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RESULTS SUPPLEMENT

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EDITORIAL

The destruction of a nation

On 12 January, Haiti, the poorest country in the western hemisphere, was hit by a massive 7.0 magnitude earthquake that all but levelled its capital city, Port-au-Prince, and surrounding area. The situation was further aggravated by the fact that Port-au-Prince is home to 10 % of the country's 9 000 000 population. Furthermore, buildings in Haiti were never designed to withstand the impact of an earthquake. As part of the international rescue effort, EU Member States have played an important role in improving the plight of the Haitian population.

Apart from this crisis response, the EU has also been funding research into seismology and search and rescue projects for many years, notably under its research framework programmes. The results of these projects are expected to dramatically improve the predictability of natural disasters, as well as increase the chances of finding survivors after they have occurred.

In this issue of the results supplement, *the section on biology and medicine opens up with the CARMA project. Researchers collaborating on this project have studied an issue of increasing concern in the EU, the care for its elderly population. One of their research fields was dedicated to the evolution of elderly care in Germany since the introduction of long-term care insurance.*

The Morepower project headlines the energy section. Its aim was to develop a new type of portable fuel cell. In order to achieve this, researchers have identified new electrocatalyst materials that have the potential to substantially boost the performance of today's portable fuel cells.

Climate change is the topic of the lead article in the environment section. The goal of the Camels project was to set up a system to help EU Member States accurately measure atmospheric transport and terrestrial carbon uptake. This is in line with one of the Kyoto Protocol's proposals on offsetting CO_2 emissions.

The opening article of the IT and telecommunications section introduces a project with an unusual title: 'Being there — without going'. Virtual reality however, its field of research, is very topical. Researchers in this project have studied the value of sound in enhancing the experience of virtual reality, something called the 'sense of presence'.

The industrial technologies section starts with a contribution on the Effort project, whose main aim was to improve the design of ships to propel them with much greater efficiency. Using the tool of computational fluid dynamics, researchers expected their new designs to bring significant fuel savings as well as a reduction in pollution, noise and vibration.

As usual, the events section offers you a non-exhaustive list of forthcoming event announcements in the field of research.

We look forward to receiving your feedback on this issue and on the research*eu *publications in general. Questions or suggestions can be sent to: research-eu-supplements@publications.europa.eu*

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Tracing the evolution of elderly care in Germany

An extensive report has been derived as a result of a collaborative analysis of services and care facilities in Germany designed to help reintegrate the elderly.

The elderly population, a growing sector in Europe, is commonly at risk of marginalisation within society. In order to help improve the well-being of this population, the CARMA project undertook a combined effort which involved academic research institutions, social service providers and educational institutions. As such, current social care services for the elderly were assessed in studies spanning coping skills and care arrangements.

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The findings which resulted from this collaboration included the documentation of services for reintegrating the elderly in Germany. This report offers a summary of the way in which home-based, semi-residential and residential care facilities have evolved since long-term care insurance was introduced. Furthermore it exhibits available social care and counselling founded by municipalities.

Although it was found that various types of health care facilities were expanded and modernised, problems were still present. One example of this regards access to various types of formal care, particularly for members in lower socio-economic classes. There is also regional disparity since the service offered is less developed in poor regions and in rural areas. Furthermore, there is a lack of adequate service for elderly patients suffering from psychological difficulties and mental illnesses such as dementia.

Although the report gives vast information on types of care services and facilities in Germany, it can also be applied by national as well as international researchers concerned with elderly care. Additionally, the report is useful for social politicians and experts involved in care insurance, not only in Germany but in other European countries as well.

German nursing under scrutiny

In order to avoid the prolonged negative consequences of a chronic nursing shortage, a far-reaching study of the profession was undertaken.

Throughout Europe there is a shortage of qualified nursing staff. In the wake of an ageing population, the 'Next nurses' exit study' project aimed to analyse the exact reasons for these shortfalls in this demanding career. The countries that make up Europe are very varied and an individual country's economic and social conditions can profoundly affect employment statistics. In all, therefore, eight countries were studied and analysed.

To analyse the situation in Germany, researchers at the University of Wuppertal collected data and analysed it in relation to the prevailing economic situation. Factors creating a unique socio-economic climate included financial constraints as a result of a diagnosis-related group reimbursement scheme occurring simultaneously with an increase in unemployment.

Data from over 6 000 questionnaires obtained from 75 health care institutions over a period of two years was analysed. Of these, around 200 were from leavers. The most significant results were obtained from those with intention to leave (ITL) and those who had actually left. As would be expected, the figures showed that a rapid decrease in other employment opportunities artificially lowered ITL. At the same time, fear about unemployment increased.

The main factor revealed by the survey to be responsible for wishing to leave the profession centred on promotion prospects. Second to this were health reasons, in particular psychological health, private life conflicts and difficult work conditions.

Long-term planning in the health sector is crucial given the importance of the social needs of the population and the imminent increase in demand. Variables affecting uptake in nursing are many and incentives, not merely financial, need to be worked out to stem dissatisfaction within the profession. The results of this comprehensive survey provide a sound basis for the strategic planning of a flexible, dynamic service to provide Europeans with the best possible health options.

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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

Early departure from nursing in France

Reasons for early departure from the nursing profession in France were examined in order to find solutions to lessen this expanding trend.

The shortage of nursing labour in Europe is likely to worsen over time with a large portion of nursing staff to leave the profession well before retirement age. In light of this growing problem, the 'Next nurses' exit study' project has delved into the causes for premature departure of nurses from health casework in primary and hospital care. Risk factors, risk groups and consequences of early departure were examined in eight European countries. One of these included France.

Since the occupational conditions in France vary greatly, five different regions were selected for a longitudinal study spanning the north and south of the country. Sample institutions of various types were selected from both the private and the public sector. Over-

all, it was found that the top three reasons for occupational dissatisfaction were psychological support, staff handovers when shifts change and physical working conditions. In light of the findings, it is evident that better working conditions are needed to prevent mental and physical disorders in staff. Furthermore team building and team support can play a vital role in reducing early exit.

At the backbone of disc problems

Tissue changes in spinal discs may reflect the mechanical strains they have to bear. A cell phenotype has been observed in intervertebral discs under severe mechanical pressure that may form an integral part in pathology diagnosis.

Degeneration of intervertebral discs is associated with severe back pain and chronic disability, particularly in the elderly. Not only does this mean a financial burden on

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European health services, but a patient's quality of life is severely downgraded. Reasons for the deterioration are multifactorial and may have their roots in genetics, lifestyle and changes in mechanical environment.

Histological studies are one means of gauging the changes in the disc structure due to disease and strain. Disc cell features like their morphology and cytoskeletal, or cellular scaffolding, composition may reflect changes in their surrounding matrix. A classic example of this phenomenon is that the presence of increased vimentin content in the cytoskeleton is associated with greater weight-bearing regions of cartilage.

A major aim of the EU-funded project Eurodisc was to examine the links between changes in the mechanical environment, tissue degeneration and associated pathologies. Specifically, the project research team based at the Robert Jones and Agnes Hunt Orthopaedic and District Hospital in the United Kingdom examined the detailed morphology of human intervertebral disc cells in diseased and non-diseased tissue.

Using confocal microscopy combined with labelling of the cytoskeletal elements, the scientists challenged the traditionally held view that there are two main types of cell in the disc. These are chondrocytic oval cells found in the soft centre and fibrocytic cells (elongated and polar) present in the tough outer section.

Both fibrocytic and chondrocytic cells were found in all intervertebral disc samples. However, a stellate form of cell was detected in both scoliotic and spondylolisthetic discs. This cell phenotype is characterised by multiple, branching cytoplasmic processes extending into the matrix. Previous research has suggested these extensions may 'sense' mechanical strain.

As this cell type is most probably associated with areas bearing abnormal load, the researchers recommended that the stellate structure be included in spinal disc cell phenotypes. These findings may contribute to the identification of genetic markers and early diagnosis for appropriate treatment.

Tagging DNA speeds up genome mapping

After genome mapping, the task of assigning a function to a gene using mutant phenotypes can be an expensive and time-consuming task. As an answer to this problem, a high-throughput single nucleotide fine mapping technique has been developed to map mutations rapidly and accurately.

In order to meet the rapidly increasing demands for high-throughput genomic sequencing, partners of the FLYSNP project based at Uppsala University in Sweden have developed a new technique, the tag-array minisequencing system (TAMS). This is a combination of the highly specific minisequencing method and a microarray format that permits multiple samples to be analysed simultaneously.

Genotype analysis is achieved using an ingenious method of tagging the single nucleotide polymorphisms (SNPs), sequences that vary by one nucleotide only. To achieve this, detection primers were designed to anneal directly upstream and adjacent to the polymorphic sequence under scrutiny. These primers are then extended with fluorescently labelled nucleotides that are complementary to the nucleotide at the SNP site. The tags then hybridise onto their corresponding cTag on the microarray thereby allowing genotyping of the SNP.

This tag-array minisequencing technique is simple, low-cost and yet can analyse up to 200 SNP positions in 80 samples simultan-

Disease-matching software could save children

By matching children with rare or life-threatening diseases and modelling potential disease progression, researchers hope to find new routes forward.

Software tools are being developed that can search and compare patient data at hospitals across Europe to find children with closely matched conditions. The doctors can then study how the matched patients at other hospitals were treated and whether that treatment was successful. The information will greatly improve doctors' ability to choose the right path for their own patient.

The tools being developed within the 'Health-e-child' project can compare a vast range of structured and unstructured data, including genetic and clinical data, as well as images from CAT and MRI scans and other records.

The 'Health-e-child' system, protected by high security, links anonymised databases of patient information at hospitals in Genoa, London, Paris and Rome. There are plans to extend the network to 25 hospitals.

'Health-e-child' researchers are working on tools for three complex paediatric diseases with at least partly unknown causes: heart diseases resulting from an overload of the right ventricle, juvenile idiopathic arthritis, and brain tumours (gliomas).

The EU-funded project has tackled fundamental data sharing infrastructural problems as well as ethical and data protection questions, data analysis and data mining issues. Both disease-specific and cross-disease tools have been developed.

For unstructured data such as images, the 'Health-e-child' project has created tools that translate visual information into machine-readable (and therefore machine-comparable) language. The project's 3D registration tool for MRI scans, and its MRI 'erosion scoring' system for juvenile idiomatic arthritis have been recognised as important advances in their fields.

'Health-e-child''s CaseReasoner tool enables clinicians to search thousands of disease diagnoses, treatments and outcomes to find a child similar to their own patients. The clinicians set the search parameters themselves. In the case of heart patients, clinicians could include factors they consider important, such as genetic markers, the age of the child, the heart rate — even the amount of exercise the child takes.

The results can be displayed as a 'network' with cohorts of patients with similar diagnoses clustered together and colour-graded accorded to the level of similarity. Clinicians can then dive into the detailed data on any of the patients or clusters to better understand their diagnoses and the success of the procedures the patients have been through.

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The CaseReasoner could also be used to search out the procedures that have been most successful, giving the clinician insights into the optimal path forward.

The Aition tool, being developed by 'Health-e-child' researchers at the University of Athens, seeks to go further. Aition will use semantic tools to search medical literature and interviews with clinicians as well as patient data. Drawing on well-established causal-probability algorithms, Aition will suggest probable disease development. Doctors using Aition will then be able to test their hypotheses on optimal treatment.

Other 'Health-e-child' researchers have combined a heart modelling tool called CardioWiz with MRI scan measurement software from Siemens, according to Siemens Healthcare's Martin Huber, technical leader of the 'Health-e-child' project.

The combination can rapidly generate animated 3D models of a particular patient's heart. The patient's doctors can play with the models and simulate the effects of heart surgery or drug treatments to see how the heart would respond.

The lack of research into child disease adds to the significance of 'Health-e-child', says Jörg Freund, from Siemens Healthcare and 'Health-e-child' project coordinator. Because the numbers of children suffering from these diseases are small, there is little incentive for commercial companies to research them. Some pharmaceutical companies calculate drug doses for children simply on weight — treating the child as a mini-adult. This fails to take account of important differences between children and adults. The most obvious difference is that children are growing.

Research on children can give important insights into the role of genetics in disease. Environmental factors can be less important in child diseases, simply because there has usually not been time in the child's short life for the environment to have had much effect.

Following their successes, the 'Health-e-child' researchers are publishing an exploitation plan mapping out how 'Health-e-child''s partners will take it forward.

This is the second of a two-part 'Health-e-child' special feature on ICT Results.

eously. The reduced cost is due to the parallel analysis and the small reaction volumes required. To analyse the large amount of information produced, software developed by the bioinformatics group IMP/IMBA translates the data into the genotype and presents the output in user-friendly graph format.

Dissemination of the technique and its applications in human genome research were a high priority for FLYSNP and the department of medical science, Medsci at Uppsala University. A practical approach included courses on TAMS offered both for visitors to the university and graduates. Globally, the comprehensive project website at http://flysnp.imp.ac.at provides full details of the TAMS technique together with links to the drosophila genome databases FlyBase and DrosDel.

Making feeding easier for a parasitic nematode

The biochemical relationships between plant parasitic nematodes and their host crops have been investigated to form the basis for research into developing sustainable resistance mechanisms.

The relationship between parasite and host is closely woven and many evolutionary adaptations are evident as a means to ensure the survival of both of the members of the partnership. Biochemical links between root knot and cyst nematodes and their hosts, the tomato and potato promote their coexistence. One classic example is that the nematode recruits plant proteins to degrade the cell walls and create modified structures within the plant for its very own feeding area.

Scientists working for the project Nonema aimed to turn the tables against the nematodes and harness these proteins as the basis of resistance to the parasite. They chose the expansins to investigate, a group of genes encoding proteins that reduce the enormous tensile strength of the cellulose cell wall. By loosening the links between the cellulose microfibrils, the cell wall yields to an increased pressure from within

the cell. The overall result is that giant feeding cells are produced by repeated nuclear division without cell cleavage.

The strong relationship between the host and the parasite is demonstrated by the properties of the expansin gene. Immunolocalisation techniques using polyclonal antibodies verified the link between expansins and the feeding site. The physical presence of the nematode was found to activate two of the identified expansin genes which it then hijacks to create the feeding area that is equipped with its own vascular tissue.

Further comprehensive details on the Nonema project can be found at the website http://nonema.uni-kiel.de. Information on resistance to nematodes relevant for all interested parties can be accessed. This includes nematode life history on video, publications,

biotechnology and related links. Developing resistance mechanisms is preferable to soil sterilisation with the attendant cost and damage to the environment. Data from this research can also be used to form the basis to improve genetic resistance of the many other crops affected by nematodes.

Animal feed clean-up using new chemical assay

Consumer concern regarding antibiotic additives in livestock feed is growing. To keep in line with European limits for these growth promoters, a highly reliable chemical assay has been developed by scientists based in Belgium.

Due to fears surrounding the use of antibiotics as growth promoters in the meat industry, some, including tylosin and avoparcin, have been banned from incorporation into animal feeds. However, the lack of effective assay methods meant authorities could not

adequately police the ban. To help enforce the regulations, the 'Feedstuffs-radius' project aimed to develop more specific tests that would also be not susceptible to feed component interference.

An unequivocal means of detection and quantification based on liquid chromatography–mass spectrometry (LC–MS) was developed by scientists at Ghent University in Belgium. The overall aim was for this technique to be used in a confirmatory capacity after other robust and highly specific assays. The team developed a series of procedures including the exact means of extraction, purification and elution and an end-capped column of high-purity silica. The method has been published in the analytic chemistry journal, *Analytica Chimica Acta*.

The process was fully validated for pig, poultry and cattle feed within Ghent University according to the standards set by the European Commission for the testing of residues in animal products. Concentrations detectable were half the advanced determined food residue limit. More credibility for the method was gained in a collaborative trial conducted in seven European countries involving 11 participants.

The mass spectrometry method developed by partners of 'Feedstuffs-radius' project has proved to be a highly reliable method specifically designed for five banned antibacterial growth promoters. Moreover, it is able to distinguish between cross-contamination at the mill and, for this purpose, the scenario whereby the substance has been added deliberately to the animal food.

Mapping milk production traits in dairy cattle

Studies into the genetic makeup of cattle have increased understanding of how traits affecting milk production are inherited. This information was gained through mapping the position of quantitative trait loci (QTL) on the bovine genome.

Scientists from the Hebrew University of Jerusalem developed a map of QTL affecting the percentage of protein in the milk of Israeli Holstein dairy cattle. Quantitative trait loci are stretches of DNA that are

closely linked to the genes which underlie the trait being studied. The researchers, working through the auspices of the Bovmas project examined four traits. These included milk and protein yield, milk

somatic cell count (MSCC) and female fertility.

The Bovmas scientists carried out a series of QTL mapping studies using female progeny from selected sires and selective DNA pooling techniques based on milk samples. The research team employed genetic markers, which acted as landmarks on the bovine

New starter for designer cheese

Research by a EU-funded project promises to take the uncertainty out of soft cheese manufacture. Use of a new routine to make designer starter packs delivers the desired cheese according to manufacturer's requirements.

Smear cheeses are unique in that the surface bacteria and yeasts help to give the cheese many of its properties including surface colour, taste and texture. Normal practice is to transfer the microbial mixture from an existing batch of cheeses to the next. This however carries the inherent risk of contamination, a very serious issue particularly when invaders such as listeria are concerned.

To avoid this situation, the EU-funded project SMEAR devised a method to concoct and test improved starters for application to the surface of the cheese. In particular, the aim was to provide better controlled production of red smear cheese, an important sector in the European market.

Action of the starter microflora makes use of their biochemical properties and the principles of intermicrobial competition and inhibition. Central to the starter ingredients list

are the yeasts that acidify the cheese. A delay in acidification can lead to increases in bacteria like *Escherichia coli* (*E. coli*). The role of the bacterial component is to encourage the characteristic red glow of the cheese, promote good sensory properties and inhibit moulds.

The project team based at Nizo Food Research in the Netherlands put together a trial routine composed of essential steps to ensure better process control. The method also serves as a platform on which to base the development of new starters. The smear mixture was to consist of five selected species, the identity of which depended on the type of cheese and the production environment.

Steps incorporated into the new routine include identification of the all important microflora together with their biochemical properties. At this stage, other selected microbes can be added to give further refine-

ment. After the application of pilot scale experiments for cheese production, the final blueprint can be applied to the manufacturer.

The outcome of this research is significant for both the small and large cheese-making concerns. It means safer cheese and increased consumer confidence. Furthermore, better controlled cheese-making means less losses and more income for the manufacturer.

The door for organic opportunities opens wider

A particularly in-depth survey of organic marketing initiatives has been conducted throughout Europe. Analysis of the data will pave the way towards maximum utilisation of employment and business opportunities in this dynamic market.

European regulations reinforcing production methods in line with conservation of the environment and maintenance of the countryside are having an impact. As regards the organic products market, one effect is that they have resulted in an expansion of the supply base. In order for all actors in the organic food production market to take full advantage of the changing agricultural scene in Europe, the EU-funded project Omiard aimed to develop successful marketing strategies. Consortium members achieved this through an in-depth examination of organic marketing initiatives (OMIs) at all levels.

Partners at the Institut national de la recherche agronomique in Haute-Garonne, France, obtained a uniquely comprehensive insight into OMIs. By interviewing managers as

well as external experts, the team collated valuable data for use in drawing up guidelines for all levels of the organic produce market. Altogether 67 case studies from 35 European regions were analysed, allowing for the huge diversity in market conditions within Europe.

The evaluation of the data showed that factors internal to organic businesses were much more likely to determine success than external determinants. A clear strategic plan based on economic foundations rather than environmental considerations tended to result in success for the enterprise. Perhaps not surprisingly, the downside to this approach was that aspects like regional networking, found to be a key success factor, could be neglected.

Overall, the most critical points were judged to be minimisation of logistics costs, such as transport and warehousing, and improving the supply of goods both in terms of quality and correct quantity. Because the supply base has been increased, modifications to improve the supply links and networking along the chain were recommended.

