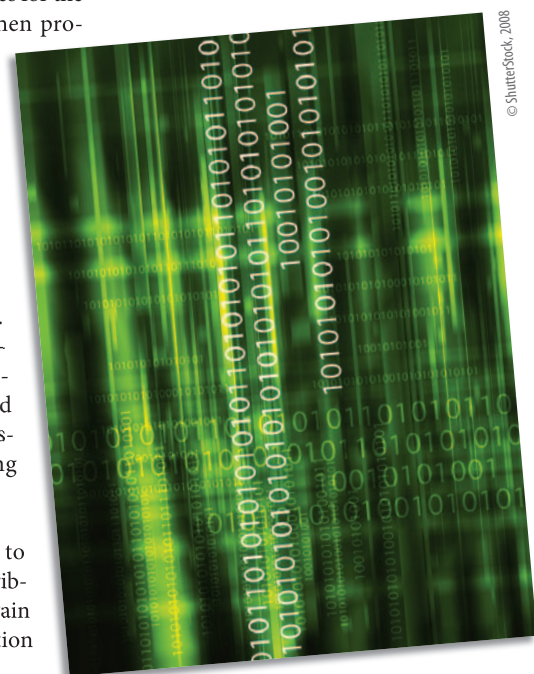
primitives. The implementing mobile calculi (IMC) framework, accessible through the Mikado project site along with all its other major deliverables, is flexible enough to support multiple and even customised communication protocols.

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Integrated data management for speech therapy

A remote exchange component has been developed to help speech therapists monitor client practice through the Internet.

The Ortho-logo-paedia (OLP) project has developed an integrated computer-based system which can assist conventional therapy for people with speech disorders. Through real-time visual feedback and automatic speech recognition, articulation can be improved, offering an interface to assertive technology and speech synthesis.

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With the OLP system, therapy can be organised off-site through the use of the Internet. The type of feedback and the recognition section can be particularly designed to fit a certain client group as well as an individual. Furthermore, databases of disordered speech, therapy needs and protocols have been set up. These aid the application and create an interface which permits the therapist as well as the client to alter the customisation.

More specifically, through the remote exchange component, therapists can supervise client practice via the Internet with an advanced system, assign exercises and examine results. Therapists can concentrate on the primary acquisition of correct articulation and hence administer more intense exercises for homework. This results in an increase in client number without a decrease in the quality of therapy.

In terms of marketing aspects, the remote data exchange component can be provided in conjunction with training and support paid services. The cost depends on user licences, that is, customer costs are reduced as additional licences are ordered. The main goal is to assist business partnerships and synergies to reach beyond conventional sales. The product will also be available to local IT specialists and consultancies for software sales and installation.

Evaluating text mining practices

As knowledge mining becomes essential for the smooth operation of modern organisations, dedicated tools for annotating textual data are continuously being developed. Targeting domain experts, whose main task is the manual revision of mark-up, the Parmenides system was developed as an attractive alternative for annotating textual data.

The Parmenides system was designed to support the entire text mining process, from gathering documents through information extraction and semantic annotation to the application of data mining techniques. Being ontology-based, it includes an ontology management system and tools for extracting new concepts and relations, in addition to providing document- and data-warehousing facilities. Although the Parmenides system can support the entire text mining process, it is also possible for users to employ only a subset of the available facilities depending on the task they wish to carry out.

During the lifetime of the Parmenides project and in parallel with the development of the system itself, an evaluation framework was developed in conjunction with the users. The ultimate aim of this exercise undertaken by the Parmenides project partners was two-fold. Firstly, they sought to perform a complete user-centred evaluation of the system architecture and to assess how well it answered the user's requirements. And secondly, the general framework built up for the Parmenides system was intended to be reusable for evaluating similar systems.

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In particular, the relative ordering tool (ROTE) was employed to build a parameterised quality model for evaluation. This was designed at the University of Geneva to help users in specifying the relative importance of different quality characteristics and associated metrics. The tool allows users to order any number of quality characteristics by comparing them in pair-wise fashion. For example, a user may consider both an ontology management system and the facility to build and maintain ontol-

ogies to be mandatory. Nevertheless, the performance of dedicated tools for acquiring new concepts may be characterised as having less importance than the quality of the management system.

Such an evaluation framework for a large and complex text mining system resulted in a quality model containing more than 180 metrics. It was this complexity of the quality model which initially led to the development of the ROTE tool. However, before its overall benefits can be assessed, it will require further testing on other systems with varying complexity.

Copper's not coping: new chips call on light speed

The tiny copper wires that connect different areas of an integrated circuit may soon limit microchip-processing speeds. So European researchers have developed technologies to produce and combine semiconductor microlasers with silicon wave guides for novel, power-efficient optical connections.

We have all experienced the effect of Moore's Law: almost from the second you unpack a newly purchased computer, it is already outdated. The next model — with faster processing power and more advanced features — is already in the shop.

Gordon E. Moore, co-founder of Intel, described the phenomenon of microchip miniaturisation in 1965 when he observed that the number of transistors you can fit into an integrated circuit appeared to double about every two years.

The microelectronics industry still follows this 'law', but unless new fabrication or microprocessing technologies are quickly developed, this relentless miniaturisation may peter out in less than a decade. Microchips based on silicon wafers are nearing their theoretical limits as physical properties of near-nanoscale silicon integrated circuits begin to interfere with their performance.

The speed of data transfer within integrated circuits is one of the major bottlenecks. At present, to pass information from one part of a chip to another, the data packet is sent as electrons through copper wires, known as copper interconnects.

These wires may be just a few millimetres in length, but for the electrons it is like running between underground trains at rush hour. The electrons must all squeeze down narrow tunnels while a crowd backs up at the entrance.

'Copper-wire interconnects place serious limitations on the performance of silicon integrated circuits,' says Dries Van Thourhout from Ghent University's Photonics Research Group and Belgium's micro- and nanoelectronics research centre IMEC. 'It is hard to transmit data down these interconnects in a sufficiently fast, power-efficient way. It is a problem of bandwidth, and copper will not be able to cope with the processing power of tomorrow's microchips.'

Optical interconnects use light instead of electrons to represent information. They are a highly appealing alternative to copper interconnects, with the potential to be far more efficient, transmitting more data but using the same or even less power.

Instead of travelling along copper wires, photons travel the distance between source and detector along wave guides, like miniature optical fibres. At this scale, however, the wave guides are made out of silicon rather than glass.

'Lots of research has shown that you can etch wave guides for photons into silicon,' Mr Van Thourhout says. 'This is great because you are using the same materials and fabrication technologies as you do to make integrated circuits. But there is one significant drawback: it is extremely hard to get light out of silicon.'

Despite extensive research to exploit many of silicon's peculiar properties, it is highly unlikely that purely silicon-based lasers will reach an efficiency comparable to that of their semiconductor-based cousins for the foreseeable future.

Mr Van Thourhout has coordinated a European consortium that has successfully combined the best of both worlds: silicon wave guides and microscale lasers made from a semiconductor called indium-phosphate. The Picmos project was a partnership between several European research institutions, universities and two French companies: STMicroelectronics and Tracit Technologies, now owned by Soitec.

Part of the research involved the fabrication of a miniaturised laser system small enough to generate light for each interconnect. The Picmos partners developed a method to etch indium-phosphate lasers with a diameter of just 7 µm, sufficiently small to integrate several thousand onto a 2 cm x 2 cm silicon chip. This is the first time that such compact lasers have been produced in a very practical, cost-efficient way.

The tiny lasers could also have applications in miniature optical sensors, such as strain detectors, or be used to build incredibly cheap, but very powerful optical biosensors. But the biggest breakthrough in the project was the development of a bonding technology that joins the silicon and iridium-phosphate materials together.

'The bonding process, now transferred to Tracit, effectively "glues" the silicon and semiconducting indium-phosphate in layers. It is possible to etch out the microlasers and the silicon wave guides and produce an optical interconnecting layer,' Mr Van Thourhout says. 'The bonding process and the refinement of the microlaser and the accompanying detectors have been major breakthroughs.'

The production cost of the prototype optical interconnect layer is still too high for mass production, although the results from the demonstrator 'chip' have been extremely encouraging. A follow-up project, Wadimos, will continue to drive the Picmos platform towards commercialisation. In particular it will develop a pilot line that integrates the fabrication of the optical interconnect layer into the regular integrated circuit manufacturing process.