The expansion of more traditional organic methods is good news for rural areas with problems like population decline. Organic production is more labour-intensive and therefore particularly valuable in lagging peripheral areas of Europe. In the process, large areas of natural outstanding beauty supporting complex animal and plant communities can be conserved.

genome, resulting in the first complete map of the percent protein quantitative trait. The project's findings showed that the cumulative genetic variation can be explained through the mapping of QTLs.

Genes responsible for genetic variation in traits affecting milk production in the Israeli

Holstein dairy cattle population can be accurately mapped and cloned. The results can also provide the basis for a cost-effective marker assisted selection (MAS) programme, where a marker indicates the presence of a particular trait. The application of the findings by cattle breeders will result in rapid improvements in milk production and

quality to the benefit of dairy farmers and the rural economy.

Optimising plant cryopreservation

Plants not only provide abundant food; they are also the source of many compounds used in pharmaceuticals and crop protection. The EU-funded Crymcept project used cryopreservation techniques to help protect and maintain biodiversity so that species do not become lost to future generations.

European scientists investigated procedures for preserving collections of plant germplasm and the genetic resources which they contain. Within the framework of the Crymcept, they used cryopreservation for the long-term storage and preservation of germplasm material, which involved keeping plant cells or whole tissue at ultra-low temperatures. The technique halted all biological activity, including degradative reactions that lead to cell death. This was achieved by subjecting the plant material to osmotic or evaporative dehydration prior to cooling.

Crymcept project partners at the Institut de recherche pour le devéloppment in Montpellier, France, studied the thermal behaviour of water. This study was undertaken using differential scanning calorimetry (DSC) which provided the essential means to determine the best procedures for cryopreservation. Through the use of

DSC the researchers ascertained the optimal exposure duration to plant vitrification solution 2 which lowers water content, and furthermore alters the freezing behaviour of remaining water. They were also able to predict the optimal duration of desiccation over silica gel and drying in a sterile cabinet.

For all three processes DSC was used to minimise the risk of damaging ice crystals formed in plant samples when prepared for cryopreservation. On the other hand, knowledge of the water behaviour can reduce the number of trial-and-error tests needed for developing cryopreservation procedures for new plant germplasm types. By reducing the time required for the optimisation of new cryopreservation protocols, the introduction of new endangered species in

cryobanks of plant genetic resources will be accelerated. The conservation of plant species is essential for maintaining biodiversity and to the long-term success of the European agricultural and pharmaceutical industries and plant breeding programmes.

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Protein family p53 keep the cell under control

Cures for cancer can be found by unravelling the complex biochemical webs and pathways of the cell. To this end, scientists have investigated the effects of a key family of cell regulators, the p53 family.

In the fight against cancer, whether a cell progresses towards programmed cell death, otherwise known as apoptosis, can be the key to tumour control. Accordingly, the EU-funded Impaled project focused its research on one of the main directors of apoptotic pathways, the p53 family of proteins. The objective was to identify the causes of tumour resistance to apoptosis despite conventional treatments such as radiation and chemotherapy.

Cell cycle regulators like the p53 family have the potential to impact heavily on multiple targets. The p53 protein exists as several different isoforms, the first one discovered being p73. Over-expression studies can yield a wealth of information about a protein's role in cell development.

Project partners at EiRx Therapeutics Ltd in Ireland investigated the consequences when members of the p53 family were overproduced. Cell types used in the expression studies were the classic lines including the immortal HeLa cell line. The qualitative real time polymerase chain reaction (QPCR) was used to amplify and quantify DNA sequences. The scientists then employed microarray analysis to ascertain

whether the relevant genes were switched on or off.

The results of the study showed that the number of p53 affected genes was enormous. In a trial running for a day, cluster analysis showed that p53 members (excluding p73) were found to regulate a staggering 1 145 genes. By itself and tested for the same amount of time, p73 was observed to control the expression of another 175 genes.

Among its many functions, p53 can induce apoptosis through many different pathways. Functional studies performed during the trials however showed that contrary to expectations, some members of the p73 group were anti-apoptotic and protected cells from cell cycle arrest.

The identification of the pathways and the gene targets involved in p53 control could lead researchers down the path to novel cancer therapies. Moreover, the phenomenon of therapy resistant tumour cells could be explained through the altered action of regulatory proteins like p53.
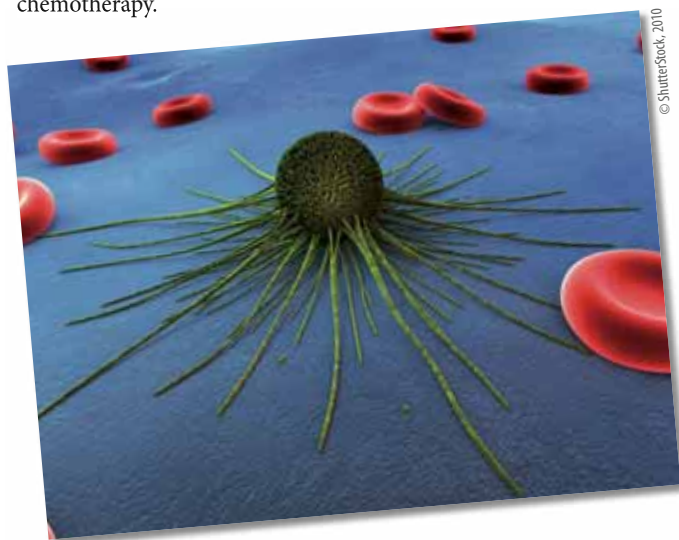
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'Vive la différence' in protein identity parade

The differential expression of proteins in cystic fibrosis (CF) patients could be part of the key to its cure. Researchers from an EU-funded project have developed a novel method to separate proteins from a CF cell prior to peptide sequencing.

The monogenic disease cystic fibrosis is normally characterised by the dysfunction of the key protein cystic fibrosis transmembrane conductance regulator (CFTR). The variation in severity of the disease in different individuals is due, to a large extent, to the role of the protein in many different pathways. As a result, the expression of the disease varies according to other genotypic and environmental factors.

The complexity of protein-protein interaction presented by CF makes it ideal for analysis by proteomics studies. An in-depth knowledge of the structure and function of the proteins involved in the molecular cascades could direct the research pathways to tailor-made therapy for each individual patient.

ProteoSys AG, a company based in Germany, are experts in proteomics-based research. As partners in the Europrocf project, one of their main aims was to adapt the analysis of proteins from cells of CF patients with the same mutation but presenting different phenotypes using an adapted version of high performance two-dimensional (2D) gel analysis.

The resulting method incorporates the labelling of two or more samples of protein with radioactive iodine isotopes. This has been incorporated into the ProteoTopeTM platform. A differential display of proteins is achieved including their splicing variants and resultant post-translational isoforms for proteomic analysis.

The differentially labelled proteins are mixed and separated while together in the sample by 2D polyacrylamide gel electrophoresis (2D-PAGE). Basically, this can be achieved as the ratio of the separated radioactive signal intensity coming from each radio-isotope can be determined.

Differential patterns of proteins present in diseases like CF have an impact on the drug discovery process. Furthermore, the ProteoTopeTM platform can be applied to other areas of proteomic interest including cancer research.

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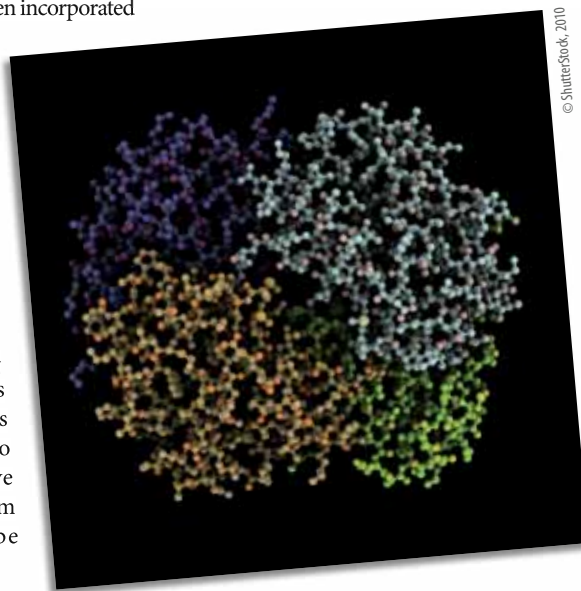
Combating iron overload

Iron, the component of supplements and fortified food, causes adverse effects both in excess and deficient supply. Research into the biochemistry of overload can lead to the development of more effective therapies for this condition.

There are two main genetic diseases that result in chronic iron overload — thalassaemia and hereditary haemochromatosis. These disorders lead to a variety of conditions including liver cirrhosis and cancer and cardiac atherosclerosis. The 'Nutrient iron toxicity' project aimed to identify the mechanisms behind iron toxicity and develop effective therapies to prevent the effects of iron overload.

Project partners at the Swiss Federal Institute of Technology investigated the precise molecular mechanisms of iron toxicity. The basis of the harmful action of iron occurs when, in the second valency state, it reacts with hydrogen peroxide. This in turn yields reactive radicals that are damaging to cell structures.

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Nitrogen oxide (NO) is known to inhibit redox cycling by slowing the rate of oxidation. NO forms complexes with iron (II) dithiocarbamate and its concentration can be monitored using electron paramagnetic resonance (EPR).

The researchers investigated whether these iron dithiocarbamate complexes could still enable redox cycling. Meas-urements using cyclic voltammetry revealed that the complexes could indeed allow efficient redox cycling. Furthermore, NO inhibited production of the free radicals.

Another detrimental effect of iron is that it also catalyses the decomposition of nitrosothiols that play a role in the modulation of vascular tension. The team investigated the mechanism of s-nitrosothiol degradation by monitoring the EPR and optical features of the complexes formed during the decay.

The scientists also researched the action of chelating agents that bind to the iron for its removal. They tested different concentrations of chelating agents, in particular CP20 (deferiprone, used to treat thalassaemia), to complex the iron for its removal. However, at very low concentrations of iron and excess agent, the iron is not fully bound to the chelator.

The molecular mechanics of iron metabolism can aid in the development of diagnostic tests. Furthermore, it can be used to test and improve the action of novel chelators.

BIOLOGY AND MEDICINE

Iron and atherosclerosis link

Iron overload, whether acquired in the diet or through a genetic predisposition, can be the cause of organ damage. European researchers have focused on finding out how excess iron may be one of the causes of atherosclerosis.

Partners in the EU-funded 'Nutrient iron toxicity' project aimed to elucidate the role of iron in toxicity and to develop appropriate chelating agents for effective therapy. In particular, the role of iron in inflammatory processes such as atherosclerosis was a main focus.

Previous research has pointed the finger at monocytic action as the main instigator of atherosclerosis. The crux of the research by project partners at the Universitair Medisch Centrum in Utrecht was to see if there was a link between iron surplus and the interactions of monocytes at the vascular endothelium.

The action of monocytes revolves around two main phenomena, rolling and diapedesis. Rolling is the initial attachment occurring before stable adhesion of monocytes to the endothelial layer of capillaries. After this, diapedesis can occur when the white cell can squeeze between the cells of the capillary lining across to the site of tissue inflammation.

To ascertain the extent of monocyte-endothelial interaction, the team measured rolling using a physiological flow model and diapedesis by an *in vitro* migration assay. Surface proteins involved and radicals at the inflammatory site were measured using flow cytometry. The activity of monocytes at different iron levels and the effect of iron-loading monocytes were recorded in the trials.

Overall, iron-enhanced monocyte adhesion. Moreover increased adhesion was evident when using iron-loaded monocytes. Evidence suggested that iron affected a range of endothelial receptors and also encouraged the accumulation of oxygen-derived radicals, a precursor to inflammation.
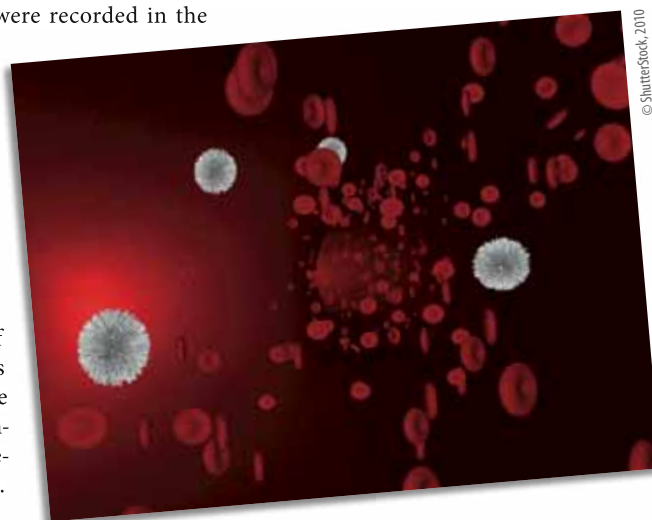
The results of the research point to an immunomodulatory role for iron in inflammation leading to diseases like atherosclerosis. On a positive note, the scientists found that chelation therapy reduced both iron-induced adhesion and diapedisis.

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Mapping for mastitis resistance

Faced with costly treatments and reduced prices for milk, the farmer pays a high price for outbreaks of mastitis. Mapping of relevant quantitative trait genes will mean that sustainable resistance mechanisms against the disease could be incorporated into dairy herd populations.

The milk industry is a valuable component of the European agricultural economy as it accounts for almost a fifth of the total income from production. Mastitis is the most common cause of illness in dairy herds. It can have devastating effects on the cows themselves not to mention the farmer's income as milk production may be seriously affected through culling or at best, a halt in milking.

Control measures such as improved husbandry and vaccination programmes can make big inroads into tackling the disease. As for a genetic approach, the heritability of the disease is low and selection for resistance traits is difficult. Consequently, breeding programmes that incorporated mastitis resistance have largely been absent.

However, data from northern European countries had amassed on genetic resistance in Nordic populations of cattle. Consequently, the EU-funded 'Mastitis resistance' project aimed to fine map the loci involved in variation for mastitis resistance. This way, breeding programmes for introgression of quantitiative trait loci for mastitis resistance can be designed.

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As part of this initiative, scientists at the Roslin Institute in Scotland focused on the bovine chromosome nine (Bos taurus 9 — BTA9). The mapping of microsatellite and expressed sequence tag (EST) markers was an extension of work done previously at the same laboratory. Under the auspices of the 'Mastitis resistance' project another 100 markers were added to chromosome BTA9.

The radiation hybrid (RH) mapping technique, suitable for fine mapping due to its accuracy in placing markers over short distances was used. As a first step, the markers were clustered into linkage groups. These linkage groups were then identified using the genetic mapping software Carthagene specially developed for RH mapping.

The use of breeding programmes as an extra weapon in the fight against mastitis means sustainable resistance mechanisms against the disease. This will help to strengthen a health-orientated animal production system. Furthermore, it can stem the increasing levels of antibiotic resistance resulting from repeated doses administered in an attempt to control the disease.

Safer, more efficient plasmid DNA extraction

A novel method for the isolation of plasmid DNA provides an alternative to the use of solvent purification systems for screening genes found in aquaculture sites for antimicrobial resistance.

Antimicrobials are natural or synthetic drugs which inhibit or kill bacteria, making them unique when it comes to controlling deadly infectious diseases. Following their success in human medicine, antimicrobials are also used for the treatment of bacterial diseases in animals and plants.

This is particularly the case in south-east Asia where the aquaculture industry is a predominant segment of livestock production. To date there has been little information available on the type and amount of antimicrobial use in fish farms; hence, the assessment of possible health risks remains a challenge. One such potential risk is the development of antimicrobial resistant bacteria caused by the release of antimicrobials into the environment, compromising human health as well as future productivity.

In light of this, the Asiaresist project examined the probability of the incidence of transferable antimicrobial resistance genes in south-east Asian aquaculture. The aim was to pinpoint critical control points (CCP) at which fish farmers can utilise monitoring systems to avert or eradicate safety hazards posed to food and the environment.

As part of these efforts, a method for the mini-preparation of plasmid DNA from bacteria found in aquaculture sites was improved. This small-scale isolation of plasmid DNA relied on alkaline lysis and permitted the extraction of high molecular weight plasmid DNA. Plasmid DNA consists of a ring of DNA that is not in a chromosome but is capable of autonomous replication. It is often used to purify a specific sequence because it can be easily purified away from the rest of the genome. Consequently the use of commercial DNA purification columns and hazardous solvents could be avoided.

Given these features, the method provides an efficient and cost-effective means to screen for plasmid DNA. Furthermore it is suitable for other bacterial groups having different bacterial growth conditions.

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Chemical counterfeit countermeasures

Coming up with a foolproof way of beating pharmaceutical patent pirating has up to now proved difficult. In response, researchers have developed a tagging method based on metabolisable molecules to protect against counterfeit chemical products.

Counterfeiting and patent abuse are big business in the pharmaceutical industry. Together, they pose a big threat, both commercially and financially for the producer in Europe. Not only that, but consumer safety may be put in jeopardy, particularly with the advent of internet pharmacies.

In order to prevent piracy and counterfeiting, isotopic techniques can be used to determine whether a molecule has been produced according to the patented process. In addition, chromatographic protocols can be applied to detect impurities and their sources.

However, there are broadly two ways the counterfeiter can circumvent these controls. Firstly, if the pathways and organisms are very similar, they may be isotopically indistinguishable from the patented route. Also, when impurities hail from the feedstock or culture medium, an inconsistent impurity profile may result.

Researchers in the appropriately named EU-funded Counterpharm project have developed a protocol whereby these 'loopholes' can be closed. Basically, the product can be tagged by introducing a small known amount of ferulic acid at the feedstock stage. As a precursor to vanillin it will then be metabolised to produce the synthetic flavouring normally used to replace natural vanilla.

This applied biotransformation process has been tested in a paracetamol production trial and was confirmed as a unique traceable tag. Not only does it serve as a recoverable metabolisable chemical tag but it is a cheap alternative to the use of expensive isotope-based tracers.

Perfumes, agrochemicals and cosmetics can also be tagged with a manufacturer's chemical signature. As such, this anti-counterfeit method will help make possible the elimination of product fraud to safeguard the rights of both consumers and industry.

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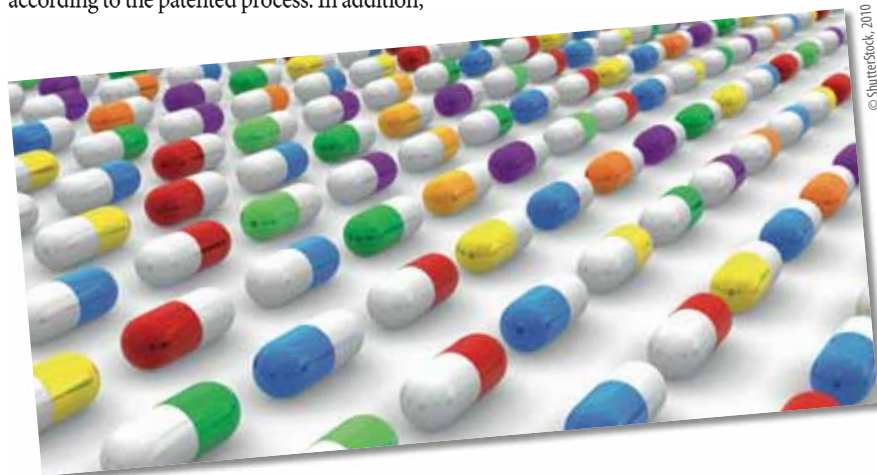
Monitoring endocrine disruptors in humans and fish

The results of an investigation into the presence of endocrine disrupting chemicals in humans and fish have been united in a single, highly valuable database.

The health threat associated with endocrine disrupting chemicals (EDCs) is real. Unfortunately, to date only a very limited amount of data about actual EDC concentrations in human tissues has been collected. Seeking to address this shortfall, the 'Life quality' programme funded the EDEN project.

The University of Granada in Spain, a member of the EDEN consortium, oversaw the sampling of tissues from both human and fish populations. They looked at a wide range of EDCs, including chlorinated compounds, biphenyls, dioxins and furans, steroids and phytoestrogens.