'We envisage a layer on an integrated circuit that sits on top of the classical etched copper electrical interconnect layer,' Mr Van Thourhout says. 'This optical interconnect layer would be less sensitive to temperature, immune from electromagnetic noise, and have lower power consumption. Meanwhile, the bonding system could be adapted for many other electronics applications, for example to stack integrated circuits and in microfluidic technologies. The application of the Picmos platform could be tremendous for tomorrow's chip technologies and wide-ranging in many other associated applications.'
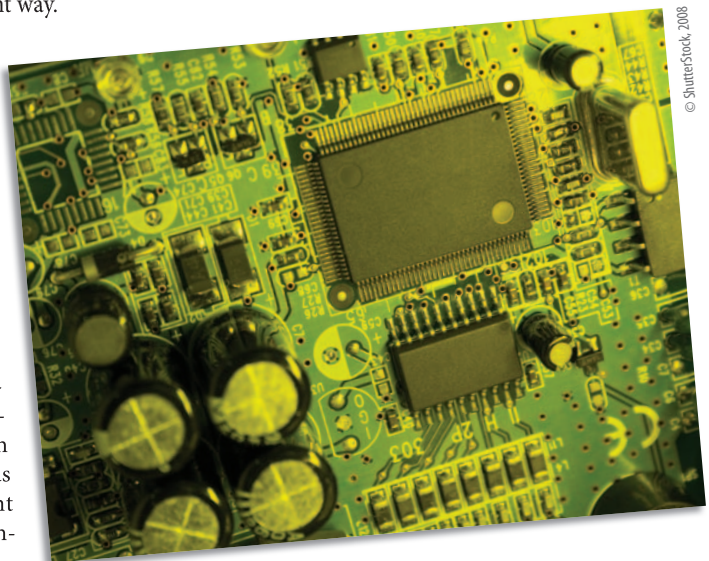
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Microsensors integrated on a chip

The integration of cantilever arrays in a single chip along with signal processing electronic circuits, achieved by the Biofinger project, may open the way for miniaturised sensing systems.

Recent advances in silicon micromachining technology have boosted the discovery of new applications for micro- and nanotools. Cantilever beams with length and thickness in the tens of micrometres range have been demonstrated to be a most promising class of biosensor. Due to their intrinsic flexibility, combined with the availability of advanced techniques designed to monitor bending, they have become versatile tools for molecular and biomolecular recognition.

Micromachined cantilevers can recognise proteins with exquisite sensitivity, as well as detect small amounts of materials, especially pathogenic bacteria. Directed micro- and nano-electromechanical systems have also been used as immunospecific and m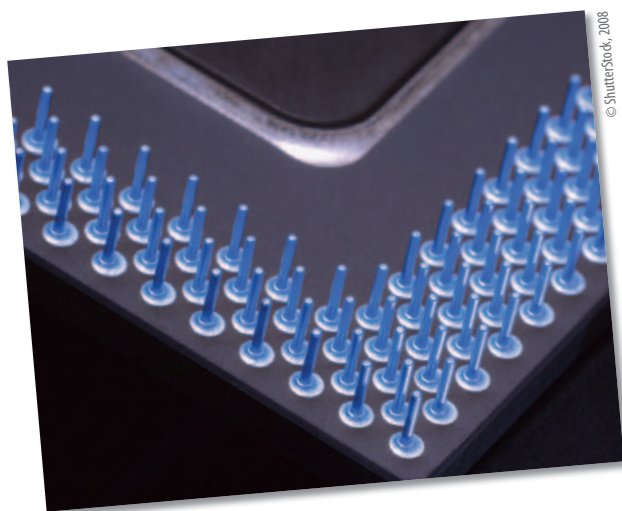ultifunctional biological detectors. The ultimate aim of the Biofinger project was to integrate cantilever arrays in one chip with signal processing electronic circuits, and thereby enhance the device's performance.

More specifically, an array-based approach was adopted by researchers at the Swiss Federal Institute of Technology to allow parallel screening of different analytes and increase the overall analysis speed. The resonant cantilever system comprises four equally-spaced cantilevers, into which the read-out scheme has been integrated to allow their fully autonomous operation.

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The resonating cantilevers are actuated by means of electromagnetic forces generated by a permanent magnet and an alternating current flowing in a metal loop. The binding of the analytes changes the mechanical properties of the cantilevers, which can be detected by piezoresistors, or stress-sensitive transistors, arranged in a Wheatstone bridge configuration. The cantilevers act as frequency-determining elements in a feedback oscillation circuit, with a counter.

Microfabrication techniques and, in particular, complementary metal-oxide semiconductor (CMOS) technology was used to devise the small-size sensor system. Post-processing and packaging of the CMOS chip was necessary to prepare the biosensor for the harsh culture environments in which it was designed to operate. Epoxy was first applied to stabilise the chip bonds on the chip and polydimethylsiloxane (PDMS) was used to isolate them from the liquid environment.

The sensitivity of the sensor system was evaluated by exposing the coated cantilevers in sample fluids with varying concentrations of prostate-specific antigen where less than 10 ng/ml was detectable.

Optical fibre: secure in all the chaos

Secure messages hidden in chaotic waveforms, transmitted at up to 10 Gbit/s, is the vision behind a group of dedicated European researchers. Now they are prototyping the equipment that could make the vision a reality.

Hiding a message within a chaotic transmission offers a way of securing information exchange — provided the message can be distinguished from the chaos by the receiver.

Two years ago, members of the European research project 'Optical chaos communications using laser-diodes transmitters' (Occult) showed that messages could be sent at gigabit per second rates over 100 km of the standard fibre-optic network of the city of Athens, using a chaotic mix of light frequencies with massive variation in amplitudes.

And the message was received with low bit error rates. Yet, anyone tapping into the fibre-optic cable, attempting to intercept the message without highly specialised knowledge and equipment, would have been unable to distinguish it from the chaotic light 'noise' that surrounded it.

Now researchers in a follow-on project called 'Photonic integrated components

applied to secure chaos-encoded optical communications systems' (Picasso), also funded by the European Commission, are designing and testing two integrated and stable chaotic sources. In effect, these are the first prototypes for a kit that will allow chaotic transmissions to be used as a standard security measure by organisations, such as banks and governments. They are also researching techniques that will enable chaotic transmissions to be made and received at tens of gigabits per second.

The key to sending signals using chaotic light sources is synchronisation. Chaotic systems are unpredictable because they are affected by many — often millions — of tiny events. The potential effect on the weather of the beat of a butterfly's wing is the most famous example of this.

But the fact that they are not predictable does not mean that they are random. In fact, the little events are interdependent and

generate discernible patterns in the chaos. A couple of decades ago, it was discovered that if, under the right conditions, two chaotic systems start to affect each other, they will synchronise their chaotic motions.

Laboratory experiments soon confirmed that lasers transmitting light in patterns that were chaotic in time and space would synchronise when they received light from one another through space or optical fibre.

The next step was to 'fold' a message into the chaotic waveform. The receiver is able to discern the message by subtracting the (synchronised) chaotic waveform he is generating from the chaotic waveform, plus message, that he is receiving.

The Occult team took the principles of synchronised chaotic transmissions out into the real world. While the signal transmitted over the Athens network was less than one second long, it proved that the technique worked.

Picasso's first challenge was to build integrated devices incorporating laser diodes

Wireless systems at millimetre wave frequencies

With low-cost integration solutions, the potential of millimetre wavelength technology to provide the next generation of multi-gigabit wireless communications has been explored within the Broadway project.

User throughputs provided by existing 2.4 GHz wireless local area network (WLAN) and new 5 GHz orthogonal frequency-division multiplexing (OFDM) solutions are already foreseen as insufficient for dense urban deployment. Their extension by means of new modes in the unlicensed 59–65 GHz band has been proposed to guarantee nomadic terminal mobility in combination with enhanced capacity and privacy.

The hybrid dual frequency WLAN designed within the Broadway project provides for the smooth ad hoc extension of 5 GHz OFDM Hiperlan/2 technology at the 60 GHz radio frequency band. Offloading infrastructure-based WLANs from data traffic and interferences, mobile terminals operating at 60 GHz can form a separate ad hoc network.

Its scalable system architecture was based on Hiperlan/2 technology to ensure easy reconfigurability for backward compatibility. Furthermore, Hiperspot was equipped with a novel modified multi-carrier transmission scheme enhancing the robustness of transmissions at 60 GHz. With Hiperspot, demanding emerging applications in highly dense areas can be accommodated and data exchange rates exceeding 100 Mbps can be achieved.

While the high path loss at the 60 GHz initially seemed to be a disadvantage, it however confined Hiperspot operation in an indoor environment and within the limits of a room. In addition, higher frequency reuse could also be achieved, allowing a very high throughput network particularly suited for peer-to-peer communications. Importantly, 60 GHz regulation allows much higher transmit power compared to other existing wireless local area networks (WLANs) and wireless personal area networks (WPANs).

The Broadway project partner therefore had a key role to play in the extension of the IEEE802.15 standard, which addresses consumer needs for low-cost and high data rate ad hoc wireless connections. Some of these applications include wireless keyboards and printers, personal video and digital cameras, digital audio players and headphone, home theatre systems and stereo system components, among others.

Project partner Motorola's contribution to the meetings of the study group formed to develop a millimetre-wave-based alternative physical layer for the existing WPAN standard IEEE802.15.3-2003 has been significant. The millimetre-wave WPAN will allow very high data rates for applications such as high-speed Internet access, real-time streaming and wireless data bus for cable replacement.

Collaboration sought: further research or development support.

Offer ID: 3692

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that were capable of acting as stable chaotic sources. They have come up with two devices. The first is a single chip about 1 cm in length which is being prototyped in a Berlin laboratory. The second is a hybrid device about 15 cm long consisting of a laser and a small piece of fibre, using an oil coating to maintain temperature and feedback strength. 'We expect both to work well quite soon,' says Claudio Mirasso, project coordinator on the Occult project and a member of the Picasso team.

Consistency is a key goal for the mechanical parts. Sending longer signals is dependent on maintaining synchronisation between the two chaotic light sources for long periods, enabling data transmission at 10 Gbit/s.

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'One of the main problems could be temperature,' Mr Mirasso says. 'Changes in temperature lead to deviations in wavelength and you can lose synchronisation easily. We are working on mechanisms that could offer better stabilisation, but at this stage we don't know how much our new devices will drift with temperature.'

During a second phase of Picasso, the research team will investigate increasing the rate of transmission using wavelength division multiplexing, where a number of signals are transmitted together at clearly separated wavelengths. 'You have to define the width of the channels very well,' Mr Mirasso comments. 'But in many ways, it is not very different from normal wavelength division multiplexing. Perhaps 10 or more channels would be possible.'

The security offered by chaotic waveforms does not match the complete security of quantum cryptography. But the rate of transmission is far higher — a security protection in itself. And attempts to break into the optical fibre and interpret the signal would be extremely difficult — if not impossible at the moment.

IT AND TELECOMMUNICATIONS

Optimising polymer processing

Motivated by practical problems from industrial environments, the 3PI project used experimental and computational tools to model the thermo-mechanics of polymeric materials during their formation, processing and final design.

Polymers are a very important group of materials today. One probably cannot imagine a modern society without them, which is quite remarkable considering that they were first introduced a few decades ago. Nevertheless, at the high rates polymers are processed, irregularities and defects appear, limiting the maximum production rates of their commercial applications.

The main objective of the research project 3PI was to provide the essential knowledge and models for the prediction and understanding of the final properties of polymeric products. These properties are determined by intrinsic (molecular) parameters and, to a great extent, by the processing conditions.

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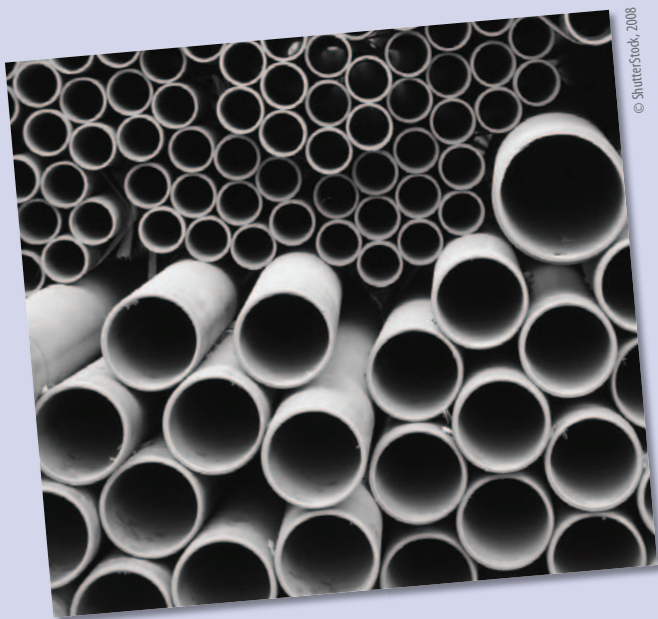
To bridge the gap between sophisticated rheological models and reliable, predictive* modelling of polymer processing, numerical tools were developed at the École des mines de Paris. The mechanisms of different constitutive instabilities of the polymeric fluids, occurring during the extrusion of polymeric melts, were progressively translated into advanced numerical models.

Dynamic modelling was quite successful in describing the onset of flow instabilities during the melt spinning process as well as of 'spurt' in pressure-driven flows. To take the study of instabilities in polymer flows one step further, general numerical tools for compressible flow simulations have been developed.

More specifically, the finite element code includes compressibility contributions together with a non-Newtonian or viscoelastic constitutive response. Based on the finite element method library MEF++, it has been configured to match time-dependent experimental data from a multipass rheometer.

Both pressure and birefringence evolution were followed for an exit/entry flow within a slit, which was assumed to be a 2D flow. From the results, it was possible to establish the relative importance of compressibility and viscoelastic contributions on the stress growth and stress relaxation components of the flow.

These failure mechanisms will be progressively translated into advanced numerical models for use in the optimisation of die materials and geometries, as well as processing conditions.

Structural design of polymeric materials

Polymeric materials are increasingly being used in real-world applications in areas where the primary material choice in the past would have been exclusively metal-based. An integrated design tool has been developed within the PMILS project to further improve their manufacturing routes to suit specific end-use needs.

Because of the tremendous diversity of their physical properties, polymeric materials in the form of fibres, elastomers, adhesives and coatings find applications from the most common to exotic products. Inevitably, the final properties of these materials depend not only on the chemical constitution of the polymer, but also on its physical structure or conformation.

Computer-aided numerical modelling has become a valuable tool for understanding how the macroscopic properties of these materials are related to their molecular structure. The ultimate aim of the PMILS project was to offer a thorough understanding of mechanisms responsible for the macroscopic behaviour of polymeric materials by means of advanced modelling tools. It would then become possible to tailor their molecular architecture to suit industrially

relevant needs for medical devices, electronics packaging, telecommunication and power distribution lines.

Under the coordination of the Technical University of Madrid, PMILS project partners combined their expertise in modelling tools and experimental methods to develop a holistic approach to polymeric materials modelling. In the course of the project, the applicability of the integrated software code developed to the level of predicting macroscopic properties for a wide range of polymeric materials was demonstrated.

Quantified data on the polymers' elastic behaviour and in particular the mechanical properties of anisotropic polymers were estimated by molecular dynamics and Monte Carlo simulations for their structure gen-

eration. Furthermore, quantum chemical calculations combined with state-of-the-art atomistic modelling methods offered unique insights into the complexation behaviour of polyamides. The diffusion of small molecules dissolved in polymeric matrices of varying molecular architecture was analysed using group contribution techniques in unprecedented detail.

Modelling multiscale morphologies in polymeric materials starting from their molecular constitution descriptions is an exciting recent development in computational analysis of polymer processing. Complementing past efforts based on more conventional simulation techniques, it could prove to be a valuable tool in the hands of polymeric materials producers seeking to improve the final product characteristics.

Advanced methods for improving polymer properties

The 3PI project resulted in a set of experimental techniques for characterisation of the flow conditions before and during the development of polymer processing instabilities.

Polymer processing instabilities have always been evident, even in early developed materials. However, they were not easily related to the relevant industrial conditions. Further material advancements and the ever-increasing modernisation of extrusion lines have brought higher flow rates in their production. At the same time, instabilities became so complicated that nowadays they are considered as the major limitation factor for further use of polymers. Flow instabilities, which are commonly called melt fracture, sharkskin or draw resonance, appear during processing.

To address this, the 3PI project aimed at developing a more rational approach for handling flow instabilities than conventional methods in current use. As such, a trial-and-error method with modification of molecular weight distribution or die geometry has been considered as an extremely time-consuming technique. Unlike this, the developed software codes provide guidelines to either polymer producers/converters or machinery equipment industry for further modifications. The modifications may involve the polymer, the die geometry or the die material, with the ultimate aim of overcoming or postponing these instabilities.