The study initially focused on Spanish females affected by breast cancer that had recently been operated upon. Multiple samples were obtained over an 18-month period. Comparison with control groups revealed a relatively high frequency of detectable levels of the aforementioned EDCs.

The next phase involved tissue collection from young children and subsequent analysis. Remarkably, the University of Granada found that the weight-corrected cumulative levels of EDCs in children were often as high as those of adults. One potential pathway for early EDC exposure is breastfeeding. It was suggested that supplemental data should be collected in order to fully examine the role of breastfeeding as well as other possible mechanisms.

Finally, the adipose tissues of fish were analysed for the same EDCs. These results, as well as those for the human tissues, were combined into a single database, which represents a significant body of EDC tissue research.

Endocrine disrupting chemicals and sticklebacks

A standard operating procedure developed in the United Kingdom will help standardise the way in which researchers test the impacts of endocrine disrupting chemicals on fish.

Over 20 leading research institutes spread throughout 10 European countries participated in the EDEN project. One of the objectives of EDEN was to harmonise endocrine disrupting chemical (EDC) research across Europe. A key deliverable was a standard operating procedure (SOP) for testing the response of the stickleback species of fish to EDCs.

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in the United Kingdom was responsible for the creation of the SOP together with other members of the EDEN consortium. Once the SOP was established, CEFAS also played a central role in its application to evaluate the risk associated with a number of EDCs.

Partners working at CEFAS cultivated the sticklebacks, contaminated their host water with oestrogens and subsequently removed their heart and kidneys. CEFAS then measured the amount of vitellogenin and spiggin, two molecular markers of oestrogenic EDC exposure, in these tissues. Finally, the host water was submitted to CEFAS for determination of the initial oestrogen concentrations. In this way the toxicity of oestradiol (E2), ethinyl oestradiol (EE2), oestrone (E1) and nonylphenol (NP), was evaluated.

Supplementary tests were carried out which demonstrated the validity of the SOP. In addition, CEFAS was able to define the radioimmunoassay curves and extraction protocols needed to derive exposure rates for E2, EE2 and E1. Peer review journals published the results of many of the experiments performed during EDEN including research involving the stickleback.

Microsporidia — biomolecular detection in bumblebees

Europe is the world leader for breeding bumblebee colonies and supplying them to farmers for the pollination of crops. This success has been protected by a new genetic technique that can quickly and effectively identify the infection of colonies by parasites.

The use of bumblebee colonies for the pollination of crops is an extremely important and environmentally friendly agricultural activity. However, the wellbeing and diversity of these pollinators can be threatened if parasites are introduced when the bees are transported to new geographical locations. The microsporidian parasite *Nosema bombi* (*N. bombi*) has been identified in bumblebees and was the subject of a detailed study by the 'Pollinator parasites' project.

The parasite can enter a colony through a number of different routes, including the introduction of queens taken from the wild for breeding purposes. Infection can also occur when bumblebees return from pollinating crops. An additional route is through the feeding of colonies with material con-

Identifying resistance to fungus in faba beans

Faba beans were analysed and their sources of resistance to the fungus **Ascochyta fabae** *were identified and characterised. The aim was to improve the crop's resistance to disease.*

There is an increasing awareness for the need to develop sustainable farming systems in Europe. The reintroduction of legume crops can promote diversity and reduce reliance on chemical fertilisers and pesticides. The Eufaba project was a European initiative which combined marker assisted selection and conventional breeding methods to create enhanced faba bean genotypes. A key element of the project was the improvement of plant health by reducing a crop's susceptibility to pathogens.

Scientists working at the University of Cordoba randomly selected 484 faba bean accessions and screened them for resistance to the fungus,

Ascochyta fabae. The researchers then chose those plants with the least damaged leaves and a pod scale value of two or less, which was the limit for resistance. Once the best plants were selected they were used to form the basis of the Eufaba-*Ascochyta*-ring test.

During the first and second year the 20 best genotypes were selected and evaluated under different environmental conditions. It was found that three quarters of the genotypes maintained a good level of resistance, with the fungus scoring lower than 10 % on leaves. They were also tested against different isolates of the pathogen.

Researchers detected differences in the aggressiveness of the isolate between crop areas. As a result new sources of resistance to *Ascochyta fabae* were sought in each area. Scientists also observed a degree of interaction between the genotype resistance and the isolate, suggesting the existence of pathogenic variability in the relationship between the fungus and its host. The Eufaba project also developed a technique, based on fluorescent microscopy, for viewing the development of *Ascochyta faba* within the plant.

Locating faba bean resistance to disease

*Gene mapping was carried out for faba bean (*Vicia faba*) to identify desirable breeding and quality characteristics. This information was used to improve crop health through increased resistance to plant pathogens and parasites.*

Work was undertaken to address the lack of plant protein produced within the EU. A joint European initiative was established to improve faba bean genotypes. Scientists sought to develop those genotypes which possessed characteristics important to sustainable agriculture. This was achieved through a combination of marker assisted selection and conventional plant breeding techniques.

Researchers from the Eufaba project developed molecular maps for the faba bean. They were used to locate the genes and quantitative trait loci (QTLs) which control resistance to the parasitic plant, broomrape, and the fungus, *Ascochyta fabae*. Researchers also studied the stability of QTLs across a range of locations and genetic backgrounds in order to identify and develop specific biomarkers. The markers were then used for gene pyramiding, where two or more genes

can be selected at a time, and for carrying out rapid screening.

The first step involved two existing populations of faba bean, which were segregated for broomrape and *Ascochyta* resistance. A linkage map and a molecular map were then created. The information was used to outline a genetic map for utilisation as a reference in QTL analysis. The map comprised random amplification of polymorphic DNA (RAPD) markers, microsatellites, seed protein genes, and expressed sequence tags (ESTs) from the model plant *Medicago truncatula*.

Resistance to broomrape was evaluated using recombinant inbred lines (RILs) derived

from populations from two different years and locations. This enabled researchers to detect the QTLs which controlled the trait. The QTLs associated with resistance to *Ascochyta* blight were then identified through the use of composite interval mapping (CIM) analysis.

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'Microsporidia — biomolecular detection in bumblebees'

taminated by microsporidia spores. Infection by *N. bombi* has a negative impact on the development and vitality of colonies and their ability to carry out pollination, and on the rearing of new queens. Because there is no known cure for the disease, infected colonies are destroyed to avoid further contamination.

The research team recommended that bumblebee colonies should be examined every four weeks for any signs of *N. bombi* or

other parasites and diseases. This enables the early detection of any infection, thereby preventing a major outbreak. The scientists from the 'Pollinator parasites' project developed a genomic tool for the detection of *N. bombi* based on the polymerase chain reaction (PCR).

The PCR tool produced multiple copies of fragments of the microsporidium's ribosomal RNA (rRNA). This method was superior to the conventional technique of

using a light microscope when spores can be overlooked or misidentified. The use of molecular detection provided an analytical technique that was fast, accurate, cost-effective and capable of identifying all the developmental stages of *N. bombi*.

BIOLOGY AND MEDICINE

Providing Morepower to portable fuel cells

New electrocatalyst materials identified during the Morepower project have the potential to substantially boost the performance of today's portable fuel cells.

Fuel cells have been touted to replace fuel tanks filled with fossil fuels in the not so distant future. Turning this dream into reality will require considerable advances in fuel cell technology. Experts from nine organisations spread throughout Europe gathered in the framework of the Morepower project with the intention of making significant progress toward improving efficiency.

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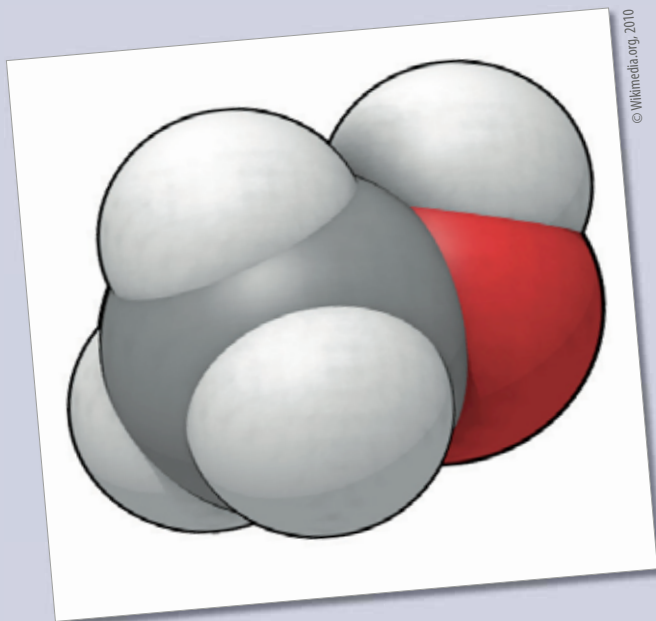
The partners focussed on direct methanol fuel cells (DMFCs), which are appropriate for portable applications due to their relatively high power density. The challenge was to construct a DMFC capable of operating at low atmospheric temperatures and pressures.

Emphasis was placed on optimising the selection of electrocatalyst materials for the anode and cathode. Experiments revealed that catalysts constructed from platinum and ruthenium delivered the best oxidation activity for methanol at the anode. Additional gains were made possible by the use of carbon support.

With respect to the cathode, the goal was to increase oxygen reduction activity. Tests with a number of different materials were performed. The best results were achieved with a combination of platinum and iron. By paying special attention to the catalyst's morphological properties, the scientists involved in Morepower were also able to limit the loss of methanol to the crossover phenomenon.

During the project, colloidal preparation procedures were employed to produce both the anode and cathode catalysts. Incorporating the new catalysts into DMFCs promises to open up a new range of applications where portability is required.

Low-cost membranes to play key role in fuel cell development

The success of portable fuel cells in niche applications can open the market for the fuel cell industry in Europe. Research by the Morepower project promises to improve the performance of compact fuel cells with potential use in weather stations, medical devices and gas sensors.

The EU is committed to a sustainable future for Europe and has funded research into environmentally friendly means of supplying power. One such initiative is the Morepower project, which has developed a compact portable power source that can produce electricity from chemical energy.

The direct methanol fuel cell (DMFC) is expected to take a leading role in replacing conventional fossil fuel-based power systems with more sustainable forms of energy supply. The cell uses methanol as fuel, a stable, energy-dense liquid that can be simply and cheaply produced on a large scale from biological material. Unlike fossil fuels, the only waste products produced are CO_2 and water.

Researchers from the consortium developed a cost-effective, low-temperature transportable device, which represents a major research challenge requiring a highly innovative approach. In addition, they investigated new low-cost proton-exchange membranes containing large numbers of proton-exchange sites and an extensive cross-linked core structure.

Modifications were made to membranes to limit permeability to methanol while maintaining proton conductivity. Laboratory test findings showed similar results for the different novel membranes with a maximum power density of around 85 mW/cm^2. This compared well to the target of 100 mW/cm^2 set by the project. The Morepower team also carried out studies into multilayer membrane electrode assemblies which were manufactured by project partners on a micro-pilot scale.

The benefits of an enhanced membrane material include better proton conductivity and thermal stability while reducing the crossover rate of methanol. These improvements enable more power to be packed into a smaller space making DMFCs suitable as an energy source for stand-alone units such as auxiliary power units and security devices. Furthermore, DMFCs have no moving parts which render them more reliable and cheaper to maintain than conventional electricity generators.

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Resolving the operational challenges of microgrids

Researchers with the Power Systems Unit of INESC Porto developed and tested a number of control measures designed to resolve specific problems associated with the operation of microgrids.

Microgrids entail the connection of multiple, smaller energy producers to the energy distribution network. Microgrids are critical for the adoption of renewable energy sources (RES) and can contribute to increasing energy production, efficiency and reliability while reducing greenhouse gas emissions.

Microgrids are not without their challenges, especially the issue of load-following which seeks to match energy production as closely as possible to energy demand. The Microgrids project received funding from the EESD programme to investigate solutions to load-following and other operational concerns.

Scientists with the Power Systems Unit employed computer-based simulations to facilitate the development of control strategies. The set-up included several microsources connected to a low voltage (LV) network that could be operated either in an interconnected or autonomous mode.

Experiments carried out during the three-year project indicated two viable options for controlling inverters, one of the most critical system components in microgrids. The solutions involved the use of inverters controlling active and reactive power (PQ) control and voltage source inverter (VSI) control logic.

In addition, various approaches to the issue of energy storage, a prerequisite for islanded operation, were studied in detail. The answer was to use a VSI to provide reference voltage information in the absence of the main network, although this required synchronisation. If two or more inverters were used, the synchronisation issue could be eliminated.

Storage devices are susceptible to overloading following islanding, thus it was necessary to create a load shedding scheme. Additional load-frequency controls were also put in place to stop the storage devices from flooding the network in case of frequency deviation.

The team from INESC Porto devised a number of scenarios to assess the new control measures. Factors such as load and generation were varied while both forced and intentional islanding were implemented. The simulation results indicate that microgrids are viable when the measures are applied.

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Restoring microgrids to operation following blackouts

Concerns regarding how to successfully restart microgrids following power failures have been put to rest thanks to a new black start function devised by electrical engineers with INESC Porto in Portugal.

Following blackouts, special procedures known as black starts must be implemented to quickly and safely restore power. This includes the restart of low-voltage (LV) networks connected to the main grid that did not manage to switch to an islanded mode of operation during the blackout.

Experts with the Power Systems Unit of INESC Porto have developed a black start mechanism designed especially for microgrids, LV networks containing several small sources usually based on renewables. The research was supported by the EESD programme in the context of the Microgrids project.

The step-by-step process relies on the main components of the microgrid control and communication systems, namely the microgrid central controller (MGCC),
microsource controller (MC) and load controller (LC). The process of bootstrapping the network entails connecting sources and loads while regulating voltage and frequency. In order to deal with the slow response of some of the microsources, the INESC team recommended the inclusion of energy storage facilities to shorten the time required to restore the network.

The performance of the black start mechanism as well as a procedure defined to reconnect to medium voltage (MV) networks was evaluated during the Microgrids project. Computer simulations using a platform based in MatLab/Simulink, combined with a specialised software tool addressing fast transients were essential during this phase of the project.

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Scientists set new record for solar cell efficiency

Researchers at the Fraunhofer Institute for Solar Energy Systems (ISE) in Germany announced that they have succeeded in improving the efficiency of solar cells, which are designed to convert available light into electricity. The quantum electronic phenomenon called the photovoltaic (PV) effect makes this possible.

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Spectacular success has been reported by the Fullspectrum project team in that the effectiveness of III-V semiconductor multi-junction solar cells, used in PV concentrator technology for solar power stations, has been increased by 2.1 % to 39.7 % — a new European record. The work was funded to the tune of EUR 8.34 million under the Sixth Framework Programme (FP6) Fullspectrum project.

The project's short-term objectives included the development of multi-junction (MJ) solar cells with very high efficiency, while long-term goals included the evaluation of intermediate band (IB) solar cells as a revolutionary high-efficiency concept. According to the researchers, the IB cell is based on the presence of electrons at three energy levels and in the electron pumping with two photons, contrary to two levels and one photon.

Project leader Dr Frank Dimroth explained that the team succeeded in improving the contact structures of the solar cells. 'As a result, using the same semiconductor structures, we now achieve the higher efficiency when converting sunlight into electricity,' he said.

When light strikes the cell, some of the light is absorbed within the semiconductor material. Essentially, the energy of the absorbed light is transferred to the semiconductor. According to the research team, the optimal efficiency of MJ solar cells must be secured between 300 and 600 suns in order to be used in PV concentrator systems. In other words, there must be a sunlight concentration factor of 300 to 600.

The metallisation of the front side of the solar cells yields different concentration factors. In the front grid, the current is conducted through a network of thin wires from the middle of the solar cell to the edge where a 50 micrometre gold wire picks it up, the research team explained.

The structure of this metal network is important, they said, adding that this is particularly true when the structure is under concentrated sunlight. The metal wires should have the capacity to transport the sizeable currents produced under concentrated sunlight; low resistance is needed for this to pan out.

On the flip side, the wires need to be tiny so as to ensure that the sunlight does not penetrate through the metal. As a result, the metal-covered cell area is not an option when contemplating which element to use in electrical conversion.

The Fraunhofer ISE researchers started working on the theoretical calculation of optimal contact structures in 2006. The team succeeded in reaching a solar cell efficiency of 37.6 % in July 2008. The team's findings represent a great step forward in the development of more cost-efficient applications for these types of cells in terrestrial applications.

'We are very pleased to have advanced a further decisive step in such a short amount of time,' remarked Dr Andreas Bett, Department Head at Fraunhofer ISE. 'Highest conversion efficiencies help the young technology to become market-competitive and to further sink the costs of generating electricity from the Sun for the future.'

The research team explained that they have been working on MJ solar cells with highest efficiencies for over a decade. However, high material and production costs restrict their use to PV systems and space applications only.

While no practical high-efficiency cells based on this concept have yet been generated, their experimental results have been fruitful and researchers the world over are keen to carry out studies on this concept, the project partners said.

A key component of Fullspectrum was its cooperative research nature, fuelling research and creating programmes in various countries, including Japan and the United States. The EU is a leader in cooperative research, a trend triggered primarily by the need to integrate European scientists.

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The future for solar energy is Crystalclear

European scientists have achieved world firsts in the photovoltaic (PV) field, making energy production using the Sun more efficient and sustainable. Could this be what the EU needs to meet its 2020 sustainable energy targets?

Europe's long-standing commitment to solar energy has resulted in a narrowing of the gap between performance in the laboratory and energy efficiency in the latest PV installations which convert the Sun's energy into power.

The timing could not be better as EU energy policy targets for 2020 — a 20 % reduction in greenhouse gas emissions with the same percentage increase in the use of renewable energy sources — are looming on the horizon.

Determined to build on Europe's already strong track record in PV research, partners in the EU-funded Crystalclear project set their sights on ways to mainstream this promising, but economically still immature technology. But to do this, the 16 partners from leading companies and research organisations across Europe realised that new materials and more efficient production methods would be necessary.

With the help of EUR 16 million in EU funding, they developed exactly that, cutting the unit costs to produce a PV module from more than EUR 2 per watt-peak to EUR 1 by improving the conversion efficiency — how much power is produced at a given intensity of sunlight — to a world-record value of over 16 %, by reducing the consumption of materials and by introducing elegant new designs of solar cells and modules. At this cost and efficiency, PV moves even closer to the cost of electricity currently paid by the consumer, a situation called 'grid parity'.

The Crystalclear scientists screened new sources of high-purity silicon, or so-called feedstock, in search of solar grade (rather than electronic grade) silicon, which has an optimised cost/performance ratio for use in PV cells. The solar grade silicon was crystallised and cut into wafers, which in turn were processed into cells. The performance of the cells is the key indicator of the quality and usefulness of the feedstock.

The team produced super-thin wafers — half the usual thickness — weighing in at just 120 micrometres to reduce the consumption of silicon and thus the cost of cells. Crystalclear developed special cutting processes — where wafers are literally 'sawn' off a large crystal ingot — with reduced kerf losses, further reducing net silicon consumption and cost.

Module design and manufacturing was also an important feature. Rear-contact cells were used to achieve potentially higher efficiency by moving all or part of the contact grids to the rear of the device. This resulted in less shadow on the front of the cell but also enabled a new module assembly process, based on gluing rather than the usual soldering for electrical interconnection of cells. This assembly process was a perfect fit ultra-thin cell, avoiding mechanical stresses and breakage.

Although PV solar modules are by definition a fully renewable energy technology, an important measure of their environmental sustainability comes down to the amount of energy used during manufacture and the recyclability of components. The Crystalclear team fulfilled the objective to reduce the energy input by a factor of two and successfully demonstrated recovery and recycling of silicon and cells from modules.

Thanks to European solar energy research, the EU may now have the edge both in industrial applications and on the electricity markets as it moves ever closer to grid parity. And looking to the future, EU energy policy targets could well move a step closer to reality.

The optimal potential of fuel blending

Emission of toxic metals from industrial combustion plants can be reduced through the use of a modified fuel blending strategy.