Based on the use of transparent tools, new experimental techniques for characterisation of the flow conditions were developed by several partners. These innovative tools include flow-induced birefringence (FIB), laser Doppler velocimetry (LDV) and use of a multi-pass rheometer (MPR). The FIB technique offers information on the stress field, both in stationary or time-dependent flows allowing characterisation of spurt conditions and volume distortions. This robust and efficient tool also enables the assessment of the parameters of constitutive equations or the validity of numerical simulations.

The LDV supports measurements of the local velocity in the flow field for the identification of the boundary conditions. It also allows the detection of vortices and calculation of their size in abrupt contraction geometries. Developed by the Cambridge project team, the MPR enables the conduction of successive experiments for characterisation of flow conditions under controlled pressure with a limited amount of material. For further information, please visit the project site: http://3pi.cemef.org

Novel insights into polymer processing instabilities

A coherent understanding of the origins of viscoelastic flow instabilities in terms of polymer composition and processing parameters has been achieved within the 3PI project.

Natural or synthetic rubbers, such as the widely used styrene-butadiene copolymers, are rarely applied in their pure form. Because of their poor strength and wear resistance, they are too weak to fulfil the practical requirements of the tyre manufacturing industry. Rubber articles, including tyres, derive many of their mechanical properties from the admixture of reinforcing fillers, processing aids along with a wide range of curatives.

By improving the polymer compounds' processability while postponing the development of flow instabilities, production costs of rubber articles can be reduced and the final product quality enhanced. On account of the increasingly competitive market, the European project 3PI adopted a rational approach to elucidate the mechanisms of the many different instability phenomena and therefore remedy resulting production problems.

In the beginning, a consistent series of commercial processing promoters were identified which reduced compound viscosity and thus improved mixing and extrusion behaviour of polymeric compounds. However, the use of two or more polymers along with the addition of carbon black appeared to provide the optimal solution for postponing the development of flow instabilities.

All rubber compounds have shortcomings. Often, one polymer's properties would fulfil the physical requirements of the end product's intended use, whereas a different polymer would satisfy some other requirement. In an effort to obtain the right compromise and optimise the end product's physical properties, blends of polymers are the rule rather than the exception today in manufactured rubber compounds.

Carbon black is essentially elemental carbon in the form of extremely fine particles with partially amorphous molecular structure, among microcrystalline arrays of condensed aromatic rings. When it is compounded into the rubber, shear and elongational properties of polymer blends were found to be improved while, as a filler, carbon black altered the rubber's modulus and tensile strength.

With a new understanding of the instability phenomena in polymer compounds, researchers at the Pirelli Tyre laboratories in Italy intend to engage in targeted research and development of new compounds.

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INDUSTRIAL TECHNOLOGIES

More reliable lead-free electronics

The EFSOT project resulted in a new reliability testing method for lead-free solder joints and a model for the reliable assembly of printed wire boards (PWBs).

According to the directive on the restriction of the use of particular hazardous substances in electrical and electronic equipment (RoHS), lead should not exceed certain limits. As basic electronic products and components need to comply with these requirements, the use of lead needs to be avoided in solders and finishes. Banning of lead also has direct environmental im-

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plications for industry in terms of toxicity, recyclability and used resources.

Aiming for an easy transition to lead-free soldering technologies, the EFSOT project focused on promoting reliability, efficiency and sustainability of lead-free soldering. From solder production and PWB manufacturing to reuse and recycling of electronics devices, integrated lead-free solutions were developed. These solutions may enable industries to select the most appropriate materials and processes that meet technical requirements, minimise life cycle impacts and lead to savings of resources.

One of the key project results involved a novel reliability testing methodology designed particularly for lead-free solder

joints. The method provides for assessment of the reliability effects of various solder and finish combinations as well as different solder joint gap geometries. Unlike the conventional bulk tests, the new testing allows reliability assessments of fine pitch solder joints taking into account the ever-increasing demands for miniaturisation.

In addition to this method, a model for the reliable assembly of complex and miniaturised PWBs was also built and tested. Model outcomes coupled with experimental results provided a detailed understanding of new complicated phenomena in key processes. For more information on the project, please visit: http://www.efsot-europe.info

Lifespan and ageing of industrial plant components

A database was created to be particularly adaptable to the parameters measured by two-dimensional x-ray diffraction (2D-XRD). It can evaluate the residual lifetime as well as simulate ageing processes of high-temperature plant components in the fossil power generation and chemical industries.

The Xpection project has created a prototype that integrates the measuring and monitoring of the residual lifetime of high-temperature plant components. This real structure analysis with onsite x-ray diffraction has been merged with an inspection and maintenance infrastructure. It is an interdisciplinary approach which spanned various fields of research for a novel ageing characterisation method.

It was necessary to measure both the ageing state of a material and the remnant lifetime of the component. Therefore a correlation of the 2D-XRD patterns with the mechanical properties of the materials was needed. In light of this, a database was designed and the Xpection-Tool was then applied to the data collected.

The database has the potential for lifetime assessment by real structure analysis of

materials in the plant components onsite and can offer information about grain coarsening and texture changes. The novel aspect of Xpection is that it can assess the ageing state and remnant lifetime prior to the appearance of cracks. Some potential end-users include fossil electric power generation and petrochemical industries as well as aircraft manufacturing and maintenance and the pulp and paper industry.

Friction stir welding gains industry's acceptance

Within the context of the Diplomat project, a joint venture collaboration scheme with SMEs set the framework for a wide promotion of friction stir welding (FSW) technology.

FSW is a solid-state joining process used in numerous applications where the metal characteristics need to be kept intact as much as possible. It is a fast, clean and highly reproducible technology particularly suitable for joining of materials with low melting points. In addition, it involves less welding time and consumable costs than other techniques, such as fusion welding. Moreover, it does not require any special skills for its operation, and its adoption promotes safety in the working environment.

Despite its technical, economic and social advantages, it has not yet gained the wide acceptance of industry. Motivated by this,

the Diplomat project focused on developing a flexible and low-cost interactive process technology database and suitable design guidelines.

The database provides the user with unique capabilities of easy and rapid identification of the most suitable FSW tool design and process parameters for a given application. The design guidelines can enable industries to implement the FSW process in the most appropriate way in order to generate high-quality welded products.

The adoption of the efficient, high-quality, environmentally friendly FSW technol-

ogy in production may enable industries to reduce the time-to-market and manufacturing costs. Additionally, offering FSW services could significantly increase potential applications particularly for European industries. On the basis of a reliable FSW system, the Diplomat consortium set the framework for a joint venture for providing services for both internal and external clients. Potential clientele may include train, civil construction or any other industrial activities involving light alloys in their products.

Lead-free solder solutions for electronic packages

Solder damage fatigue is a common cause of failure in consumer electronic goods, and conventional lead versions are environmentally unfriendly. This led IMEC, a top-notch research centre in Belgium, to search for lead-free solder solutions that can withstand the inherent thermo-mechanical stresses and strains.

Lead is a toxic heavy metal. It has recently been removed from gasoline, paints and other materials in order to reduce the risk of lead poisoning. The Imecat project aimed to remove lead from another common application — solders.

Project partner IMEC began by reviewing all previous research into lead-free alternative alloys. Several promising compounds were identified and their material properties (e.g. brittleness) were evaluated in the laboratory setting. Finally, IMEC turned to finite element models (FEMs) to simulate normal wear and tear in order to derive expected lifetimes.

Various electronic package types were evaluated, including under-filled flip chips, polymer stud grid arrays (PSGAs), ball grid arrays (BGAs) and chip scale packages (CSPs), and compared with a tin-lead (SnPb) benchmark.

IMEC discovered that increasing the silver content raises the temperature at which the solder becomes brittle, but it may not be appropriate for low-temperature applications. It also identified the conditions under which the different package types may develop cracks or other problems that can lead to solder failure.

IMEC has moved to copyright its Imecat research results, which will contribute to de-leading the electronics industry.

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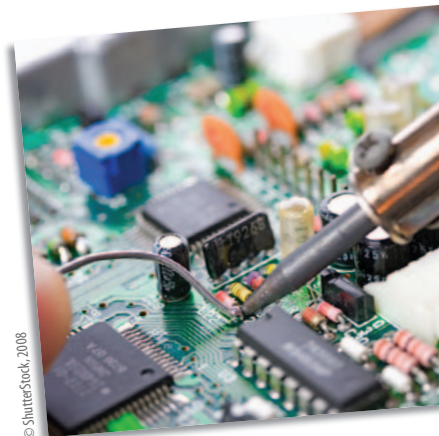
Evaluating the lifespan of industrial plant components

An algorithm for assessing the state of damage and the remaining lifetime of a material from two-dimensional x-ray diffraction (2D-XRD) patterns has been compiled in a detailed final report.

The Xpection project developed a prototype integrating a measuring and monitoring system for residual lifetime assessment of high-temperature plant components in fossil power generation and the chemical industry. The project created an advanced inspection methodology employing real structure analysis by onsite x-ray diffraction and merged it with the inspection and maintenance infrastructure.

An interdisciplinary approach spanning several research fields was applied. The work resulted in hardware and software for data acquisition and residual life time assessment in addition to an ageing process simulation.

An algorithm known as the 'counterclockwise loop' was integrated into the Xpec-

tionTool which uses selected data. Its main potential lies in its complete assessment of the ageing state with regard to the expected residual lifetime. Additionally, it provides quality control in production and inspection in other fields outside the project. The most likely end-users consist of those involved in fossil electric power generation and in the petrochemical industry.

Managing all costs effectively in mining

The Licymin project followed a new approach to limit the full life-cycle impacts of mining and developed a mining financial database framework for more effective cost management.

Aiming to minimise the full life-cycle effects of mining, the Lycimin project adopted an integrated approach taking into consideration all aspects of industrial mining and mineral processing systems. From exploration and development of a mineral deposit to mining, ore processing and concentrate production, the new approach also takes into account other activities. These include waste disposal and remediation as well as environmental monitoring, decommissioning and long-term control and monitoring of the impacts of the mining-related activities.

All these activities are interconnected with cost flows. The costs in mining activities

distinguish between those that are preliminary, direct, indirect, by-product credit, non-operational and environmental. Direct costs regarding excavation and beneficiation influence the environmental costs which include costs of environmental protection, waste disposal as well as closure, reclamation, monitoring and redevelopment. The direct cost of every process as defined in the developed life cycle assessment system was mapped to the sum of costs for each operational unit exploited in each separate process.

The new system offers the users unique opportunities to explore the financial cost

and benefit of numerous alternative scenarios. Aided by the life cycle costs facility, users may conduct economic analysis of various solutions. Thereby, costs are presented in monetary terms and benefits are shown quantitatively as well as in monetary terms. For instance, a monetary valuation study is the result of reduction of charges and damages after environmental investment. This analysis is part of an environmental management tool that may significantly contribute to the minimisation of potential environmental damage and cost reduction in mining.

INDUSTRIAL TECHNOLOGIES

Crash warning for connected cars?

European researchers have demonstrated in the lab a collision warning system for cars that could alert the driver several seconds in advance of an imminent impact. The device could save thousands of lives and usher in the first steps towards the 'connected car'.

It knows its location, can talk to other cars and can predict the future. Are we entering the era of truly automated cars? The collision warning system (CWS) is the brainchild of the 'Relative position for collision avoidance systems' (Reposit) project, which recently fired up a fully working prototype of their system.

The prototype can find its position using the global positioning system (GPS), and find the position, speed and trajectory of neighbouring and oncoming traffic using an emerging car communication protocol called Vehicle2Vehicle (V2V).

It can use that information to calculate the relative position of other cars, and then extrapolate where they will be in a few seconds' time. If the data predicts a collision, it warns the driver.

'So far, we've got predictions about 1 to 3 seconds ahead of a collision … but anything from 2 seconds up gives drivers time to react. It works better at medium-to-high speeds,

above 50 km/h,' reveals Jose Ignacio Herrero Zarzosa, coordinator of the Reposit project.

High-performance GPS systems, that can locate a car within a metre or so, perform far better than low-performance GPS systems, but even with poor GPS technology, Reposit has managed to get warning times to 1.5 seconds in a simulator, not too far from the useful minimum of 2 seconds. Zarzosa believes the system can do even better, with further work using vehicles' available sensors.

But the system does work, at least in a simulator, and that is a concrete result. The team has also perfected a simulator that other projects can use to model car collisions, another useful output. But will it be a success?

It is possible, in time. Crucially, the system uses technologies such as GPS and V2V, which are already becoming common or are emerging as a feature of modern cars. More and more cars come with GPS already

installed, Mr Zarzosa explains, and many owners are self-installing a GPS system, so for these cars Reposit takes advantage of the installed base.

V2V is an emerging standard for communication between vehicles, and so it will become more common as time goes by. The Rosetta stone of the system, the programme that ties all the devices together, is just software and so relatively cheap.

That is very important. Keeping cost down is essential for any new car technology. The economics of the motor industry are unforgiving. 'New car devices must be cheap if they are to be commercialised,' Mr Zarzosa notes.

The Reposit team discovered that the rules for automobile innovation are unforgiving, too. Right now, there is no standard for integrating new functions into an existing car system. Every manufacturer uses different system integration methods. 'This significantly pushes up the cost of third-party technologies like Reposit,' Mr Zarzosa warns. Although the European Commission reports that it is working hard on this.

So far, the car industry finds Reposit's work interesting, but remains unconvinced of the commercial application. 'The car industry is … very price sensitive,' Mr Zarzosa notes.

Even so, the popularity of GPS and the emergence of V2V as a standard mean that the system will become more attractive over time. Before long, drivers might take the first, tentative steps into the era of connected cars.

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See also page 22 (offers 3653, 3693 and 3679)

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Ultrasound-treated materials for dental application

The Ultraset project developed new advanced materials that can be polished and shaped with the aid of ultrasound immediately after placement in dentistry.

Mercury-based amalgams used for tooth filling are considered to be potentially toxic and environmentally unfriendly due to mercury's volatilisation after cremation. Alternative materials should display reduced wear, improved handling characteristics and resistance to secondary tooth decay, as well as capability of direct tooth bonding in order to preserve tooth structure.

In answer to these needs, glass ionomer cements (GICs) constitute a very good option. These materials are formed through reaction of aqueous poly-acrylic acid with an acid-degradable glass. This results in a release of metal cations that further cross-link to the poly-acrylic acid. The end-product is a cement consisting of residual glass particles embedded in a poly-salt matrix.

These cements display unique features, such as the release of protective fluoride ions to the adjacent tooth structure that inhibits subsequent tooth decay. Yet, there are still some inherent problems including early hydrolytic stability and poor fracture toughness. Aiming to overcome these, the Ultraset project developed innovative glasses for incorporation in the cements that could be further optimised under ultrasound application.

The project studied an extensive range of cement structures under exposure to different ultrasound frequencies to obtain

Hot microbes for industrial pathways

Microorganisms are a potential goldmine of genetic material to be harnessed for use as industrial catalysts, many under inclement conditions. Researchers from the PYRED project have isolated a gene for an enzyme that yields organic products which form the basis of many manufacturing processes.

The microbe *Pyrococcus furiosus* (*P. furiosus*) is an amazing life form. It has an optimal growth temperature of 100 °C, a temperature normally used to inactivate most microorganisms. It is highly resistant to radiation and has a very speedy doubling time. PYRED project partners aimed to capitalise on the extraordinary properties of hyperthermophiles like *P. furiosus* and to isolate the enzymes responsible.

As part of this research, partners from the University of Wageningen in the Netherlands identified the gene adhD in *P. furiosus*. This sequence produced an enzyme that promises to be a valuable tool in the field of industry. The catalytic activity of

the enzyme increases up to the expected 100 °C in line with its natural habitat — the hot sand by sulphurous springs. Not only does it possess high thermostability, but it was found to display a broad substrate specificity. The researchers found that it prefers the reduction of ketones and the oxidation of secondary alcohols. Analysis with gas chromatography showed that the predominant adhD product was 2-pentanol when 2-pentanone was used as a substrate.

The secondary alcohol, 2-pentanol, has many industrial applications. In the bid to reduce the use of harmful global warming fossil fuels, 2-pentanol is an important biofuel and

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an alternative to petrol. It is also used as a solvent for the coating on CDs and DVDs.

Leading to safer, cleaner vehicles

Aiming to promote natural gas or hydrogen transportation, the ZEM project developed a demonstrator vehicle that allows online monitoring of gas storage.

Future mobility relies heavily on the use of cleaner vehicle technologies such as hydrogen-fuelled and natural gas vehicles (NGVs). Natural gas and hydrogen fuels may bring significant environmental benefits, including lower emissions and improved air quality. Another important aspect of NGVs lies in the reduction of the vehicle's weight and hence fuel consumption.