In line with supporting EU policy to lessen CO_2 emission, the use of fossil fuels in the field of heat and power production has been reduced. Biofuels are thus being exploited as viable power generation alternatives. However their use has a negative impact when it comes to combustion conditions, leading to the volatilisation of elements and particle formation. Examples include toxic metals (ToMes) such as lead, chromium, cadmium and particularly mercury which are altered within compounds they have formed due to oxidation, reduction and sorption.

In light of this, the Tomered project has pinpointed behavioural changes that occur in the course of ToMe emission during the (co-) firing of bio fuel/coal fuel blends. Furthermore the means for creating and analysing ways to lessen these emissions with fuel blending and the use of low-cost sorbents and multi-pollutant cleaning systems was sought.

The answer to this pursuit lies in primary measures such as the utilisation of fuel blends with low ToMe emission; thus, major process modifications and additional equipment can be eliminated. The fuel blends were evaluated for interactions and in turn the results of those tests were used for fuel blending protocols.

This fuel blending strategy has promising potential thanks to being cost-efficient as well as versatile with respect to its applicability with various fuels such as coal and biomass/waste.

ENERGY

Estimating Europe's carbon dioxide fluxes

Climate change is one of the greatest challenges facing the world today. The Kyoto Protocol attempted to address the problem by trying to maintain greenhouse gases at a level where they cannot disrupt the climate. The Camels project was established to help EU Member States meet their obligations under the Kyoto agreement.

The treaty allowed some countries to partially offset their CO_2 emissions against carbon accumulated as a result of changes in land use and forest management. However, the reporting of CO_2 sources and sinks must be transparent and verifiable in order for the system to work.

The 'Carbon assimilation and modelling of the European land surface' (Camels) project measured atmospheric transport and terrestrial carbon uptake. The information was used to optimise parameters on the stand scale. In addition, consistent uncertainty bounds on carbon fluxes were produced. The parameter

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values were applied to the prototype carbon cycle data assimilation system (CCDAS).

The CCDAS was based on the biosphere energy-transfer and hydrology (BETHY) ecosystem model. The BETHY model used information from satellites to determine optimised values for water status, seasonal changes and total plant cover. The BETHY model was improved by combining the data with atmospheric CO_2 concentration observations. The prototype CCDAS and optimised BETHY model were used to gain greater insight into the processes behind the current terrestrial carbon sinks. This was achieved while isolating the contribution from direct land management.

Results indicated that changes in terrestrial CO_2 fluxes were mainly due to the El Niño southern oscillation. However, long-term CO_2 flux indicated a large uptake over the northern hemisphere and tropical regions. This was partly compensated for by the high levels of background CO_2 originating from changes in land use. The researchers found that the European terrestrial sink, excluding Russia, was about a third of the regions fossil fuel emissions. The findings by the Camels team showed that climate change does not respect international borders and must be tackled at a global level.

Improving estimates of surface emissivity over the poles

Scientists at the University of Bremen in Germany successfully demonstrated that satellite data can be used to determine critical atmospheric parameters when surface measurements are unavailable.

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It has been predicted that the effects of climate change may be felt the most at the Earth's poles. Unfortunately, both current and historical meteorological data for these remote regions is extremely limited. This has provided significant motivation to exploit Earth observation (EO) data collected by satellites.

Atmospheric physicists with the University of Bremen coordinated a multinational research effort aimed at delivering new EO products for polar regions. During the project, entitled Iomasa, a novel algorithm was developed to produce estimates of surface emissivity from advanced microwave sounding unit (AMSU) radiometers aboard National Oceanic and Atmospheric Administration satellites.

The first step involved initiating a radiative transfer model with upper air data from the European Centre for Medium-range Weather Forecasts. The predicted atmospheric brightness temperature was then compared against the actual brightness temperature recorded by the AMSU, after which the surface emissivity could be properly determined.

Surface emissivity is an important component governing the Earth's energy balance. Therefore, more accurate estimates of this critical variable, particularly over the poles, could help improve the performance of global climate models.

Studying microbial biodiversity in Europe's seas

Scientists involved in the Basics research project developed a new theory explaining why some species of marine microorganism flourish while others flounder.

Despite their microscopic size, microorganisms are known to play an important role in the cycling of nutrients, such as carbon and sulphur, in the world's oceans. The health of marine ecosystems is also strongly dependent upon functions performed by these tiny inhabitants.

The EESD Programme funded a group of universities and research institutes spread across Europe to study levels of biodiversity in marine microbial communities. In addition to collecting data regarding the different types and relative populations of microorganisms, an effort was also made to understand the factors governing biodiversity.

The research was led by experienced marine microbiologists with the University of Bergen in Norway. To their surprise, they discovered that traditional theory, which favours smaller species due to their ability to better capture limited nutrients in the sea environment, does not always hold true.

In fact, it became apparent that osmotrophs, species that absorb their food across cell membranes rather than digesting it, could obtain a competitive advantage in certain conditions. They found that large bacteria benefited from carbon-rich environments while excess silicon facilitated the growth of diatoms. Furthermore, increased size helped reduce the threat from predators such as microzooplankton.

This research may provide important insight into how these microorganisms will fare as the composition of the Earth's oceans is modified by global climate change.

The role of biodiversity in the health of marine ecosystems

A better understanding of how microorganisms help keep marine ecosystems healthy is imperative in light of the way human interference is altering the environment, often for the worse.

Single-celled microorganisms such as bacteria and Archaea play an important part in the cycling of carbon and sulphur in the oceans. The role of species biodiversity in this and other marine ecosystem processes is not well understood. Several leading research institutes combined forces during the Basics project to shed some light on these matters.

One of the participants, the Centre national de la recherche scientifique (CNRS), spent one and a half years exploring the Bay of Villefranche off the southern coast of France. They found considerably high levels of biodiversity. In fact, nearly 30 different phylotypes were identified.

Cluster analysis, a powerful statistical tool, was used to group the phylotypes according to chronological criteria. The marine microbiologists with CNRS discovered that there was a varied reaction to external factors such as phytoplankton blooms and Saharan dust episodes. In addition, the phylotypes were further differentiated with respect to their position in relation to the thermocline, the lower boundary of the mixed layer of the ocean.

Finally, artificial neural networks (ANNs) were employed in an attempt to establish relationships between phylotypes and marine ecosystem functions. The research-ers at CNRS concluded that the non-linear nature of the ANN results reflected the inherent complexity of the system. While evidence of important links was uncovered, further research has been recommended by the Basics participants.

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Bringing the Atlantic bluefin tuna back from the brink

Scientists in the United Kingdom discovered that maximum sustainable yield may not be the 'silver bullet' it is portrayed to be with respect to restoring fish stocks on the brink of extinction.

Steps must be taken to help stocks of Atlantic bluefin tuna (*Thunnus thynnus*), which have been severely depleted by overfishing, recover. Much attention has recently been focused on management practices based on maximum sustainable yield (MSY). It is not clear, however, whether this method will produce the desired result given the inherent complexity of the ecosystem in which the tuna reside.

Looking to address this issue, the 'Life quality' programme funded the FEMS research project, the aim of which was to evaluate the suitability of an MSY-based approach. Scientists with the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in the United Kingdom led the investigation.

Stock assessment methods are an essential tool in such exercises, thus it was first necessary to compare the accuracy of several different techniques. Subsequently, the strategy proposed by the International Commission for the Conservation of Atlantic Tunas (ICCAT) as well as the 'Adaptive framework for virtual population analysis' (ADAPT-VPA) were put to the test.

The CEFAS scientists found that reference points based on fish mortality (F) outperformed their counterparts based on biomass or yield. Furthermore, reliable insight could be obtained from F-based reference points when the catch had been perturbed by a change in carrying capacity. Regardless, no single approach proved infallible.

The members of the FEMS research consortium believe the key lies within improving our understanding of the dynamic processes driving the stock cycle as well as a range of fishing industry parameters.

Sensor system detects harmful environments for pipe organs

The organ belongs to the core of European culture, reflecting a diverse history of traditions and stylistic periods. The European heritage of the organ is preserved in more than 10 000 historical instruments throughout the continent. A major threat to this heritage stems from harmful indoor environments.

The EU-funded Sensorgan project has looked at ways to monitor the deterioration of organs, thereby helping to preserve them. An organ is a complex instrument containing wooden parts like the bellows, wind conductors, windchests and metal parts like the sounding pipes. Changes in the indoor climate through, for example, the installation of a new heating system or the restoration of a church can cause serious damage to the instrument.

A humidity decrease can cause cracks in the wooden parts causing key action malfunction or leakage in the windchest containing the valve mechanisms. Damage of this nature renders the instrument unplayable, and major and expensive repair work has to be performed, often resulting in the replacement and loss of historical materials. Unfortunately this is a frequent problem.

Organic acids, in combination with condensation, create pipe corrosion (lead and lead-tin alloys) in many of Europe's historical organs and the number of instruments affected by corrosion seems to be growing. The aggressiveness of this corrosion is a major environmental threat against this acoustic heritage.

Corrosion starts inside the pipe foot and moves gradually upwards to the mouth area. If nothing is done, there will be cracks and finally holes in the pipe foot wall. If the corrosion reaches the mouth, the sound properties will gradually change and finally the pipe will be silent. This is of course a very serious situation because the sound quality of the ancient instrument will be changed causing the loss of this aspect of acoustic cultural heritage forever.

The objectives of the Sensorgan project were to make available new instrumentation for monitoring and detection of harmful environments for organs through the development of sensors for real-time measurement.

The system developed by Sensorgan contains three different sensors to detect:

- levels of organic acids harmful to organ pipes using piezoelectric quartz crystal (PQC) technology. When an electric field is applied to PQCs, they start to vibrate. Monitoring changes in their characteristic resonant frequency such as those from corrosion provides important feedback about the level of organic acids which causes damage.
- environments damaging to wooden parts of organs through an acoustic emission (AE) sensor. The sound emitted when a microcrack is developed can be detected by the AE sensor, thereby providing early warning of the emergence of cracks in the wood.
- possible dew formation both inside and outside the organ pipes. The change in the reflectivity of optical fibre in contact with organ pipes was exploited to determine when water or ice crystals are formed on their surface.

These sensors constitute a powerful tool for the detection of harmful environments and the assessment of measures to impede them. They were installed in the historical organ in the Minor Basilica of St Andrew the Apostle in Olkusz, Poland, 60 km east of Cracow. One of the oldest organs in Poland, it has been in use since 1611. Not much written documentation from this time has survived, leaving the organ as a rare link to the true sounds of the Renaissance and Baroque periods. However, like many cultural heritage artefacts, its age is beginning to show. The need for preservation has prompted many European scientists into action.

During the Sensorgan project, physicist Lukasz Bratasz from the Polish Academy of Sciences' Institute of Catalysis and Surface Chemistry visited this particular organ on a monthly basis. He used special sensors to monitor the micro-acoustic emissions from the cracks in the wooden structure. The inside of the organ is very sensitive to changes in its environment, be it climatic, biological, chemical or physical. During a church service in winter, it is not unlikely for the temperature to rise from 0 to 20° C, due to human activity. Lukasz is of the opinion that the organ in St Andrew the Apostle is in quite good condition, but requires continued monitoring.

Research has shown how the most dangerous environmental changes are those that occur very quickly, for example through the use of air conditioning systems. However, drastic changes

Probing ocean sediments for methane hot spots

To reduce the cost and improve the quality of methane measurements on the ocean floor, scientists with the National Environmental Research Institute (NERI) in Denmark turned to sound waves.

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There is concern that changes resulting from global warming could lead to the release of large amounts of methane, an important greenhouse gas, from the Earth's oceans. Global mapping of the oceans' methane reserves is a daunting task, but thanks to research supported by the EESD programme, it may become feasible.

The project, entitled Metrol, brought together a number of leading research institutes, including NERI. The team at NERI borrowed from a technique used in seismic surveys. It takes advantage of the fact that the methane gas bubbles contained in ocean floor sediments reflect sound waves.

The method proved capable of delivering highly resolved measurements of the methane saturation depth. Compared to conventional sediment sampling, the new approach was not only more accurate but also required less time and money to perform. In addition, by exploiting the high statistical correlation between the two variables, it was also possible to produce estimates of methane net oxidation from the methane saturation depth.

The NERI researchers propose the use of the new technique to map methane deposits, in particular to identify regions with relatively high methane concentrations. Such information will be especially valuable to scientists studying the effects of the oxygen depletion associated with these so-called hot spots on the local ecosystem.

An open forum for land use management

The application of democratic principles in the decision-making process towards sustainable development may offer solutions to the problem of land degradation and desertification in the Mediterranean.

Sustainable development and the problem of desertification was the main focus of 'Medaction 4' which was comprised of four projects constituting a programme of integrated multidisciplinary research. Four modules were created which spanned the issues of land management, scenario generation and policy formulation both locally and across the Mediterranean. The four target areas were in Greece, Spain, Italy and Portugal.

Stakeholders, meaning those who have an interest in or are directly affected by the issues discussed, were responsible for producing these scenarios on regional as well as local levels. Stakeholders hold the role of specialists and play a major role in the decision-making process; therefore, their participation is considered vital in achieving a democratic balance in policy-making. Moreover they channel communication between the general public and experts which allows an open forum for the exchange of ideas.

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Under these auspices, objectives were created for the 'Medaction 4' stakeholder workshops. These included enhancing local public perception of land degradation and desertification, assisting broader implementation and dissemination of the research results and offering the foundation for long-term stakeholder involvement in decision-making.

Stakeholder groups comprised of 15-20 persons were formed in each of the target areas which increased involvement and supported feedback. The individuals spanned a broad spectrum. They included community members, representatives of non-governmental organisations, farmers, journalists, students and free thinkers/artists. After the first series of workshops, a second series was created for backcasting, that is, using the initial material produced in a more thorough and structured manner.

in temperature and humidity are at their most threatening when the material is exposed openly to interact with the environment.

The data collected from all the sensors will continue to be analysed, microclimatic factors creating harmful environments studied, and conclusions drawn up for publications, mitigative strategies and to support the Committee for European Standardization (CEN).

The efforts of the Sensorgan project to rescue these age-old instruments must be considered of utmost importance to the EU. Looking at the overwhelmingly rich organ heritage in eastern European countries (more than 1 000 historical organs in Croatia alone and more than 4 000 in Poland) gives an indication of the need for measures to safeguard these as an important part of European life and identity.

Fighting desertification through policy integration

Investigators involved in the 'Medaction 4' project have published a set of recommendations designed to improve Europe's approach to policy-making where desertification is concerned.

Chronic mismanagement of land and water resources has intensified the rate of desertification worldwide. Climate change and a growing population threaten to further exacerbate the loss of arable land and biodiversity. Now more than ever, it is imperative that effective policies be put in place to tackle desertification.

The EESD programme supported important research in this field. Extensive analysis of existing policy at both European and national levels culminated in a number of recommendations and guidelines to better integrate elements related to desertification.

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The work was led by scientists with the Department of Geography at the University of the Aegean in Greece. Due to the complex nature of the issue, economic, social, regional development, environmental and transport policies together with a number of other topics were included in the study.

The aim of the recommendations was to optimise existing policies and to drive the development of future policies. They target common European policy as well as National Action Programmes in four EU Member States which face a high risk of desertification: Greece, Spain, Italy and Portugal. The focus was on procedural aspects, including guidance concerning successful policy integration through the use of specific policy instruments.

The recommendations are of value not only to policymakers, but also to other stakeholders, such as non-governmental organisations and the academic as well as professional communities. The approach applied during the project and its results may also have implications for other multifaceted policy issues like climate change.

Molecular markers in dark bush crickets

*Molecular markers were identified for the dark bush cricket (***Pholidoptera griseoaptera***) to help determine the vulnerability of populations of indicator species in agricultural systems. The work was part of the Greenveins project, which studied the biodiversity of European farmland.*

Agricultural landscapes cover more than half the surface area of the EU. However, the level of knowledge regarding their biodiversity has been relatively limited until recently. An EU-funded project, Greenveins, investigated the relationship between the structure of the European landscape, the intensity of use of agricultural land, and biodiversity. It was already known that biodiversity declines when land use intensity is increased and there is a loss of semi-natural elements such as hedges, woodlands and ponds.

The results from this study were used to determine the vulnerability of biodiversity in agricultural landscape. The Greenveins project collected information on plants, songbirds and insects from 26 landscape test sites (LTS) in seven countries in north-western Europe. Researchers investigated metapopulations of nine indicator species, including *P. griseoaptera*. A metapopulation comprises populations of the same species spatially separated over the landscape.

Using metapopulations the scientists could therefore study how such populations are affected by changes in landscape and land use. The results also revealed how biodiversity can become vulnerable, and these findings could be used to develop policies that support sustainable biodiversity in agricultural systems. Data on metapopulations was obtained through use of the capture-recapture technique and through the employment of genetic analysis.

Population geneticists studied *P. griseoaptera* in order to identify novel microsatellite markers. These are repetitive stretches of short sequences of DNA which can be used for tracking the inheritance of genes. The scientists employed 12 microsatellite loci, which contained as many as 37 alleles per locus. These molecular markers can be used to investigate how landscape structure and land use intensity can affect genetic diversity in *P. griseoaptera*.

The molecular markers were used to monitor cricket populations in two landscape study sites in Belgium and Switzerland. By investigating the relationship between indicator species and landscape structure and land use intensity the Greenveins project can develop tools for assessing biodiversity in agricultural systems. These tools can contribute to the monitoring of biodiversity in the EU and help in policy development and spatial planning.

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Plasma catalysis for in-vehicle air quality

Interior air pollution originating from the outdoor environment, interior materials, human activities and air conditioning systems can have an effect on drivers and their passengers. Poor air quality inside a vehicle can result in fatigue and eye problems for the occupants, even if they are in good health.

The aim of the Cleanrcab project was to provide a comfortable and safe environment for drivers and their passengers. This was achieved through the development of an innovative and effective air quality management system for within vehicles. The work is of particular benefit to children, the elderly and asthmatics, who are the groups most vulnerable to pollution when being transported.

The Cleanrcab consortium comprised nine partners from four EU Member States plus Switzerland and included industrial groups, SMEs, universities and research institutes. The research team developed a system which purifies the air by breaking down gaseous pollutants using an innovative plasma catalysis process.

Scientists investigated the efficiency of the plasma catalyst device in removing toluene and observed that an increase in energy improved its efficiency. Furthermore, the system could become even more efficient with the addition of the catalyst manganese oxide supported on activated carbon.

The Cleanrcab team found that concentrations of toluene as high as seven parts per million (ppm) could be completely removed with an energy density of only 15 joules per litre (J/L). Researchers carried out experiments which revealed that the plasma efficiency in the removal of volatile organic compounds (VOC) increased when the VOC concentration decreased. Therefore, the amount of energy required outside the laboratory under real conditions would be expected to be lower.

The results indicated that for the plasma catalyst system to work most efficiently it should be installed in the largest vehicles, such as trucks buses and trains. This is because more energy is available in a heavy vehicle than compared to a car and constraints are less severe regarding the size and energy consumption of the system.

Innovative approach to seismic hazard assessment

Some regions will always be prone to earthquakes. The hope is that scientific study can shed light on how to limit the loss of human life associated with these natural disasters.

Extensive surface rupturing triggered by two severe earthquakes in western Turkey in 1999 caused significant damage and cost thousands of lives. A multinational team, supported by the EESD programme, visited the site to collect data with the aim of improving seismic hazard assessment in the region.

Geophysicists with the Swiss Federal Institute of Technology Zurich participated in the project, entitled Relief. They applied their expertise to better address the impact of complex geometry on surface rupturing in seismic modelling. Another important contribution entailed the use of realistic heterogeneity in the treatment of rate and state friction.

A fresh evaluation of the threat of further significant earthquakes affecting this region, namely the nearby capital Istanbul, was performed with the updated models. It marked the first time ever that earthquake cycle models were combined with those designed to predict ground motion.

The results of the simulations were remarkably consistent with the type of earthquakes that have been observed to date in the region. This held true not only for the slip characteristics of the events, but also for their distribution in time and space. Finally, with respect to surface rupturing, the revised models were able to successfully reproduce important differences between young faults and their more mature counterparts.

Protecting Europe's monuments against biofilms

Participants in the Biodam project have discovered a viable alternative to traditional methods of removing dangerous microorganisms from Europe's treasured monuments.

Buildings, statues and other monuments spread throughout Europe form an integral part of the region's cultural heritage. Preserving this inheritance for future generations requires a dedicated effort. One of the threats comes in the form of tiny microorganisms that merge with one another to form biofilms on the surface of the structure. Over time, the biofilm can degrade and damage the original stone substrate.

Geomicrobiologists with the University of Oldenburg in Germany led a research project entitled Biodam, the aim of which was to investigate safe methods of eliminating biofilms. Following laboratory-based experiments, the effectiveness of a range of measures was evaluated in the field. Several different sites were selected in Germany, Scotland and Spain.

The approach entailed a polyphasic treatment plan, which incorporated biocides, permeabilisers, pigment and polysaccharide inhibitors as well as photosensitisers. Data collected during the trials addressed both biofilm and climate parameters.

The analysis that followed indicated that by combining the non-biocide treatments, it was possible to limit biocide application while still successfully controlling the biofilm. Further to these encouraging results, the University of Oldenburg and its partners have copyrighted the Biodam methodology.

Sound approach to sense of presence

For virtual reality to be at its most effective, the feeling of actually being there for the user is of paramount importance. Researchers have investigated the value of sound in enhancing this phenomenon — sense of presence.

The rise in demand for interactivity in games, cultural activities and medicine has created a need to increase the sense of being there, without being there. Producing this so-called sense of presence has led to the development of interdisciplinary research combining cognitive and haptic perception with advanced communications and multimedia design.

The objective of the EU-funded project aptly entitled 'Being there — without going' (Benogo), was to develop new 3D camera technologies that would allow real-time visualisation in locations for a moving observer. Also tackled was the concept of sense of presence, a combination of embodiment and presence and how it arises.

How real the experience is to the user depends on certain factors in the photographic environment such as texture, movement and, all importantly,

sound. At Aalborg University in Denmark researchers investigated how sound augmented the sense of presence, its level of importance and in what way it enhanced this elusive notion.

Acoustic environments (multichannel surround sound) were designed to supplement images projected by several means. These included head-mounted displays (HMDs) and large screens, in one case taking the form of a six-sided cave.

Three main aspects reflecting the importance of sound in a visual environment were monitored — perception of distance, memory and sense of presence itself. To locate an object, visual cues proved more effective. However, memory was prompted more effectively by sound stimuli than visual cues.

Sandals equipped with pressure-sensitive sensors, a footsteps synthesiser, provided a source of sound from the subjects themselves. The interactive sound produced while navigating the virtual environment significantly enhanced the sense of presence.

Applications for photorealistic 3D visualisations with an optimised sensation of presence would seem to be limitless. For the hospitalised and elderly, escape from dull reality can be realised. Still in the medical field, virtual surgery can be made more effective. Leisure and education, in theory, can be equally enjoyed in the virtual world.

Exploiting man and machine in search and rescue operations

Search and rescue operations stand to benefit from an innovative approach to sharing information between emergency workers and robots working side by side in what is often a difficult setting.

Coordinating the interaction between human and non-human entities in a common environment presents a number of challenges. Yet much could be gained from combining the diverse capabilities of man and machine. This was the objective of Pelote, a pioneering RTD project funded by the IST programme.

Informatics specialists with the University of Würzburg in Germany, a participant in the Pelote project, developed a new concept for knowledge-sharing. The application involved search and rescue missions in buildings on fire. The aim was to move beyond current static fire rescue maps that frequently contain too much information and present them in a coherent fashion.

The solution was a new prototype search and rescue map (SRM). The building's ground

plan was stored in digital format. Information concerning fire exits, sprinkler installations and the location of toxic and flammable materials is then added as separate layers over the ground plan. Each user in the system can access the specific data they require from a centralised database at any given time.

Knowledge can also be shared directly between humans and robots taking part in the rescue exercise. The experience acquired during Pelote revealed that the most important variables were an entity's status (for example, busy, free, in need of assistance), its position on the SRM and its intended path. In the case of missing entities, it was possible to determine their

location through triangulation when the distance to known entities was available.

The SRM database could be housed at local search and rescue centres and individual SRMs retrieved in emergency situations. Further tests of this approach are planned in the context of the Pelote project.

Fixed olfactory receptors for electronic noses

Electronic 'noses' have been developed by European scientists that can enable doctors, public health officials and police to detect and diagnose problems by their smell. The sniffer device was made up of a layer of natural proteins immobilised on a microelectrode.

The 'Single protein nanobiosensor grid array' (Spot-nosed) project developed a detector based on nanobiosensors that can mimic

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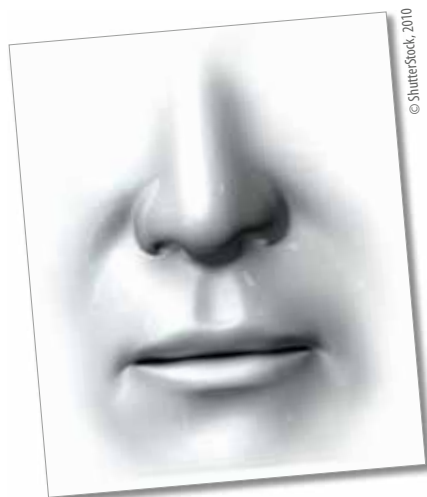
sensitive animal noses. The work was funded under the European Commission's 'Future and emerging technologies' initiative. The system was capable of measuring odorant molecules at much lower concentrations than can be detected by humans. It comprised a layer of olfactory receptor (OR) proteins from rats placed on a gold microelectrode and then mounted on a computer chip. The system measured the reaction when the ORs come in contact with the odorant molecules.

Scientists from Crelymo at the École centrale de Lyon, France, developed a method for fixing ORs onto the measuring chip. This new technique used a mixed self-assembled monolayer (SAM), which was a one molecule thick film that assembled itself at the interface with the bare gold. Following the immobilisation of ORs onto the gold elec-

trodes, the sensing action was monitored by electrochemical impedance spectroscopy (EIS). The results showed that EIS was a suitable technique for monitoring the formation of the immobilisation layer. It was also capable of monitoring the concentration of immobilised ORs.

The work undertaken by the 'Spot-nosed' project enabled new portable instruments to be developed based on electronic biochemical sensors. These devices can play a significant role in health care by testing for the presence of disease processes in a patient's urine, blood and pus. Such instruments are also invaluable to the food industry for determining the quality of food and beverages and to the police for detecting drugs and explosives.

Mobile ad hoc networks: from theory to reality

Self-organising wireless networks are one of the hottest topics in the area of ubiquitous computing. The Mobileman project has devoted a lot of effort in supporting these new computing environments with information and communication technology everywhere, for everyone, at all times.

Mobile ad hoc networks are a collection of mobile nodes connected together over a wireless medium. These nodes can self-organise into arbitrary and temporary network topologies, allowing people and devices to interwork in areas with no pre-existing communication infrastructure.

While WiFi technology is ubiquitous, users seldom operate 802.11 wireless cards in ad hoc mode. This seems to be due to a gap between what end-users might find useful and what technical issues research is addressing. Indeed, research largely concentrates on the optimisation of lower-layer protocols in unrealistic scenarios.

Little attention is devoted to the quality of service (QoS) that ad hoc networks provide to end users in realistic scenarios. The Mobileman project aimed to reduce this gap by a research plan that combined theoretical analysis with experience gained with real ad hoc networks.

A key facet of the research entailed an extensive measurement study, as popular simulation and analytical approximations may lead to inaccurate results. To understand the potentialities of this technology, the dependence of the communication range on several parameters was analysed.

Emphasis was placed on characterising key networking features, such as the maximum communication distance between a small number of nodes and the interactions between simultaneously transmitting nodes. Besides the effect of environmental parameters, the effect of technology-dependent parameters was also analysed.

Measurements under varying environment humidity and data transmission rate were used to revise formulations reported in computer networking handbooks and to define a more accurate channel model for 802.11 wireless cards. With the use of a more realistic channel model, well-known hidden and exposed node problems were addressed.

A variety of extensions to the 802.11 medium access control (MAC) protocol were investigated to cope with the lack of coordination among

nodes. These modifications also addressed the problem of unequal allocation of channel resources to each node.

The hardware/software platform, designed for experiments with the implementation of an enhanced 802.11 MAC card in realistic scenarios has also opened the way for a variety of new research directions. These include the design of shared memory components allowing the exchange of network information for all network layers, including the routing and transport layer.

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Wireless is getting personal

The future generation of mobile and wireless communications will not only be user-centric, but will also enable access to personalised services anywhere, anytime. Research on short-range wireless systems targeted the technological breakthroughs necessary to realise this ubiquitous access network.

While mobile communications networks will inevitably take time to reach their full potential, the attention of the Pacwoman project consortium has already turned to the longer term. Future broadband mobile technology will not just be about higher data transfer rates or public networks. The evolution of the so-called third generation (3G) networks must put user needs centre stage.

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Pacwoman's research on ultra-wideband (UWB) radio technology followed this user-centric approach and aimed to pave the way for advanced network design concepts. The UWB radio technology is considered as an emerging technology with a multitude of potential applications. The main applications are personal area networks (PANs) to link one person's digital devices together, or local area networks (LANs) to link devices in a room.

This technology provides for data transfer rates as high as a gigabit per second, but is also suitable for the emerging body area networks (BANs), requiring low data transfer rates. The UWB propagation channel is, however, highly dependent on the type of the transmitter and receiver antennas, and more importantly on the operating conditions. For example, the presence of a human body in the proximity of the UWB antennas can dramatically change the characteristics of the radio channel.

Engineers at the Centre suisse d'électronique et de microtechnique SA investigated the potential of imprinting information on the transmitted signal using various modulation techniques. Based on the UWB device specifications set by the Federal Communications Commission (FCC), a novel solution was proposed for low to medium data transfer rates (not exceeding 5 Mbit/s). This was based on fast on-off keying (OOK), the simplest technique of binary modulation.

The motivation for this approach was the availability of off-the-shelf hardware and software, making it relatively easy to implement. Furthermore, a new technology — referred to as frequency domain UWB — was employed to eliminate the need for synchronisation between transmitter and receiver. A scaled-down prototype of UWB transmitter and receiver has been designed and is intended for medical tele-monitoring at home and live transmission of webcam video.

Designing peer-to-peer networks to mimic nature

A novel algorithm created during the BISON project significantly reduces the amount of time required to perform searches on peer-to-peer (P2P) networks.

The Technical University of Dresden in Germany received funding from the IST programme to apply lessons learned from biological systems to computer applications. They set their sights on P2P networks, which offer a number of advantages over client-server architectures, but are limited in terms of speed and robustness.

An innovative search algorithm was designed based on behaviour observed in immune systems in nature. The software engineers with the Technical University of Dresden replicated the proliferation and mutation response, which enabled faster transmission of message packets associated with the query.

In addition, the peers comprising the P2P network were encouraged to form clusters around common types of data. This allowed the network to develop a memory over time, which was subsequently exploited to further reduce the amount of time necessary to execute queries.

The new software, which has been protected by copyright, has been published to the website of the project. It is accompanied by a report composed by the Technical University of Dresden that describes the theoretical background behind the design in detail.

Lift-off for the semantic Web

Researchers from the EU-funded Wonderweb project have made a major contribution to the development of the semantic Web. They have created the technical structures and supporting tools required by real world applications such as e-commerce.

The World Wide Web has become a standard feature of daily life. Researchers from the Wonderweb project predict that the latest development to the Web, known as the semantic Web, will be just as revolutionary and successful. At present data stored on the Web is primarily for use by humans. However, the aim of the semantic Web is to provide data that can also be processed by machines. This can enable a whole spectrum of intelligent services, providing users with much more sophisticated searching and browsing capabilities.

Central to this advance in the Web's potential is the development of ontologies. Ontologies are metadata and provide a control-

Exploiting GIS for landslide risk management

A special geographic information system (GIS) developed to facilitate landslide prediction in Hungary could be adapted to other regions.

Landslides can result in the loss of human life and the destruction of property. Warning citizens in advance could help save lives. The EESD programme aimed to do just that when it funded the OASYS project.

The OASYS research consortium included organisations from Europe as well as China, regions that both suffer from landslides. One of the European partners, the Geodetic and Geophysical Research Institute (GGRI) of the Hungarian Academy of Sciences, implemented a GIS.

Landslide research involves a number of different disci-

plines and GIS provides a means of combining, viewing and analysing different types of data on a single platform. The geometric nature of GIS also lends itself to geodetic deformation monitoring, one of the primary components incorporated by the GGRI scientists.

The core of the GIS is comprised of four different topographic maps covering an area of approximately 100 km^2 in Hungary. This is complemented by other maps that were carefully transformed into the same raster data format. The result of GGRI's efforts is extremely high resolution, in the order of one centimetre. This ensures that the GIS is capable of detecting early warning signals occurring on very small spatial scales.

Next-generation internet to facilitate search and rescue

Search and rescue missions in beautiful yet complex terrain such as England's Lake District stand to benefit from advanced mobile internet technology validated during the 6NET project.

The rise of the internet and the mobile phone has brought about significant changes in the way in which humans share information and communicate with one another. Not surprisingly, improving mobile access is one of the principal focuses of the next generation internet, known as IPv6.

Well over 30 academic institutions and major industrial players joined forces to deploy and test IPv6 infrastructure to major cities across Europe during 6NET. The project received substantial funding from the IST Programme. Several application trials were arranged in order to demonstrate the feasibility and added value of IPv6.

One such trial was supervised by computer scientists with the University of Lancaster in

the United Kingdom. It involved search and rescue (SAR) missions in England's Lake District. The objective was to successfully connect multiple users dispersed in a remote mountainous environment with each other as well as with their home base and other organisations participating in the SAR operations.

The solution was to implement nested mobile networks using mobile IPv6 and the network mobility (NEMO) protocol. Software was also developed to track the network topology associated with the various members of the SAR team in the field. The challenges identified during the 6NET trials that must be overcome prior to more widespread adoption of the technology include issues related to battery and wireless interface technologies.

led set of terms, each one with a precisely defined meaning which can be processed by machine. The use of ontologies is intended to allow human beings and machines to communicate more effectively. The result will enable content-based access and interoperability raising communication across the Web to a new level.

The Wonderweb researchers developed the extraction tool OntoLiFT which semi-automatically extracts lightweight ontologies from legacy resources such as XML. Schema languages document type definition (DTD) and XML schema (W3C) were included. Focussing on the most important languages means that these existing infor-

mation systems can still serve a vital role in web services.

IT AND TELECOMMUNICATIONS

European researchers usher in Telco 2.0

European researchers have created a platform that allows users with no special expertise to generate telecom plus internet services. The backers hope the platform will pave the way for the Telco 2.0 era.

This year could be the date when, finally, we enter into the era of converged internet and telecom services. Call it Telco 2.0.

It is well due. Up to now, the promise of converged telecom and internet services has remained just that, a promise. Those solutions that do work seamlessly are very effective, like the Blackberry, but they require proprietary software and special devices. This is hardly the promised happy marriage of two telecom worlds.

That is about to change. European researchers have created a service development platform, called OPUCE, which makes two important breakthroughs. First, it offers a way to create converged Telco-internet services from scratch or using already created basic services; second, it is so simple to use that non-experts — regular surfers with no programming skills — can create their own compelling services, reportedly in minutes.

OPUCE allows users to create converged services by combining internet technologies like instant messaging, email, maps, photo albums and directories with Telco services, such as SMS, MMS, voicemail and so on.

It may sound a bit vague, but the real-world applications enabled by the OPUCE platform are specific, unique and very compelling. They work just like mash-ups; small, software driven services on the internet that combine data from two or more sources to create exciting new information. The classic example online is services that combine, for example, Google maps with real estate listings; users can instantly see where there are new houses for sale.

Now imagine that service delivered automatically to your mobile phone whenever a house in an area you are interested in hits the market. Or perhaps you are looking for a new job, and when listings you want to apply for get published online alerts are automatically forwarded to your phone using whatever channel — voice, SMS, MMS.

But the second innovation from the OPUCE team is even more revolutionary. These are not services that users must wait for someone to develop; these are services that users can set up themselves, in minutes.

This is a huge paradigm shift, particularly in the telecom world. Up to now the telecom network was a walled, even secret, garden. But the OPUCE platform moves it to an open garden, says Alberto Leon Martin, the project's coordinator. 'Users access the front end via the web, but the back end is still controlled and kept secure by the network operator,' he explains.

It is an apparent paradox; a system that appears both open and secret. OPUCE resolved the paradox by using application programming interfaces (APIs). This is a standard web technology that provides a 'socket' for services to plug in to, like selecting a particular map, for example. The map API is plugged into other APIs that deliver, for example, real estate listings for a particular area.

OPUCE has added telecom services to these internet-based APIs, and by combining them in interesting ways, users can create all sorts of compelling services.

'In the past, the internet has been about user-generated content: photos on Flickr, videos on YouTube and blogs everywhere. OPUCE is about enabling user-generated services,' explains Leon Martin.

This is a huge shift, and could have an enormous impact on information technology generally. Users are, as a mass, enormously creative, adaptable, dynamic and imaginative. It is impossible to predict what new services will emerge, but there is every probability that some of them will be 'killer apps', those pieces of software that are so appealing, useful and simple that they completely change culture and society, like SMS and blogging have done before.

The EU-funded OPUCE project, led by Telefónica I+D, has completed the technical platform, and feedback from users has been positive. Now they are concentrating efforts on creating commercial models that will make the OPUCE platform a reality.

'We are looking at a variety of scenarios. One that interests us very much is revenue sharing, where the creator, whether it is a user or an SME, and the network share revenue generated by new services. We like this scenario. Everybody wins,' reveals Leon Martin.

Other options are also under consideration, for example a free and premium model, where some user-created services are offered for free, and some are charged for. Telecom companies are also looking at a move beyond network traffic generated revenues. They want to become part of the value chain — something that has been hugely difficult for them to do in the past; they were essentially used as a pipe.

'The OPUCE platform was conceived to allow networks to become part of the value chain,' Leon Martin notes. Time will tell, but sooner rather than later. Leon Martin believes the era or Telco 2.0 will begin to go live this year, as the telecom players start deploying OPUCE functionality across their networks.

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Practical recipes for the simulation of quantum computations

A library of numerical codes that can simulate quantum computers during information processing has been designed to help optimise the operability of the next generation of quantum computers.

By taking advantage of nuclear magnetic resonance, scientists have been successful in coaxing molecules in ordinary liquids to serve as an extraordinary type of computer. This physical realisation of a quantum computer with a small number of quantum bits (qubits) implies that this will soon be available for the experimental implementation of simple algorithms.

The main problem for the operability of such a computer with ten or an even larger number of qubits is related to effects appearing during information processing. Almost any interaction a quantum system has with its environment — say, an atom colliding with another atom — would cause the superposition of quantum-mechanical states to collapse into a single definitive state.

This phenomenon, known as decoherence, makes further quantum calculation impossible. An efficient way to test decoherence effects is to create numerical codes capable of modelling imperfections in quantum information processing and to simulate simple algorithms with a few tens of qubits. This was the precise objective of the research project Ediqip.

The research groups participating in the project had developed efficient algorithms for physical problems of classical and quantum chaos, as well as error correcting codes. The first numerical simulations of these algorithms had been reported by each group before the beginning of the Ediqip project. Because of their rich dynamics, existing together with newly developed algorithms, they were ideal for the investigation into decoherence.

At the Université Paul Sabatier in France a comprehensive suite of numerical codes was created to simulate these quantum algorithms. The Quantware library can give insight into the physics of decoherence in the direct context of these algorithms and determine their accuracy in realistic conditions close to experimental setups. Also it will make possible the testing of quantum error correcting codes in numerical simulations.