Aiming to minimise potential hazards related to the structural integrity of vehicles, the ZEM project focused on the safety of the composite high-pressure tanks for natural gas or hydrogen. Until now, most conventionally used inspection techniques for composite vessels require off-vehicle visual

inspection as well as labour-intensive and costly pressure testing.

Unlike these, the project developed a diagnostic system capable of fault detection and early identification of critical conditions onboard using inexpensive sensor technology. More specifically, the project developed fibre-optic sensors, embedding techniques, composite tank manufacturing methods and signature recognition algorithms. A demonstrator vehicle was generated on this basis.

The FIAT Multipla 1.6 includes a 16v bi-power engine and three all-composite tanks housed beneath the floor. The tanks offer a maximum of 144 litres of fuel storage, which is sufficient

for driving a distance of 440 km. Each tank incorporates four fibre-optic sensors and a thermocouple for onboard monitoring purposes. Two pressure gauges provide pressure measurement during refilling and working.

Finally, a suitable interrogation unit is placed in the trunk and connected to a laptop next to the driver. The demonstrator vehicle verifies the feasibility of the developed technologies, and it shows the potentialities of an integrated onboard monitoring system in the design of safer, cleaner vehicles.

improved mechanical properties. Under exposure to ultrasound, the developed glass (ionomer) polyalkenoate cements were shown to display improved hydrolytic stability at short times after placement.

With excellent mechanical properties, such as fracture toughness, strength and abrasive wear resistance, they may be polished and shaped immediately after placement. Researchers gained a better insight into the clinical use and application of ultrasonic curing of these cements. Tests on the efficacy of new ultrasound tip geometries and delivery systems were also conducted.

The Ultraset project's results can contribute to the reduction in the use of amalgam-based materials and consequently mercury contamination. Moreover, the advanced filling materials may considerably prevent tooth loss, which is highly associated with speech problems, eating disorders and loss of self-esteem. Their handling characteristics allow easy placement facilitating dentist's work significantly. Furthermore, associated costs for the patient may be substantially reduced in comparison to other filling materials.
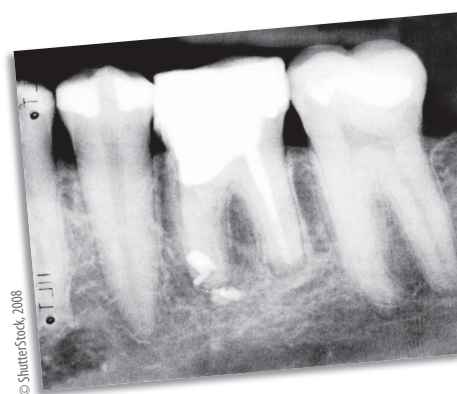
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Plasma technology produces better barriers

Consumer demand for convenience food requires that the contents remain unspoiled by microbial agents, oxidation and other contaminants. Scientists have investigated nanocomposite coatings for use on plastic films to improve the shelf life of processed products.

Packaging is a multibillion euro industry, and its value is forecast to continue to rise. This development is partly driven by demographic changes, with the consumer increasingly demanding safe yet convenient, well-prepared food. Added catalysts to development are changing legal stipulations for labelling and product technology changes.

Consequently, the properties of packaging must satisfy some very demanding criteria. As well as protecting the item inside, pack-

aging must be low cost, have an acceptable production speed and possess adhesion and printability properties for labelling. Solplas, an EU-funded project, has undertaken research into coatings designed for plastic films for food and sensitive electronic devices. With regard to food, low permeability to water and oxygen and anti-microbial properties are particularly important.

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Project partners harnessed a combination of technologies in order to achieve the required product. Scientists at Vito in Belgium, the Flemish Institute for Research, amalgamated aerosol and atmospheric plasma technologies on various hybrid sol-gel precursors. The result was a coating that was superior to the film produced by wet-chemical coating with traditional curing methods. It was 10 times less thick — up to three microns only. Not only that, but the oxygen migration performance was more than 10 times superior for some of the sol-gel systems under observation.

The improved barrier properties together with the faster curing rate for the material are due to two main factors. First, the high surface area of the sol that is atomised, and secondly, the plasma environment that is highly reactive. These features combined result in more cross-linking, which leads to the desired novel properties of the film.

Project partners include manufacturing companies and academic institutions. Potential applications from this innovation are multi-purpose given the range of products that require packaging. This can undoubtedly help to improve the competitiveness of SMEs as well as the larger European manufacturers.

Plasma in health applications

Plasma technologies have useful applications in many industrial sectors, like health with numerous functions in pharmacy, biology and medicine.

Plasma is simply an ionised gas, with one or more free electrons that make this matter electrically conductive and responsive to electromagnetic fields. The generation of most artificial plasmas is derived from the application of electric or magnetic fields.

The advent of this breakthrough technology several decades ago brought several consumer products with the most popular one, the plasma display panel that is used in flat - screen television sets. The first use of plasma technology in a medical device application did not occur until recently — in 1995. First applications involved surface modification techniques and sterilisation.

Aiming to promote the use of eco-friendly plasma technology in the health, food and environment sectors in order to create new

industrial applications, the Plasmatech network was built. The key project objective was to collect, structure and manage information from the industry to inspire new developments. Moreover, the network acted as a means for exchange of experience through demonstration tests and experiments between the different sectors and research.

Special functionalities of plasma technologies can also be introduced in applications concerning surface modifications of medical devices. In addition, cold plasma chemistry and sputtering as well as hot plasma temperature can be employed to develop or optimise biomaterials. For example, osteo-conduction in coatings and osteo-induction with bone growth can be advanced by using plasma-based techniques.

Moreover, through deposition grafting, chemical functionalities with specific biological functions can be introduced. The plasma technology was also found suitable for protein immobilisation on surfaces to induce desired cell responses. Researchers also explored techniques for antimicrobial adhesion and release as well as anti-adherent properties for proteins/macromolecules, cells and tissues with the aid of plasma.

Several plasma sterilisers are commercially available, yet research in this field is ongoing to investigate the full potential of plasma action to sterilise and clean surfaces. Opportunities to complement plasma sterilisation include low pressure, thermal effect, direct destruction of DNA by ultraviolet radiation, erosion by intrinsic photodesorption and etching of microorganisms by a radical.

RFID pilots: towering solutions for global supply

The once imposing barriers to mass implementation of radio frequency identification (RFID) tracking solutions along global supply chains are starting to come down. Pilots are under way in some of Europe's most important industry sectors that should prove the business case for a number of RFID radio-tracking solutions and promote implementation of standards.

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The mass implementation of electronic, Internet-based systems to track products along global supply chains in real time comes a step closer following a series of pilots involving companies in the pharmaceutical, textile and other major European industry sectors, including the so-called fast-moving consumer goods (FMCG) sector.

The tracking of individual items, cases or pallets relies on tiny RFID tags that can supply an electronic product code to a reader specifying not only the product's ingredients, but also information on its maker, place and time of origin.

'The technology has evolved dramatically in terms of performance, quality and costs,' says Henri Barthel of GS1 Global Office and coordinator of 'Building radio frequency identification for the global environment' (Bridge), the EU-funded project that is behind the latest pilots.

As the technical, commercial and political barriers to RFID implementation are removed, the total number of tags purchased annually in Europe is expected to increase from 144 million in 2007 to 86.7 billion in 2022, according to a Bridge survey. The total number of locations with RFID readers in Europe should increase from some 2 750 to around 450 000 during that 15-year period. And the number of RFID readers should increase from a few thousand to more than 6 million.

Bridge participants see RFID as the route to some fundamental supply chain improvements. One pilot aims to provide a benchmark for traceability systems for the European pharmaceutical market, supporting a range of applications including product authentication and financial reconciliation systems.

One of the biggest barriers to the uptake of RFID in the FMCG sector has been the belief that retailers will see all the benefits while suppliers will carry all the costs. One Bridge pilot should dispel that myth. The confectionery manufacturer Nestlé UK is prototyping an RFID system for tracking assets, such as plastic crates and roll cages, through their production process. They have identified more than 20 areas where they believe RFID will, in fact, deliver cost savings.

Meanwhile, the French retailer Carrefour and its supplier Benedicta are tracking a range of reusable assets, including pallets and crates, with RFID tags and sharing the information between the two companies to increase their efficiencies.

'Bridge will document the business cases achieved in these pilots as examples to other companies so that they can gain from the initial [lessons] and roll out the technology,' Mr Barthel says.