The Quantware library is freely open under http://www.quantware.ups-tlse.fr. It gives quantum numerical recipes to simulate realistic quantum computations in the presence of static imperfections, noisy errors in quantum gates and dissipative decoherence. The Ediqip project partners hope that it will help experimentalists to improve the reliability of quantum information processing.
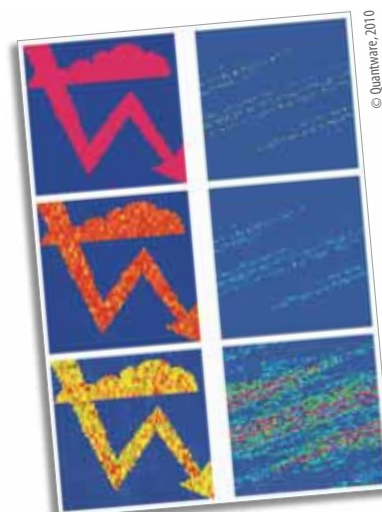
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Fault-tolerant quantum computing

Researchers in the field of quantum information processing are now beginning to explore the possibilities of basic quantum circuits. However, one ubiquitous question that needs to be addressed is how to improve their computational accuracy given the available resources.

Current developments in quantum physics demonstrate in an impressive way its technological potential. In quantum computation the weird logic of the quantum world can be exploited for solving complex computational problems more efficiently than any other means.

However, the realisation of the quantum computer remains a challenge, since they are prone to errors. Consequently, the Ediqip project received funding from the IST programme to address the influence of random noise errors and static imperfections in quantum gates.

Logic gates operating on quantum bits, the quantum analogue of classical bits of information, are easily affected by their interactions with an uncontrollable environment. The accuracy of quantum computations is further influenced by the presence of residual static couplings between quantum bits.

To protect quantum information processing against such undesirable influences, powerful methods of error correction have been developed over the past few years. These have concentrated predominantly on decoherence caused by parasitic couplings of a quantum information processor with its environment.

The error correction method which was developed by Ediqip project partners is more general, in the sense that it can also correct errors originating from coupling between quantum bits. It is based on the repeated random application of Pauli operators to all the quantum bits to be processed.

The resulting random changes together with appropriate compensating changes of the quantum logic gates slow down the rapid decay of the gates' fidelity. A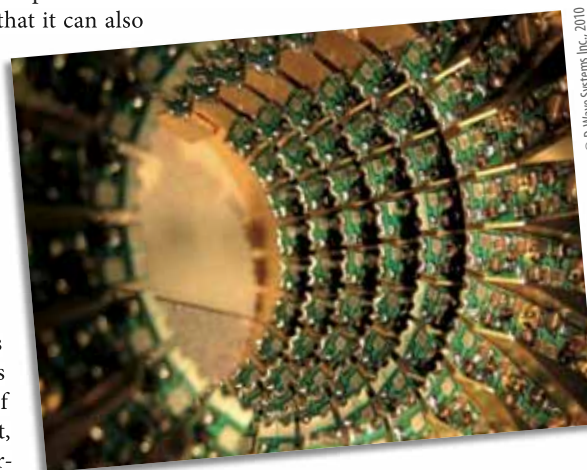s a result, this Pauli random error correction (PAREC) method significantly increases the maximum time scale of reliable quantum computations.

Furthermore, in contrast to conventional error correcting methods which exploit redundancy, the PAREC method does not require any extra qubits as the available qubits are used in an optimal way.

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IT AND TELECOMMUNICATIONS

Software that gets reduced, reused, recycled

Service-centric software engineering is the latest paradigm in computing, and European researchers have developed a platform they believe will launch the concept into the business world.

Currently it takes a long time to develop applications, it costs a lot of money, and if it fails you must either start again or limp along with a poorly performing system. Worse, development is so lengthy that, by the time you are finished with one large project, technology may have moved on, and you have to start again.

There is another way. Service-centric software engineering defines every action a computer program can take as a service. Want to print a document? That is one service. Type a document? That is another. By combining many services, you can develop very complex, very sophisticated applications.

And once the task is complete, the services disappear. When a new function appears, a better way of doing something, you do not have to get into complex integration or redevelopment, you simply exchange one service for another.

It has a lot of advantages. You can reuse bits of code in many different applications, so you do not have to constantly reinvent the wheel. Application development also becomes more competitive, because if one service charges too much, or does not work very well, customers simply choose another.

Up to now, services have been deployed on a relatively small scale, for fairly simple mash-ups by leading-edge web developers. A mash-up takes one data set, like Google maps, and plugs it into another dataset, like estate agent listings, and creates a new ser-vice, for example, a map with all the houses for sale in your town.

Now European researchers have developed a platform that offers service-centric software engineering for industrial-strength applications. And industry is very interested. 'This is very much the computing model of the moment,' says Peter Sawyer, a researcher with the SeCSE project. 'It is creating a lot of excitement in web applications, and companies are interested in it for business applications, but up to now they have held off the technology because there was no integrated development environment. That is the gap we tried to fill.'

SeCSE, pronounced sexy, is a major integrated project over four years with 14 partners and a budget of more than EUR 15 million. It created a service-centric development platform that spans the entire software lifecycle from design to deployment. The platform uses Java to create software that integrates services from different providers regardless of the underlying operating systems or programming languages.

It is a powerful, liberating paradigm and the Gartner group predicts that this service-centric development will see some significant deployment for business applications. This is just a prediction, but it indicates the promise of service-centric applications. The technique will represent a very significant slice of software development expenditure in future.

'With this approach, you can have a developer set out a design and then test it, very clearly, early on by going out and getting some available services. That validates the approach early on, and that is a very radical change from what has happened before,' Sawyer notes.

The primary goal of the SeCSE project was to create methods, tools and techniques for system integrators and service providers and to support the cost-effective development and use of dependable services and service-centric applications.

SeCSE focused on four key areas for engineering software systems: specification, discovery, design, and management. For each of these areas, SeCSE developed new techniques and tools, mainly in Java, a platform-independent programming language.

'Technically, the real biggie was defining the real needs [at the start]. We were trying to develop technologies for emerging needs, but we worked closely with industrial partners and were able to identify quickly any design dead-ends,' Sawyer reveals.

These tools and techniques were integrated to provide a SeCSE development environment. Even better, based on visionary scenarios led by the Fiat Research Centre, SeCSE developed domain-specific applications. It is a significant validation of both SeCSE's vision and execution.

Exploitation is primarily appearing through the planned products of SeCSE's commercial partners, though the potential of the technology was demonstrated in some compelling applications in the automotive sector.

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Object-oriented techniques for designing hardware

Managing the steadily increasing complexity of embedded systems is among the most serious challenges in the area of electronic design automation today. One of the major problems in the existing design process, the step from the initial specification to the first implementation, has been addressed by the Odette project.

The spread of embedded systems comprising hardware and software components has been on the rise for the past few years and is still increasing. Today they have an impact on many areas of daily life, from the workplace to leisure time. At the same time, the requirements for these systems are steadily growing, along with their complexity.

The current technology based on integrated circuits with several hundred million transistors on a single chip is able to meet most of these requirements. However, the state-of-the-art methods of hardware design cannot keep pace with technology's rapid advance. In light of this, the Odette project was funded by the Fifth Framework Programme (FP5) to develop an object-oriented hardware design methodology.

This new design methodology allows the hardware design community to take advantage of the object-oriented paradigm and follow its success in the software community. The SystemC™ language subset and modelling techniques defined during the Odette project enable the use of object-oriented and other useful features in the synthesis of hardware designs directly from object-oriented specifications.

More importantly, the possibility of describing hardware by means of object-oriented C++ constructs makes the step from a C++-based system specification to a first hardware model for simulation a much easier task. Furthermore, it enables a simple transformation of system parts from hardware to software and vice versa.

After system modelling and model testing is successfully finished, the designer must decide which parts to implement in hardware and software. Due to the inherent complexity of this task, it is common practice to perform partitioning manually. After partitioning it is essential to perform some architectural exploration of the hardware/software system, with significant impact on the design cost and time-to-market.

The design approach proposed by the Odette project avoids some of the major disadvantages of the design flow by modelling the whole hardware and software system using one description language. The design is incrementally refined in small sections to allow the designer to implement design changes easily and verify the model. Documentation and the additional class library that is needed for applying this design methodology is freely available at the project's website: http://odette.offis.de

Nature-inspired management of modern dynamic networks

Modern computer and communication networks are becoming increasingly large, heterogeneous and dynamic. Traditional network management practices fail to deal efficiently with this increased complexity. The EU-funded project BISON addresses this problem by drawing inspiration from nature.

Being able to transfer information between sources and destinations is the prime function of a communication network. At first glance, finding paths for the data flow through the network may seem to be a trivial task. However, when the network load and topology are continuously changing, this becomes a true challenge.

The multitude of services offered with, to some degree, conflicting requirements has invited new approaches relative to those used in traditional communication networks and the internet. One such approach is the use of swarm intelligence, where mobile agents explore, map and manage the network in a manner similar to the way ants explore their environment.

When a path is found, the agent returns on the reverse path and leaves markings, resembling the pheromones left by ants during trail development. The strength of the markings depends on the quality of the path found. Subsequently, agents searching for a path select their next move based on the current markings distribution.

Swarm intelligence was implemented on internet protocol (IP) software routers as a 'proof of concept' to gain experience of technical issues that are hard to predict with simulations. AntPing is a working prototype implementation that visualises how agents are searching and updating paths. The animation is live, showing how agents are moving or being dropped in the network because the 'time-to-live' has expired.

In addition, changes in current and historical values of each virtual path are plotted as a function of time. The AntPing implementation has moderate hardware and software requirements, which makes demonstrations inexpensive and portable. Users are allowed to unplug and re-plug cables between nodes or the power supply to the nodes, and thus introduce some network dynamics.

Although swarm intelligence has been applied to a small, 10-node network and has coped well with different network management challenges, additional insights are required into scalability issues. The BISON project partners are looking further into these issues.

IT AND TELECOMMUNICATIONS

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The self-managing, 'unbreakable' internet?

High-powered internet applications typically need teams of experts to maintain them. Not any more, say European researchers who have built a system to create applications that manage and fix themselves.

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Part of the internet's potential lies in its ability to link hundreds, thousands, or even millions of devices. Whether a user is downloading a video from a peer-to-peer service, performing scientific research on a grid, or using 'cloud computing' to manage a business, programs that let many devices and applications work together are crucial.

The problem, says Peter Van Roy, coordinator of the EU-funded Selfman project, is that it's getting harder to keep those systems working. 'The central challenge when you build big internet applications is how to keep them running without having to tweak and manage them all the time,' he says.

The Selfman team set out three years ago to solve that problem by finding out how to build programs that take care of themselves in the rough-and-tumble internet environment. 'We wanted to make big internet applications easy,' Van Roy says, 'so that all the management problems you normally have are handled by the system itself.' The payoff, he says, will be huge. 'It will take the internet to the next level.'

The Selfman researchers identified four vital functions for a distributed application to manage itself — self-configuring, -tuning, -healing and -protecting. Software is continually being patched, updated or replaced. For a distributed system to configure itself, it needs to keep track of all its components, update them as needed, and make sure that all parts of the system can still talk to each other.

'Our system can ask a component, what version are you? Who are you talking to? It can then replace an old version with a new one as needed,' says Van Roy. Self-tuning means that the system can instantly adjust to changing loads and to components leaving or joining the network. 'Suppose one node is getting overloaded,' says Van Roy. 'Our load-balancing algorithm allocates new nodes close to that hotspot. It spreads the heat to the other nodes and the hotspot cools down.'

The internet is an unpredictable environment. Routers crash, cables get cut, parts of the system overload and grind to a stop, and components come and go. 'With Selfman,' Van Roy says, 'each node stores some of the data and each piece of data is replicated a certain number of times. If a node crashes, the other nodes detect the crash, find a new node and give it the missing data. The system heals itself.'

One of the biggest problems Selfman tackled was self defence. The researchers discovered that a system's security depends on its topology — how nodes are linked to each other. They found that 'small world' networks — in which most nodes are not directly linked, but in which any node can communicate with another in a few steps — were the safest.

'With a small world network, it's easier to detect, isolate, and eject bad nodes,' says Van Roy. 'The security service observes the system's behaviour. If it notices that certain parts of the network are acting abnormally, it takes action.'

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The Selfman team found that building these advanced capabilities into useful applications required a highly structured approach. The foundation of each application is a structured overlay network. That's a program — itself replicated across the network — that keeps track of all the nodes and connections between them, and can decide when and how to fix problems.

The next level is a replicated storage system. It makes sure that each node has access to the same data, and that data are always replicated to ensure they do not disappear.

The third level houses Selfman's transactional problem-solver. It relies on a sophisticated algorithm called Paxos to provide a systematic way of reaching consensus among any number of fallible components. Van Roy uses the analogy of a transfer between two bank accounts. 'If you want to reduce one bank account by EUR 100 and add that 100 to another, you want both or nothing,' he says. 'Each node must see the same data.'

'Getting all this fluid behaviour — where even if nodes are crashing or new nodes are coming in or the network has problems it never blocks the system — was a big technical problem,' says Van Ray. 'We needed Paxos to get it to work.'

The Selfman architecture and components have been used to build some impressive applications. These include a prize-winning distributed Wikipedia that can handle far more queries than the current version, a commercially successful media streaming service, and a graphics program that lets multiple users collaborate on a design.

Van Roy believes that Selfman opens the door to a host of high-powered, flexible, and 'unbreakable' internet applications. 'Right now we're just scratching the surface,' he says.

Reducing water resistance in hopper dredgers

Computational fluid dynamics (CFD) was used by the EU-funded Effort project to design ships to be propelled with much greater efficiency. This could result in a significant saving of fuel and a reduction in pollution, noise and vibration.

Naval architects have traditionally predicted the flow of water around a ship's hull and the inflow to the propeller using hydrodynamic tests on a scale model in a towing tank. Researchers from the Effort project used CFD to achieve reduced resistance and improved propeller inflow and propulsive efficiency. This technique also helped to reduce the level of vibration and cavitation.

The use of validated full-scale CFD can result in reduced time and costs during the design phase which can contribute to the increased competitiveness of European shipbuilding. Europe specialises in high-quality vessels, including high-speed ferries, cruise liners, container ships and dredgers. A team of researchers from the Effort project carried out extensive flow measurements onboard a hopper dredger.

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The transom of a vessel forms the horizontal surface at its stern. The immersion of the transom in the water is a common feature among hopper dredgers and affects resistance to water flow. In order to avoid immersion the stern can be stretched so that the transom is above the waterline. However, this would require the craft's length to be dramatically increased. A second solution is to curve the transom upward but this may result in flow separating from the hull thereby increasing resistance. Furthermore, water separated from the hull and entering the propeller plane will increase vibration.

The water flow and resistance of the transom stern and the extended, curved stern were compared. The wake field predicted by CFD was not affected by the extended stern replacing the transom stern. The change to the transom also created a minor difference in pressure from the propeller plane to the transom. Calculations at full scale for shallow water conditions showed a slight effect on the axial flow. The results achieved by the Effort team will lead to further investigations into improvements to the stern using CFD.

Detecting damage in high-pressure composite tanks

A new and extremely reliable non-destructive evaluation technique for certifying the integrity of composite tanks was developed by an EU-funded consortium. The tanks were used for on-vehicle storage of natural gas or hydrogen.

Proposed methods of inspection for composite tanks are highly labour-intensive, requiring the use of expensive equipment to carry out off-vehicle inspection and pressure testing. However, a new approach developed through an EU-funded project can quickly and easily evaluate the structural integrity of a tank during refuelling.

The ZEM project developed a monitoring system based on fibre optic sensors for high-pressure tanks made from composite materials. Sensors embedded in the composite material can provide a simple but detailed evaluation of the structural integrity of the tank. The monitoring system is able to detect faults or critical conditions at a very early stage.

The consortium successfully developed and tested algorithms for detecting damage which could reduce the burst pressure of the tank below a warning threshold. Researchers predicted that damage to the tank would result in greater flexibility and overall deformation. An additional important feature that required monitoring was the symmetry of the strain field of the tank, which was expected to change in the case of damage.

Analysis showed that the sensor layout could detect any cutting and impact damage to the composite tank that would decrease the burst pressure. Defects were identified well before the burst pressure was reached, enabling a swift response to any damage that might threaten the integrity of the tank.

The ZEM project's development of fibre optic sensor technology for structural monitoring will enable Europe to compete with the United States in this relatively new field. The technology will help to improve health and safety and facilitate the use of natural gas and hydrogen for vehicles operating using alternative fuels and fuel cells. This will result in lower emissions, as well as energy savings due to the decrease in vehicle weight, since composite tanks are significantly lighter than metal ones.

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Cooperative cybercars, a question of priorities

European researchers have developed new control systems that let driverless vehicles communicate and cooperate with each other. Could fleets of high throughput rapid transit systems soon be cruising our cities?

Many metro and tram systems effectively run automatically nowadays. Still, it is reassuring to see the driver in the cab, knowing someone is there to take over in an emergency or to override the computer's controls if necessary. But European researchers in the Cybercars2 project have now demonstrated that vehicles can be left to themselves much more. If allowed to 'talk' to each other, automated vehicles can organise themselves well enough to get around efficiently and safely.

Two earlier EU-funded projects, Cybercars and Cybermove, developed the sense and control systems by which unmanned road-based vehicles, called cybercars, could safely navigate the streets.

Now the follow-on Cybercars2 project, has added a communication layer to the system and data analysis software so that vehicles can exchange data and coordinate their movements.

These results from this latest project will drive forward the development of high-throughput, efficient automated transportation systems (as opposed to single vehicles) that could be deployed in traffic-free zones.

A number of the consortium's partners have been involved in basic research to develop the rules by which the flow of traffic is governed. What happens, for instance, when two automated vehicles arrive at an inter-section at the same time? Who takes priority and who decides to go first? Should a car stop at the junction and give way, or just slow down until the other car has passed, then speed up again?

The early days of the project saw researchers creating software to simulate all the possible manoeuvres and scenarios that a fleet of automated vehicles might encounter. The scientists then used the simulator to explore a wide range of situations. They looked at the behaviour of vehicles and tested different rules and prioritisation strategies that vehicles could follow to negotiate complicated situations.

The simulator software allowed the researchers to test millions of negotiations and draw up mathematical rules, known as algorithms, that would control how the cybercars negotiated and navigated junctions, traffic lights, merges and emergency situations in utmost safety.

The project also developed new techniques to handle the enormous volume of data that cybercars might have available to analyse — imagine how much information would fill the airwaves at a city centre terminus where a hundred automated vehicles might be moving around in close proximity.

The researchers adopted a technique called data mining, which uses complex mathematical analyses of data to find patterns and trends. In a typical data search you have to know what you are looking for, then a computer can rapidly churn through the data to find what you want. For example, it might reveal that vehicles are always late when it rains on Mondays and Fridays, but not mid-week — something that you would probably never have thought to look for.

The Cybercars2 data mining allows the cybercar con-

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trol systems to cope with the enormous volume of transient data and identify which elements are the most important or critical to its safe manoeuvring.

One of the biggest breakthroughs in Cybercars2 is the replacement of the traditional 'block system' to control traffic flows with techniques that let vehicles follow each other at extremely close quarters.

'The software developed by the predecessor Cybercars project was for moving vehicles independently at fairly large distances,' explains Michel Parent of INRIA, coordinator of Cybercars2. 'We used the same block system as railways, where a vehicle cannot proceed until the one in front has cleared a section.

'But block technology only allows a low throughput. The communication and decision-making modules we have developed help to increase the efficiency of an automated service through coordination which will adjust the speed of vehicles as they approach junctions so they can cross without having to stop.'

If the stunt-like four-way crossings don't impress you (which they might not at the current speeds of about 5 km/h), then perhaps the 'platooning capabilities' of the Cybercars2 test vehicles might at least raise an eyebrow.

Platooning lets cars drive close behind one another, almost as if they are coupled together. As they are communicating and cooperating with each other, if the car at the front has to stop, the one behind also applies its brakes in an instant. Safe stopping distances for cooperative cybercars could be less than a metre, depending on the speed.