Kaufhof, the major German department store, is sharing RFID-generated information with garment supplier Gardeur and testing the benefits of in-store applications, such as 'smart' shelves — fitted with RFID readers. With Bridge support, the Austrian clothing retailer Northland is also using RFID to improve inventory management on the sales floor.
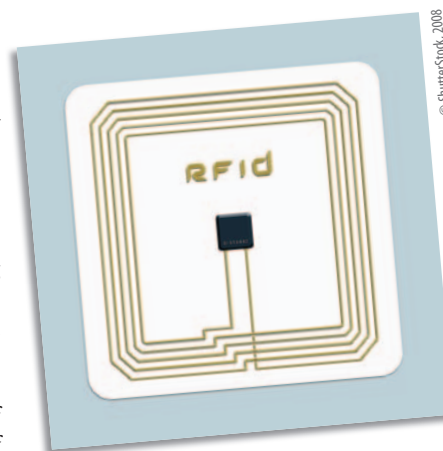
In another pilot, electronics giant Sony is looking for cost savings and increased efficiencies in its service operations, using RFID tags to track products and parts between its Spanish factory, its Dutch warehouse hub and its German store and service centres.

There is more to Bridge than these pilots. It is also supporting the development of hardware, software and standards that make it cheaper to implement RFID solutions and share electronic product code (EPC) information over the EPC global network of the future.

Because much of the information about product flows is commercially sensitive, it is essential that access to it is strictly controlled. Another group of researchers within the Bridge project has developed a 'Discovery service' software prototype. It will provide the searcher with data on the movement of goods along a supply chain and predict its likely destination. But it is more than a search engine: the prototype identifies the searcher to each information provider and helps to authenticate the searcher's right to view that information.

Each RFID-EPC solution proven by the Bridge project helps the movement towards agreed standards and lower-cost implementation. Taking cost out is key to mass RFID implementation, according to Mr Barthel. Even where pilots show a good return on investment, companies, particularly multinationals, often baulk at the massive investments they would need to deliver a comprehensive RFID-enabled operation.

'The standards have to be in place, EPC and RFID solutions have to be plug and play, and the return on investment has to be calculable,' Mr Barthel stresses. 'When these three parameters converge, there will be massive adoption compared to what we see today.'

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Unwearable, durable components of complex geometry

A new software tool allows the prediction of wear behaviour and durability analysis of industrial components of complex geometry.

The performance of machinery and aerospace friction joints relies heavily on the allowable contact loads and operating temperatures. With the ultimate aim being to improve this function, the TRIBO project focused on the development of advanced high-performance solid lubricant coatings (SLC).

More specifically, the project work explored the use of high-energy fluxes for deposition of this novel nanophased powder material. High energy fluxes which are characterised by high rates of heating or cooling can lead to minimised damages in the materials' structure due to the associated crystal growth.

One of the key project results involved the development of a software application suitable for tribology and durability analysis. The robust simulation tool offers strength analysis for turbine blades restored through coating deposition and destruction. The software also allows the user to perform stress analysis for the glue layer between friction parts in a knee joint model under different boundary conditions and loads. Other useful applications include wear analysis of bearings and cutting tools for machining.

Based on the finite element analysis method, the software is suitable for simulation of the dynamic behaviour of a real butterfly valve in terms of contact stresses, friction coefficient and contact temperature. In comparison to conventional methods involving expensive tribological trials of butterfly valves, the virtual experiments are less costly for the selection of the most appropriate coatings.

Fast track to processing of woven textile-reinforced thermoplastic components

A successful new system for monitoring dynamic heating and cooling processes in the manufacture of woven textile-reinforced thermoplastic components will lead to increased industry competitiveness.

Under the umbrella of the Amiterm project, two new mould technologies were developed to improve energy usage during the manufacture of large thermoplastic parts. As part of this initiative, project partners at Regloplas AG in Switzerland designed a monitoring system for the new processes. Tests on modular plate moulds were carried out on several thermoplastic resins, and results showed that this system is applicable for monitoring JETex and HTex mould technology.

The main uses of the new system are the online monitoring of the temperature of the mould, the determination of the running cycle and the flow rate. Pivotal to the overall process control were the energy balance measurements and the resultant possibility of exchange of heat between cold and hot circuits which may lead to energy saving.

The monitoring system is an online unit which is used for analysis of materials used with the JETex process. Two computer systems working in parallel make up the monitoring system during the processing cycle. One system writes processing data on a hard disk. Data includes information on phases of the cycle such as the injection piston movements during the mould filling phase, hydraulic pressure and the injection speed. These processes are all shown on the computer screen.

This system was successfully tested and systematic processing studies were planned during the second year of the project.

New mould technologies for energy savings

Two innovative mould technologies for producing large thermoplastic composite parts with minimised energy consumption were tested with the use of a set of moulds developed for this purpose.

Current processes used in the production of large thermoplastic composite parts are extremely energy consuming. This is mainly due to the large amounts of energy required to heat up the mould tools very rapidly and subsequently to cool them down faster than they were heated. This energy balance is not only tremendously expensive, but it is also environmentally unfriendly.

Answering this need, the Amiterm project developed two novel techniques: the JETex and HTex processes. The JETex process involves injection of a viscous pre-polymer into a specialised non-metallic mould carrying textile (woven, braided, laid, knitted) reinforcing structures. Microwave or high-frequency energy is then used for dynamic heating required for polymerisation that leads to the formation of the thermoplastic part.

The HTex process consists of positioning of pre-impregnated textile inserts in a dedicated mould. The inserts involve high-performance materials (carbon, para-aramid or glass) coated with a thermoplastic resin. Once heated and compressed, the molten resin becomes the matrix of the solidified thermoplastic composite. Whether it is the resin or the textile that is heated, it results in more energy savings than heating a metal mould.

The processes were successfully tested using a set of prototype moulds specially developed for this purpose. The first prototype was a flat panel for test plates and involves a basic tool frame for manufacturing of different plate thickness for testing both processes. Designed for the HTex process, the second set included an aluminium mould, an auxiliary one for injection moulding and the so-called polyetheretherketone (PEEK) polymers, a microwave-transparent material. The third prototype was developed from aluminium with an optimised temperature system for the JETex process.

Sailing into smoother waters

New guidelines aiming to mitigate motion sickness will increase passenger and crew comfort on ships and improve reliability and competitiveness in the EU shipping industry.

Ships are technically able to operate throughout the year, but in reality shipping schedules are often stopped or delayed by bad weather conditions for many months during the winter. The main reasons for these potential delays are discomfort to passengers and safety issues.

The motion sickness prediction models currently in use are 25 to 30 years old. As a result, the objective of the Compass project was to create new standards for motion sickness prediction models. The objective was to not only improve the comfort and safety of passengers and crew onboard ships but to improve reliability and operability. Raising standards in these areas will also increase the competitiveness of the European shipping industry.

A questionnaire monitoring system has been set up onboard certain ships including cruise ships, ferries, high-speed craft and catamarans. These are spread out over different geographical areas including the Baltic Sea, the Mediterranean, the Norwegian Sea and the English Channel. The questionnaires provide crucial information on parameters of motion sickness and passenger comfort and the way they are dealt with by staff.

The experience gained through the project questionnaires will lead to a standardised methodology for evaluating comfort and passenger satisfaction onboard ships. Permanent long-term monitoring systems will be installed on ships including a set of accelerometers, a wave meter and a PC unit. The PC unit will be used for data acquisition and processing using dedicated software. The computer system will be able to monitor overall comfort levels on ships and adjust for operational guidelines on speed and wave height in relation to passenger comfort.

Purging nano's innovation bottleneck

There is plenty of innovation in micro- and nanotechnologies, but bringing new devices to market is often prohibitively expensive. Many microdevices have small production volumes, while design, packaging and testing are costly. Now European researchers are breaking down the barriers by developing design methodologies that focus on manufacturing, packaging and testing.

In laboratories dotted across the continent, dedicated and ingenious researchers work feverishly for years, or even whole careers, to increase our understanding of science at the small scale. Along the way, they develop new, innovative devices to detect pressure, acceleration, temperature or direction — and that's just the beginning.

Researchers now explore tiny devices that eject a dose of medicine at predetermined intervals. They create entire, micron-sized laboratories or computer systems on a chip. They are discovering just how much room there is at the small scale, as physicist Richard Feynman famously predicted almost 49 years ago.

But innovation at the sharp end lags behind scientific advances. Often the devices only exist in the laboratory as a demonstration.

These prototype lab demonstrations look ugly, but often work, and they prove functionality at the nano- or microscale. They also often determine whether the invention will ever see the light of day.