The Cybercars2 research has developed real-time controls that bring the distance between vehicles down to 0.3 seconds. Imagine travelling at 40 km/h, but only three metres behind the vehicle in front!

'This is an order of magnitude better than what exists for existing automated systems,' says Parent, who remarks that the automated transit system being installed at Heathrow Airport has a spacing of six seconds.

But could you trust a ride in such a daredevil machine? Safety is evidently the ultimate limiting factor to the uptake of automated transport systems, and these cybercars are developed with safety first. For example, the software is designed to handle

Monitoring access roads to Rome

A full-scale operation of automatic access control systems in Rome has been implemented as a means of safeguarding the city's historical centre.

The tranquil preservation of European cities has become increasingly challenging given the demands of modern daily rhythms. Monitoring and controlling the flow of automobile traffic is a major step toward maintaining a pleasant historical centre for local citizens and tourists alike.

In light of this, the Miracles project has installed the limited traffic zone (LTZ) in Rome, Italy. The LTZ constitutes a system of electronic gates which operate on access roads to Rome's centre. Optical detection is possible via the vehicle plates with the use of automatic plate number recognition (APNR) techniques. These techniques are also able to gauge whether or not a vehicle is licensed to enter and enforce the rules accordingly.

Consequently, vehicles are pinpointed by swapping information via radio between the gate (road side unit — RSU) and a mechanism known as on-board unit (OBU) located inside the vehicle. The LTZ in the historic city centre of Rome prohibits ve-hicles on week days, during working hours and afternoon on Saturdays.

Since results were positive, an additional service known as the Trastevere LTZ sub-system was later implemented. With signs put up close to the gate, this subsystem's key function is that it is able to assist users regarding the conditions of the gate. The implementation of additional electronic gates was planned.

Eliminating engine knock in automobiles

Faced with increasingly stringent emission standards, Europe's car producers are constantly striving to improve fuel economy and engine performance. This was the aim of numerous engine tests and computer simulations performed during the Minknock project.

European car manufacturers have established a strong reputation in one of the world's most competitive industries. In order to maintain a leading position in the 21st century, the focus must shift to building fuel-efficient, environ-mentally-friendly vehicles.

One way to achieve this is to reduce engine knock, which causes increased fuel consumption and emissions of air pollutants and greenhouse gases. The participants in the Minknock project, which included car producers, fuel companies and research institutes, set out to do just that.

Engineers with Ford Werke AG in Germany began by testing a production engine with several different types of fuel over a wide range of operating conditions. They found that performance depended on the research and motor octane numbers (RON and MON respectively), but other factors such as the stoichiometric air-fuel ratio also played an important role.

In addition, the relationship between each fuel octane rating and knock sensitivity was investigated, as well as the link to spark advance. Ultimately, it was shown that an index proposed by Shell incorporating both RON and MON was the most appropriate for predicting knock sensitivity.

The engine tests were complemented by extensive simulations using computational fluid dynamics (CFD) models. Specifically, the STAR-CD, FIRE and Shell auto-ignition models were applied, in some cases in combination with an extended coherent flame model (ECFM). The Ford engineers experimented with various parameterisations of heat transfer, turbulence and other phenomena in order to optimise agreement between the model results and experimental data.

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a loss in communication between vehicles. If the communication network breaks down, the vehicles revert to 'line of sight' procedures; they will not cross intersections, for example, unless they visually detect that the coast is clear.

Indeed, the first applications of Cybercars2 technology could well be found in somewhat normal looking cars. Part of the Cybercars2 project involved the building of several 'dual-mode' vehicles that could be switched between fully automatic and manual driver modes.

But while a car is under manual operation, the automated systems continue to work, providing the driver with useful information about the road and other vehicles in the vicinity. The advanced driver assistance systems (ADAS) are being developed in a number of EU-funded projects and manufacturers have started to install them in cars.

Meanwhile, the Cybercars2 project continues to push cooperative, automated transport systems as the answer to many of the transport issues facing European cities, especially through the EU-funded Citynetmobil project which will explore the possibilities for such systems in five demonstration cities.

'All the basics are there for a functioning, efficient and safe system,' Parent asserts.

This is the second of a two-part special feature on 'Cybercars2'.

Vessel designs for high-speed freight transport

Vessel designs suitable for high-speed freight transport on inland waterways were prepared for two routes.

Inland waterways serve as transnational channels of transport. In this respect initiatives involved in freight transport need to be implemented on a broad scale particularly regarding operator requirements. The Pacscat project is a prime example since its operations serve primarily the Rhine and the Danube which flow through many European countries.

In light of this, a vessel which is suitable for deployment in the Rhine and Danube freight logistics market was needed. Therefore a detailed design and performance assessment was conducted for implementation by a transnational consortium. This involved the designer of the vessel as well as the operator in cooperation with regulatory authorities.

As a result of these efforts, the designs for two types of Pacscat river freighters (one for the Danube and one for the Rhine respectively) were prepared along with general arrangement drawings. The concept behind each design is to provide the environmental benefits of high efficiency and low wash while possibly doubling speed.

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Effective damping of vibration in aircraft rotor blades

Insight gained from a unique set of experiments funded through FP5 may be exploited to help make tomorrow's aircraft engines safer.

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The rotor blades in aircraft engines can develop cracks and even break when subjected to extremely high loads, a phenomenon known as high cycle fatigue (HCF). Engineers frequently overcompensate for HCF, often at the expense of fuel efficiency. The Growth programme set aside significant funding to address challenges in aeronautical engineering such as HCF.

The Adturbii project involved a consortium of 16 partners, including engine manufacturers, research institutes and universities, hailing from several different European countries. During the five-year project, engineers with the École centrale de Lyon in France performed a number of experiments aiming to optimise the impact of damping.

A variety of dampers were tested on two blades rotating in a vacuum. This enabled the researchers to eliminate any possible interference from aerodynamic effects and focus specifically on the role of friction. Data was collected from strain gauges fixed to the blades themselves.

This set-up was employed during Adturbii to evaluate damper efficiency for several different blade vibration modes. The researchers from the École centrale de Lyon also manipulated the configuration to investigate the potential of damping to address phase differences derived from engine order variation. The knowledge acquired from the experiments will be used to improve engine simulation software.

Investigating cavitation erosion in diesel engines

Studies were carried out to quantify erosion in the fuel injection systems of diesel engines as a result of cavitation. Experimental and theoretical results were used to enhance the development of an erosion model.

Polluting emissions from diesel engines can be dramatically reduced by increasing fuel injection pressure. However, this can lead to increased erosion in parts of the engine and a reduction in the durability of the injection system. Erosion can be caused by cavitation, the formation and rapid collapse of vapour bubbles in the fuel flow resulting in a shockwave, which can degrade engine components.

One of the main challenges facing Prevero project researchers was to integrate the model with observations of flow characteristics and the resistance of materials to erosive effects.

This required a detailed understanding of how the materials comprising the injector system were affected by the fuel flow characteristics.

Researchers from the Laboratoire des écoulements géophysiques et industriels (LEGI) in Grenoble, France, undertook experiments to verify the erosion model. The model was validated both from a hydrodynamic and a materials perspective and used to predict incubation time and erosion rate.

The model revealed that the cavitation region fluctuated in size. The size and location also matched the area of erosion recorded from experimental observations. Erosion was predicted in the region which experienced bubble collapse, which also agreed with the observed measurements.

Project partner AVL List GmbH incorporated the erosion model into the FIRE computer program, which they had developed. The erosion model was validated by AVL using results from LEGI. The ability to predict the probability and rate of erosion meant less time spent in developing new prototype engines thereby reducing costs.

Robots reach new levels of accuracy and adaptability

The precision of industrial robots is influenced by various mechanical effects. Technology developed in the Arflex project improves positioning accuracy by 10 times compared with previous generations, while providing ample application flexibility to meet the needs of large and small users.

The ability of robotic tools to handle tasks requiring very tight tolerances is limited by mechanical effects such as flexing of the arms, imprecision in the coupling joints, gearbox backlash, general non-linearity and friction. In Arflex, a seven-member consortium led by Italian SME EICAS Automazione has succeeded in achieving a 0.1 mm absolute positioning accuracy of the tool centre point (TCP) — a tenfold improvement over earlier systems.

At the same time, it has provided flexibility and ease of use through the application of advanced technologies in control theory, embedded systems, sensor devices and vision systems. Added advantages are that the innovative solution is inexpensive and able to operate as a plug-and-play resource in an industrial environment.

In order to correct the positional error of a robot, a suitable sensor system has to be located beyond the active tool, or 'end-effector', in order to measure the gap between it and the appropriate reference position. The Arflex concept entails direct measurement of both the position and orientation (collectively described as the 'pose') of the TCP by means of multiple cameras fixed around the robot, with real-time control to ensure constant accuracy.

The system includes a specially designed contactless sensor able to measure the pose of a mobile object. Sophisticated self-calibration procedures make this fully autonomous and readily adaptable to different working conditions. As a result, it is possible to use low-cost cameras, without the need for expensive calibration procedures.

The Arflex system works in two operating modes:
- start-up calibration mode — using advanced algorithms as the basis for fully automated self-calibration in relation to the robot and the working environment, without requiring any accurate prior knowledge of the camera installation;
- normal mode — where the cameras measure the TCP position and attitude during routine operation, so that the vision control loop can compensate for any error and assure the required accuracy.

To optimise performance under all working conditions, the self-calibration procedures are designed to recover errors due to non-ideal characteristics of the vision sensor and optical lens. Furthermore, fault detection, isolation and recovery (FDIR) algorithms implemented in the core system enable it to complete a task, even in the event of smart camera failure.

Multi-hierarchical control architecture, implemented on a COMAU C4G open controller, provides a good combination of accuracy and flexibility. Importantly, it allows existing robots and their associated control systems to remain essentially unchanged.

The robot's own controller forms the lowest architectural level, providing commands to the motors for the execution of movements to perform specific tasks. All that is necessary is to make it open to receive and implement reference trajectory corrections sent from the higher levels of the Arflex controls, where the vision control loop receives the flow of pose measurements and determines the adjustments to compensate for positioning error.

This structure allows the system configuration to be both modular and distributed, with sensors that can be positioned or changed depending on the application requirements. It also permits further control functions to be incorporated at a higher level. One example is a force compliance control loop developed by research partner Fraunhofer IPK-FHG using a software-controlled force sensor to measure external forces acting on the TCP and also to modify the trajectories accordingly. The robot can thus follow profile changes on a surface, or react to forces applied by an operator during a task involving human-machine interaction.

A crucial part of the research was the construction of a powerful simulation environment, founded on the Eicaslab platform for automatic control design, forecasting and testing. Algorithms designed and validated in such an environment are compatible with the real-time requirements and are naturally suited for integration into the hardware platform without changing the code. This ability to shift rapidly from prototype to field application makes it a simple matter to transfer control functions to the actual hardware and software components.

The Arflex system also accommodates the storage of a large volume of data (system variables, states of robot and control system, host commands, measurements, etc.) that can be used to perform offline analysis. This feature allows replication of experimental field trials in the simulation environment, where control algorithms can be evaluated and verified in considerable detail.

Today, there is a real demand for industrial robots working at higher accuracies than the best available to date. In aerospace applications, riveting and drilling operations require 0.1 mm positioning — as do metal cutting, milling and deburring in other critical sectors. A 0.15 mm maximum error path is also desirable in sensor-guided robotic laser welding.

For SMEs to adopt robotic production, flexibility and adaptability are overriding considerations. Such businesses tend to manufacture in small batches, for which robots must be readily pre-programmable and easily switched between differing procedures — which is where facilities such as force and compliance controls can be especially advantageous.

The Arflex concept meets all of these needs, opening the door to wider deployment of industrial robots to the benefit of both large and small European enterprises.

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European expertise in machining applications

Significant progress was made toward developing environmentally-friendly grinders in the context of an FP5 RTD project.

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Grinding is an essential machining procedure. Unfortunately it consumes large amounts of energy and materials. The Growth programme invested heavily in the development of new grinding technology. The ENGY project, which brought together experts from both industry and academia from across Europe, is a prime example.

Saint-Gobain Abrasives Ltd, a leading manufacturer of grinding tools headquartered in the United Kingdom, designed new grinding wheels and then constructed them from cubic boron nitride (CBN), an extremely hard material. They managed to extend component life while at the same time reduce the amount of energy consumed by the equipment.

Encouraged by these results, Saint-Gobain Abrasives Ltd attempted to transfer the new technology to grind hardening. They concluded that further testing is required to resolve issues related to control before the procedure can be implemented in an industrial setting.

The structural advances achieved during ENGY were, however, deemed mature enough for immediate use in several different grinding applications. The initial feedback obtained by Saint-Gobain Abrasives Ltd indicated that the new grinders lasted up to three times longer than their conventional counterparts. Furthermore, it was possible to maintain good geometry without causing burns.

Dry lubricants for stamping dies

An EU-funded project consortium combined their expertise to develop a dry stamping process based on coated self-lubricating dies. The low-friction surface coatings were applied using the thermal spray process and wear resistance and friction coefficients were investigated.

The goal of the Ecostamp project was to develop a dry lubricant as an alternative to the toxic liquid lubricants used in sheet metal stamping. Exposure to the lubricants can result in skin diseases including dermatitis, tumours and changes in skin pigment.

Reduction of harmful liquid lubricants can also contribute to the EU's policy for sustainable development and help European companies achieve certification for the environmental management standard ISO 14001. Furthermore, significant cost savings can be achieved by managing and reducing the negative environmental impacts from sheet metal forming lubricants.

Researchers from the Ecostamp consortium used thermal spraying to coat the surface of stamping dies with a composite material made up of solid lubricant. Different amounts of graphite and chromium carbide were mixed with a nickel-chrome metallic matrix before being deposited onto a steel substrate with an atmospheric plasma spray.

Following the spraying of the dry lubricant on the steel, results indicated only minor levels of wear and a low friction coefficient. The Ecostamp research team ascertained that the friction coefficient was reduced when the graphite content was increased. The optimal level of wear resistance was achieved with a graphite content of 35 % by volume.
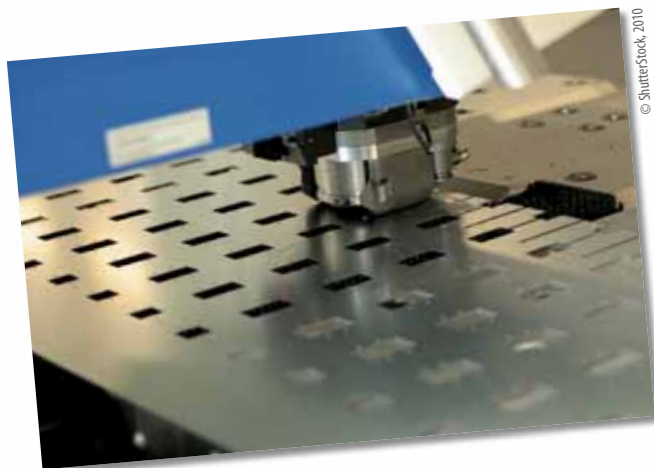
Innovative technology for quiet punching

Integration of solutions for vibration in the design of industrial machinery can certainly improve their sound quality, but it will not prevent noise problems. The Noiseless project considered a relatively new method for noise reduction, which is based on active vibration control.

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The evolution of production towards a constant increase in performance has been associated with an increase in the machines' operational speed together with a reduction in the weight of their mobile components. As a result of these two tendencies, the problem of vibration and noise pollution in industry is more and more widespread.

Recently acquired knowledge of the damping and noise-absorbing properties of different materials has opened the way to new possibilities through the application of passive and active noise control techniques. Though they provide an adequate solution for the reduction of noise emissions at low frequencies, passive methods such as the use of noise-absorbing materials often lead to an unacceptable increase in mass and volume.

The Noiseless project therefore proposed an alternative method to control repetitive impact noise produced by punch press machines as close to the source as possible. In active structural acoustic control (ASAC), minimisation of noise emissions is achieved

Activated carbon leading the way in purification solutions

European research has shown that activated carbon can be produced from polymeric materials. Despite the inevitably higher cost as compared to carbon derived from natural raw materials, the enhanced absorption properties of these new materials open the way for innovative purification solutions.

Activated carbon has become an attractive solution for an increasing number of applications ranging from tertiary water treatment to supercapacitors. These large scale applications reflect the high throughput of the most commonly used process for its preparation from wood, coal or coconut shell.

The relatively low purity of activated carbon produced in rotary kilns, however, hinders its wider use in demanding electrochemical and biomedical applications. Furthermore, it suffers from substantial particle to particle variations. The Creation project aimed to overcome these problems through the carbonisation of phenolic resin.

In particular, the Creation project focused on the development of a synthetic carbon material, the pore structure of which is maintained up to a very high degree of activation. Mast Carbon Technology Ltd, specialising in activated carbon, was behind this new material which evolved from the company's research into new polymer-based carbon materials.

Porosity, which influences the performance of carbon materials in a multitude of applications, was introduced with the use of polymer solvents on precured resin powder. Once control over the pore structure was ensured, the ability of the carbonised phenolic resin to recover catalysts used in the synthesis of fine chemicals was put to the test.

Typically, finely powdered activated carbon with a mean particle diameter of less than 20 microns is used in stirred autoclave reactors. Mast Carbon Technology Ltd found that highly porous carbon in the form of beads approximately 500 microns in diameter outperformed their conventional counterparts.

These results have opened the way for applications beyond the recovery of catalysts. In the future, these novel carbon materials can be used in the filtering of blood as well as the absorption of solvents and other volatile chemicals released from industrial processes.

Deactivating bacteria in water using sunlight

This project tested a method of purifying drinking water without using added chemicals but instead, a photocatalytic solar reactor system. The results demonstrated that this method can be applied to the problem of how to purify drinking water simply in remote locations, the solution to which could save lives in developing countries.

The Solwater project initiated research into the development and testing of a fully autonomous solar reactor system. The idea behind this was to use it for drinking water purification in remote locations. This process allows for purification without any chemicals needing to be added.

The scientific and technological requirements for this research were based on analysing solar disinfection by heterogeneous photocatalysis. This involved using sol-gel immobilised titanium dioxide (TiO_2) films over glass rings. The drinking water was collected from a Mexican drinking water source that had been naturally polluted by coliform bacteria. It was then exposed to sunlight in plastic bottles and was measured for disinfection effectiveness.

The results of the experiments conducted showed that on a sunny day, disinfection with immobilised TiO_2 needed 15 minutes of irradiation to reduce the faecal coliforms content to zero and 30 minutes to destroy all the coliforms. It was demonstrated by the researchers that the disinfection process using TiO_2 keeps water free of coliforms for at least seven days.

Ciemat, one of the project partners, contributed by conducting several sets of experiments. In particular, these researchers performed experiments using water suspensions of TiO_2 in a reactor and on an Ahlstrom paper matrix. They concluded that the total photocatalytic deactivation of pure *E. Coli* suspensions is a consequence of the combined effect of sunlight and the oxidant substance generated in the TiO_2.

Potential applications of these research findings could include disinfecting water in rural areas in developing countries in the simplest of ways. It is also a possibility that this method be used, in the short term, to disinfect naturally polluted water in areas where distribution systems have collapsed due to extreme weather phenomena.

by modifying the machine's vibrations using dampers directly attached to the vibrating components.

More specifically, project partner, Cedrat Technologies in France focused on the use of piezoelectric dampers for vibration control. The key benefits of using piezoelectric dampers instead of other control actuators are their low weight and volume. Furthermore, when combined with high power linear amplifiers, multiple dampers can be incorporated into the machine's structure.

By multiplying the available electrical power of standard power supplies, the high-power amplifier can provide the voltage levels needed to drive the piezoelectric dampers. They also allow for the fine tuning of the control system and ultimately for the control of noise over a wide frequency bandwidth. The Cedrat Technologies' experience in developing smart control systems has made possible the wider use of piezoelectric dampers for reducing noise produced by industrial activities.

Innovative compounds for optical sensors

A novel photoluminiscent polymer has been developed within the framework of the OPAMD project for cost-effective and environmentally-friendly optical sensors.