'For certain types of device, targeting very large volumes in sectors like the automotive and, more recently, the computer gaming industry, there is a promising future,' reveals Patric Salomon, a partner with the Patent-DfMM network of excellence (NoE). 'But for many others, the lab is the only place where these devices are ever really used.'

The reason? Up to 80 % of the unit cost for micro- and nanodevices is in the packaging and testing phase, and the unit cost must often come in under a euro. 'Many innovations are just too expensive to commercialise,' Mr Salomon notes.

But not, perhaps, for much longer. The Patent-DfMM network was set up to find a way to cut the cost of packaging, testing and manufacturing micro- and nanodevices. To do it, the 22-strong consortium had EUR 6.2 million funding from the EU.

'We had a lot of control over how we assessed projects for funding within the network,' Mr Salomon says. 'As a result, we were able to get quite a sig-

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nificant impact.' In the end, the NoE supported over 60 small-scale projects.

These looked at ways to simplify the 'Design for micro-manufacture' process. In essence, researchers learn about manufacturing constraints before starting a design, and they take these into account during the concept phase, to optimise units for manufacturing processes. This drives down costs and the time to market.

The network funded research into ways of reusing one design, or its building blocks, for a different type of product. It also studied more efficient ways to test for robustness and perform quality control. Already, these projects have had an important impact, though Mr Salomon admits that they are difficult to quantify.

But that's just the beginning. Patent-DfMM also conceived a series of service clusters, groups of specialists in particular areas of micro- and nanotechnology, offering services in design for manufacture, testing and reliability. 'These target specifically SMEs and can provide help for companies seeking to commercialise a nano- or microtechnology,' Mr Salomon notes. So far, Patent-DfMM has set up two: one specialised in miniaturised health-monitoring systems (HUMS), the other focusing on reliability (Eumirel).

In all, it offers hope of a commercial life for the thousands of lost innovations gathering dust in labs across the continent, and more importantly, to make sure future inventions are 'designed for manufacture' from their initial development phase.

Removing hard coatings with abrasive water jets

An abrasive water jet (AWJ) cutting technology has been designed for controlled removal of hard coatings.

Developed by the Abrade project, the AWJ can be applied to a conventional industrial robot or manipulator. The technology includes an industrial robot or a simple xy

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manipulator to which a water stripping gripper is attached. The gripper is made up of a water jetting nozzle, a hard coating thickness measuring sensor, a water jet rotation system, together with ultra-high-pressure water and abrasive attachments. Furthermore, the gripper is flexible and can be altered to different water stripping grippers, nozzles and sensor combinations that have been created for other work pieces and coating combinations.

The process is regulated through the robot control unit combined with adaptive feedback from the coating thickness meas-

urements. Feedback can also be obtained from the stripping strategy. Other devices and machinery include the ultra-high-pressure pump with high-pressure pipes, valves and drains, working cabin with safety devices and work piece fixing and handling device.

The Abrade unit is able to remove coatings from complicated shaped components and it requires less manual labour. With the development of an online hard coating thickness measurement device, it is likely that unwanted base material erosion through jetting can be prevented. This can offer an environmentally friendly and cost-effective method for hard coating removal as an alternative to the chemical stripping method.

Innovative lanthanide compounds for optoelectronics

The 'Optical amplification in polymer-based materials and devices' (OPAMD) project has developed novel lanthanide complexes for cost-effective and eco-friendly infrared semiconductor applications.

Compared to its existing inorganic counterparts, polymer-based technology has been considered as more environment-friendly. Due to its excellent performance coupled with inexpensive production and ease of manufacture, this technology is highly suitable for use in data, telecommunication and optical computing applications.

Motivated by this, the OPAMD project focused on the fabrication of new polymer-based materials and devices for further deployment in photonic technology platforms. Research work resulted in two families

of materials emitting in the visible spectrum and in the infrared along with device demonstrators for further commercial exploitation.

One of the key project results involved novel lanthanide complexes of sandwich type and perhalogenated sandwich-type erbium. For the synthesis of these innovative complexes, a wide range of compounds was developed. This range included quinolinate, betadiketonate and sulfonyl imide as well as other complexes of mainly erbium, neodymium and ytterbium ions for applications in the near-infrared spectrum.

The developed lanthanide complex doped polymers are capable of emitting in the infrared region by photoluminescence and possibly electroluminescence processes. In both processes, there is light emission due to either photon absorption or an electrical field/current passing through. Their primary applications include infrared light-emitting diode applications. For further information on the project, please visit: http://www.tyndall.ie/projects/opamd

Newly developed 'ancient' copper alloys

Within the context of the Efestus project, a set of new copper alloys with a microchemical structure similar to that of ancient alloys was produced.

Conservation and restoration of copper-based archaeological artefacts relies heavily on understanding the mechanisms of their degradation. For this purpose, part of the Efestus project work was dedicated to the systematic identification of causes of artefact degradation.

Based on this knowledge, innovative techniques for restoration and conservation of copper-based archaeological artefacts were

developed. In order to validate these techniques, researchers generated 13 reference copper-based alloys that are not commercially available. These feature a chemical composition and metallurgical characteristics that are similar to ancient alloys used.

Their chemical composition distinguishes five material classes, namely copper-tin, copper-lead, copper-tin-lead, copper-iron and copper-zinc-tin-lead. These classes

cover most of the families of the copper-based alloys used in ancient years. The 13 reference alloys replaced standard materials in tests carried out for optimisation of the analytical performance of portable and laboratory diagnostic equipments. For further information, please visit the project site: http://www.efestus.just.edu.jo/index.jsp

Industrial energy savings with grinding technology

The ENGY project focused on improving the energy efficiency of eco-friendly grinding technologies.

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Grinding constitutes one of the key machining operations in precision manufacturing as its adoption leads to significant improvements in the quality of finished parts and the performance of machines and tools. Yet, it involves high amounts of energy consumption, leading to system inefficiency and waste production.

Urged by this, the ENGY project improved the energy efficiency of grinding by following an integrated approach on the entire grinding system. More specifically, the project's work addressed issues related to machine, tool and process control.

Apart from the traditional use of grinding as a finishing operation, grind-hardening processes were also investigated for reducing the operation time required. Thereby, the heat generated during grinding can be exploited to harden high-quality machined parts.

Within this context, a set of guidelines referring to the energy balance assessment in grinding processes were released. Analysis of the process life cycle took into account energy, material and coolant consumption along with the grinding wheel wear for both processes, grinding and grind-hardening.

Comparison against benchmark criteria that were originally defined within the ENGY project verified the environmental benefits of grind-hardening processes. This was shown for both bearing and automotive components industries. Adoption of optimised grinding process parameters in the defence industry may also significantly limit the environmental impact.

Particularly in the case of grinding of hardened gears, appropriate machine and process changes can offer an average energy reduction of the order of 38 % and consequently minimise environmental damage by 43 %. For further information on the project, please visit: http://www.lms.mech.upatras.gr/engy

Efficiency measures for process improvements

The tool and process monitoring system proposed by the ENGY project provides constant control of grinding machine functions, and thus allows grinding cycle optimisation and reductions of machine downtime.

Grinding was once thought to be a secondary finishing process, providing good surface finish and close geometrical tolerances. With recent advances in grinding wheel and machine tool technologies, it has become a critical machining operation and an attractive material removal process.

Further improving the energy and resource efficiency of the grinding process by a holistic approach addressing the entire grinding system was the ultimate objective of the ENGY project. While looking at the machining process outputs, optimisation of the machining tools' performance and the coolant support was sought along with the establishment of adequate energy balances.

To achieve these ambitious goals, a detailed knowledge of the process behaviour had to be evaluated by detecting grinding forces and power demanded on the spindle motor driving grinding wheels. In most manufacturing operations, grinding processes are adjusted to speeds and feeds set by the operators who follow a company-determined baseline for a particular job.

In addition, it is the operator who judges if these company-set parameters can be adjusted to obtain an acceptable quality in reduced processing time. The mobile measurement system developed by the grinding tool manufacturer Tyrolit Schleifmittelwerke Swarovski KG allows flexible monitoring and evaluation of fundamental process properties.

Such simple information can retain much of the operator's experience, and just as importantly can contribute to troubleshooting and achievement of the desired productivity. In the future, non-intrusive monitoring techniques may prove to be a valuable method for acquiring grinding process experience and the company preserving the experience of operators after their departure.

Further information on the research results featured in this issue and on the projects which have delivered them is available on CORDIS.

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