Among the various methods implemented so far for the detection of nitro-aromatic compounds such as explosives and herbicides, fluorescence quenching seems to be the most promising for the next generation of optical sensors. Quenching refers to the decrease in the fluorescence intensity of specific materials containing emissive and charge-transporting compounds.

Numerous inorganic materials can be used to identify the presence of nitro-aromatic compounds by a clearly distinguishable change in their photoluminescence. However, the interest in replacing inorganic materials in optical sensors with organic molecular materials has been increasing because of their ease in fabrication and low cost.

Within the framework of the OPAMD project, researchers at the laboratories of Thales Research & Technology in France synthesised a molecularly functionalised polymer from the aromatic monomer styrene, PST-NI. With the introduction of a moiety of naphthalimide chromophores in polystyrene, they achieved fluorescence quantum yields in thin solid films, which can reach up to 60 %.

Similar spectroscopic properties were observed for solutions, indicating the absence of interactions between polymer side chains. The absorption and fluorescence spectra of PST-NI were also studied after the introduction of different organic pigments. Addition of quinacridone and perylene imide chromophores resulted in the fluorescence intensity peak being displaced towards the green and red portion of the visible spectrum, respectively.

Moreover, the fluorescence lifetimes of PST-NI were measured both in the presence and absence of nitro-aromatic compounds, such as 2,4-dinitrotoluene (DNT). The drop in the fluorescence intensity verified upon several minutes of exposure to DNT did not exceed 50 % which makes these polymeric materials very attractive for sensing applications.

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Optoelectronics to play key role in sensor development

Research headed by the University of Manchester in the United Kingdom indicates a promising future for optoelectronic sensors with regard to biological processes.

The need for rugged yet cost-effective sensors for applications such as waste processing and environmental monitoring has never been greater. Important research in this field was supported by the Growth programme. The University of Manchester (UoM) assembled a team of experts in the context of the Matinoes project to assess the potential of optoelectronic technology.

The fruit of their labour was an instrument capable of measuring the level of oxygen quenching of fluorophores and enzymes. It induces excitation at a specific wavelength then collects and amplifies the signal using a photomultiplier tube. Monitoring the flow of photons over time provides important feedback about the decay in fluorescence.

The UoM engineers exploited optical theory to determine oxygen levels at the fluorophore sites using a ratiometric technique. It involved successive measurements of light intensity to form a ratio that is solely dependent on the decay lifetime. Oxygen quenching can then be determined with the aid of pre-calibrated lookup tables.

During the project, UoM provided the instrument platform to its Matinoes partners to facilitate the testing of unique sensors, such as those suspended in Ormocer® films. In addition, it was also used for the ensuing field trials of the new instruments. Further to these developments, UoM was seeking patent protection for the platform.

Nanocantilevers as molecular sensors

Scientists have combined advances in complementary metal oxide semiconductor (CMOS) circuitry with nanotechnology to produce advanced molecular sensors. Researchers from the EU-funded 'Nanomass II' project fabricated a novel and extremely sensitive mass detector comprising an array of nanoscale silicon cantilevers and CMOS circuitry.

A cantilever is a beam supported at only one end which carries a load along its length or at the other end. Traditionally used in construction for bridges and balconies, cantilevers can now be created on a microscopic scale through nanotechnology. These nanocantilevers can be used to undertake mass measurements, thereby acting as mechanical mass sensors. The minute cantilevers were integrated with CMOS circuitry, which provided a readout signal, using a nanolithographic etching process.

Mass added to the cantilever was recorded as a shift in resonant frequency. This occurred when nanometre-scale particles were deposited on cantilevers which had been electronically excited by an electrode. A team of scientists based at the Autonomous University of Barcelona measured the mass of a drop of glycerine, with a mass of only 40 femtogram, using an electron beam.

A gold probe for scanning tunnelling microscopy (STM) was used to deposit the drop

Detecting the spring constant of nanoscale cantilevers

It is now possible to accurately measure the spring constant of nanoscale cantilevers thanks to the efforts of researchers at Lund University in Sweden.

The ability to produce sensors on the scale of nanometres has opened up a new range of applications. For example, environmental monitoring may eventually be able to target individual molecules of pollutants.

The IST programme funded an innovative project entitled 'Nanomass II' that aimed to develop a new, highly sensitive mass sensor based on nanoscale cantilevers. Once the cantilevers were fabricated, it was necessary to determine their mechanical properties, specifically the spring constant.

The research was performed by physicists with Lund University. They employed an atomic force microscope (AFM) in contact mode. The spring constant of the AFM probe was known. Through careful modifi-cation of the signal, the scientists managed to generate a fixed force in the order of nano-newtons. Scanning enabled precise quantification of the amount of deflection along the entire length of the cantilever, something previous methods had not been able to achieve.

By varying the magnitude of the force applied and measuring the subsequent displacement, the team at Lund University was able to determine the spring constant of the cantilever. Large deflections indicated a high degree of flexibility in the cantilevers, but no lasting deformation was detected following the experiments. The 'Nanomass II' participants believe the relative simplicity of the AFM technique constitutes a significant advantage over other approaches.
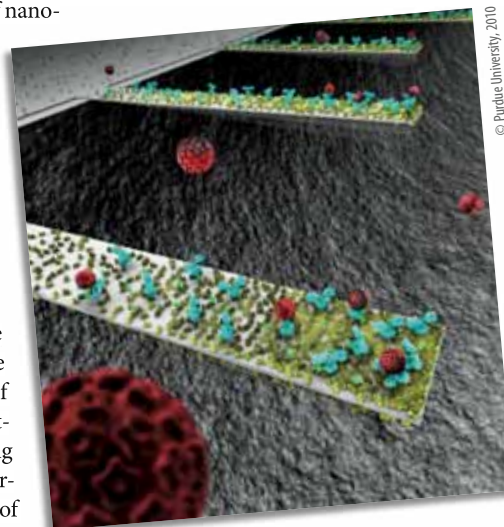
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Accurate measurement of current loss in superconductors

Researchers in the United Kingdom have discovered not just one, but two ways that, when applied together, can accurately measure individual current losses in superconducting materials.

High-temperature superconductors (HTSs) have the potential to revolutionise power transmission. The EU, realising the importance of supporting innovative research in this area, funded the 'Big-powa' project through the Growth programme.

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During the project, several different Bi-2223 prototypes were developed with the aim of minimising alternating current (AC) losses. Whereas previous research efforts only managed to measure the total AC loss, engineers with the University of Southampton succeeded in determining AC loss of individual components.

This important breakthrough was made possible by the creation of two new experimental protocols. The first protocol exploits the third harmonic of the pick-up voltage, a direct approach to measuring superconductor loss. Also, indirect measurements of the coupling current loss are derived by measuring the total loss from which the AC loss of the superconductor is deducted. The second protocol relies on a pair of voltage taps configured in parallel with the applied field and at right angles to the longitudinal direction. This enables direct measurement of the coupling current loss.

The 'Big-powa' participants recommend combining the two protocols for optimal results. In addition to facilitating the accurate measurement of individual AC loss components in superconductors, the new techniques may also provide valuable insight into the behaviour of HTSs in general. Ultimately, this is expected to enable the production and use of commercial HTS applications.

onto the free end of the nanocantilever. The CMOS readout circuitry was used to measure the change in resonant frequency before and after placing the drop, enabling the researchers to determine mass sensitivity. Operation of the sensor within a vacuum can result in an increase in sensitivity.

A sensor comprising a line of nanocantilevers can be used to monitor a range of physical and chemical processes. The technology can be used to integrate the extremely compact and highly sensitive sensors into a portable device for biochemical or environmental applications. For further information please visit the project website at: http://einstein.uab.es/_c_nanomass/Introd.html

INDUSTRIAL TECHNOLOGIES

Lead-free solder paste for electronic systems

A European consortium was established to replace conventional tin/lead alloy soldered assemblies with a lead-free equivalent. A lead-free solder paste was developed and tested before becoming a standard product.

Europe needs to develop high-density, environmentally friendly interconnection technology in order to compete successfully with products from America and Asia. The development of lead-free solder by the Imecat project will enable European manufacturers to perform in domestic and foreign markets following a ban on lead in solder.

The Imecat project developed lead-free solder paste for ecologically sound assembly technology of electronic systems. The consortium comprised nine partners from five different EU Member States including W. C. Heraeus GmbH & Co. KG an expert in the electronic development and commercialisation of interconnection materials.

The Heraeus team developed a standard solder paste using a 'type 3' powder with a tin/silver/copper alloy suspended in a flux medium. Different factors were investigated including soldering quality, solder printing, and resistance to corrosion.

Soldering quality was maximised using wetting performance and solder balling tests which were carried out in both air and nitrogen. Solder balling can create short circuits thereby affecting reliability, particularly when devices become reduced in size.

Different factors affecting printing behaviour were also investigated, including fine pitch capability, stencil life and cold and hot slump. Slump, the collapse of the applied solder due to gravity, is particularly undesirable as it causes spread of the material beyond the area where it was initially deposited.

At the end of the testing process the developed paste was compared with two other products already found on the open market. The paste is now a standard product and is also commercially available.

The researchers also developed a lead-free paste for the wafer bumping process using 'type 6' solder powder which has the smallest particles specified according to national and international standards. The team tested four different lead-free alloys, the most suitable of which was SnAg4Cu0.5, which formed the basis for a novel product that is available for all manufacturers and interested consumers.
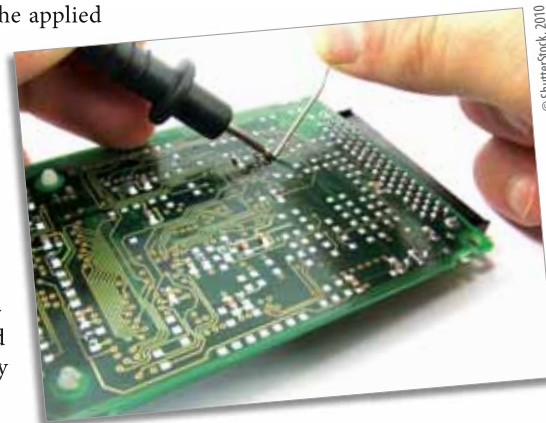
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Test board for evaluating lead-free solder

Lead poisoning can be responsible for blood and brain disorders particularly in children and, as a result, its use in solder has now been banned. An EU-funded consortium has investigated a viable alternative to lead-based solder paste.

The use of lead in the manufacture of electronic and electrical equipment was prohibited under the Restrictions of Hazardous Substance (RoHS) Directive. The metal was banned due to its detrimental impact on human health and the environment. In order for a ban on lead in solders and finishes to be effective a suitable replacement material needed to be developed.

The EFSOT project created a test board for evaluating the reliability of the new lead-free solder paste. The paste can be applied to a broad spectrum of applications, ranging from consumer to automotive electronics.

The test board was used to validate different types of very fine pitch printing and soldering. It was also used to confirm the solder's suitability for a number of other more specific properties. These included ease of cleaning, insulation, power components soldering and compatibility with different finishes for printed wiring boards.

The design of the test board reflected the different standard patterns of three industrial project partners, which were compared. The industrial partners used their designs to manufacture boards and validate a range of processes for lead-free solder. Researchers identified the design which gave the best results for high-volume production using automated optical inspection.

The EFSOT project involved collaboration between technical and environmental experts who focused on the entire life cycle of solder. The life cycle extended from solder production to the manufacture of printed wiring boards and the reuse and recycling of electronic equipment.

Electronic nose under test

European researchers have developed an electronic chemical biosensor incorporating mammalian olfactory receptors. Tests revealed that the receptors continued to mediate normal chemical responses in their new electronic environment.

The fusion of nature with nanotechnology promises to enhance the quality of life for every citizen in society. One area with huge potential is electronic sensor technology. The reduction or removal of human involvement in the detection of toxic substances could vastly improve safety and accuracy standards in a range of applications.

The aptly named 'Spot-nosed' project, funded by the EU, aimed to develop olfactory nano-biosensor arrays. Nanosomes some 40 to 60 nm in size were produced that housed the olfactory receptors. These were then immobilised onto solid supports on a sensor chip.

Following tests to verify the attachment of the nanosomes, the response of the olfactory receptors to odorant molecules was monitored. Odorant molecules can be very small and their binding to the receptors cannot therefore easily be detected. The researchers therefore applied surface plasma resonance technology using a

Sulphur traps reduce pollutant emissions

New nano-structured materials, developed during the Nanostrap project, will help engineers to eliminate the poisoning of catalytic converters by sulphur compounds.

The current strict environmental legislation demands advanced concepts to reduce the emission of harmful gasses. Reducing the emission of nitrogen oxides (NOxs) emitted by diesel and lean-burn petrol engines is one of the challenges faced. These fuel-efficient engines produce exhaust fumes that are particularly rich in oxygen. A conventional catalytic converter is therefore not suitable for converting the generated NOx into nitrogen.

The Nanostrap project was funded under FP5 to investigate the addition of specific components, such as barium, to store the NOx formed. For this new type of NOx storage-reduction catalytic converter, the fuel is alternately combusted in the engine under oxygen-rich and fuel-rich conditions. During a long oxygen-rich period the generated NOx is stored in the barium component. When this component becomes saturated, an oxygen-poor emission gas is produced and the catalyst is regenerated.

Research work conducted at the Technische Universität München in Germany addressed the only limitation for an immediate application of the NOx reduction-storage concept. Due to the high affinity of NOx storage components to sulphur, the storage capacity of the catalysts decreases rapidly in the presence of sulphur oxides (SOxs). To remove SOx before they reach the catalytic converter's materials, an innovative sulphur trap was developed.

The sulphur trap was based on a new class of nano-structured porous materials that ensured effective storage of SOxs at temperatures lower than 300 °C. More specifically, metal-organic frameworks with copper ions linked by benzene-1,3,5-tricarboxylate molecules were impregnated with barium chloride ($BaCl_2$). This combination of materials offered well-defined pore structure, in addition to large pore sizes. The superior uptake capacity of the sulphur trap, which reached 50 ppm of SO_2 in an oxygen-rich atmosphere, was verified by means of the X-ray scattering and the Brunauer, Emmett, Teller techniques.

Highly charged ion trapping and laser spectroscopy

Physicists from the Hitrap project designed a set-up for studying highly charged ions (HCIs). The ions, such as hydrogen-like lead and lithium-like bismuth, were trapped and cooled, and measured using laser spectrometry.

The Hitrap project is an RTD network comprising nine European research teams from seven different countries. The aim of the consortium is to produce novel instrumentation for a range of interactive experiments based on trapped HCIs. The work addresses questions concerning the fundamental properties of physics.

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Project partner Imperial College, London, developed an equipment including an ion source and an ion trap for carrying out laser spectroscopy on HCIs. Researchers used an existing super conducting magnet when designing and building the ion source. The source can produce singly or doubly charged ions, which possess magnetic dipole reactions in the visible range.

The HCIs were trapped, cooled and compressed into a small dense cloud in a Penning trap. The trap was designed to give excellent fluorescent rates, with the intention of measuring ground state hyperfine splitting in the HCIs, using laser spectroscopy. The researchers aimed to achieve an extremely high level of accuracy that would be three orders of magnitude better than previous results.

The use of laser spectroscopy and the cooling of HCIs in Penning traps have helped to provide valuable insights for scientists. Physicists now have a much better understanding of how ions behave when confined in traps and subject to excitation by quadrupole fields.

Findings from the experiments will enable researchers to achieve optimum use of the Penning trap designed under the auspices of the Hitrap project. The work will also lead to a deeper knowledge of laser spectroscopy, including the detection of low light levels. The data collected by the Imperial College team will contribute greatly to further Hitrap experiments.

Biacore instrument to detect the biochemical reactions involved in the olfactory response.

Levels of Golf, a G protein that mediates biochemical cascades leading to the olfactory response, were measured. Despite the fact that immobilisation of nanosomes was not verified, Golf was detected in its active form when heptanal odorant stimulated its release.

Remote sensing can mean the removal of danger during environmental monitoring. There is also potential for a vast improvement in the accuracy of testing in the health care and food safety areas. Due to the natural specificity of olfactory receptors, the electronic biosensor can be designed according to the target odorant.

See also page 27 (Fixed olfactory receptors for electronic noses)

The following upcoming events were selected from the event diary of the Directorate-General for Research and from the CORDIS event calendar. For further information on past and upcoming events, please visit:

http://ec.europa.eu/research/events

http://cordis.europa.eu/events

Workshop series on gender aspects in research

The EU-funded 'Gender in research — toolkit and training' project is offering a series of training workshops on how to integrate gender aspects into FP7 research between September 2009 and November 2010.

These one-day training sessions are intended for anybody interested in rendering research gender-sensitive: researchers, project managers, national contact points (NCP), expert evaluators and others. The sessions will provide practical guidance on how the gender dimension can be integrated in research, using clear examples of how gender is relevant to existing FP7 projects.

Training sessions will take place at different locations across Europe and address different areas of research. The following dates have been set up to May 2010:
- 12 March 2010, Montpellier, France: health/food, agriculture and biotechnology.
- 18 March 2010, Barcelona, Spain: science in society/health.
- 26 March 2010, Brussels, Belgium: socio-economic sciences and humanities/health.
- 7 May 2010, Sofia, Bulgaria: science in society/socio-economic sciences and humanities.
- 19 May 2010, Urbino, Italy: health/science in society/environment.

For further information, please visit:
http://www.yellowwindow.be/genderinresearch/index_calendar.html

European conference on nanofilms

The 'European conference on nanofilms' (ECNF 2010) will be held in Liège, Belgium, from 22 to 25 March 2010.

The event will centre on technical talks, poster sessions and thematic roundtables, as well as numerous networking opportunities. Participants will also have the opportunity to select and meet scientists and/or business partners in one-to-one meetings.

Topics covered by the event will include:
- advanced nanocoatings for mechanical and tribological applications;
- recent progress in biomedical coatings;
- stimulus responsive and multifunctional coatings for a smarter world;
- nanosystems: fundamental approaches towards understanding;
- from nanoparticles to nanofilms: manufacturing methods and processes;
- from science to society: mass production and integration of nanofilms.

For further information, please visit:
http://www.vinf.eu/ecnf

Conference on the integration of miniaturised systems

A European 'Conference and exhibition on integration issues of miniaturised systems — MEMS (micro-electro-mechanical systems), MOEMS (micro-opto-electromechanical systems), ICs (integrated circuits) and electronic components' will take place on 23 and 24 March 2010 in Como, Italy.

The event will provide a communications platform for research institutes and manufacturers to exchange know-how on smart systems integration and create the basis for successful research cooperation with a European focus.

Smart systems integration allows users to form a component system which is able to gain information from the environment, process it electronically, communicate signals and data and give enabled feedback.

The event is part of the activities of the European Technology Platform on Smart Systems Integration (EPoSS).

For further information, please visit:
http://www.mesago-online.de/en/SSI/main.htm

Workshop on the planet Mars

A workshop on the planet Mars will be held in Les Houches, France, from 28 March to 2 April 2010.

The goals of the workshop are to integrate the main results of recent Earth-based observations and the missions to Mars (MarsExpress, Mars Reconnaissance Orbiter, Phoenix and Mars Exploration Rovers) into a new global picture of Mars evolution.

The event aims to further discussions among scientists of different disciplines and help refine the scientific goals of future missions to Mars. This workshop will also be an opportunity for young scientists to be updated on the most recent results and to be trained in some specific data processing techniques.

For further information, please visit:
http://www.sciops.esa.int/index.php?project=MARSEXPRESS&page=planet_mars3

Conference on photonics

'Photonics Europe', a five-day conference on photonics, optics, lasers and micro/nanotechnologies will be held in Brussels, Belgium, from 12 to 16 April 2010.

The gathering will host 19 conferences, special forums, events, courses, workshops and exhibitions. The conferences include keynote presentations from international experts and academics. Plenary, technical, networking, professional, and student events are also scheduled.

A 'Hot topics in photonics' session will aim to present the most important developments in the field for researchers and engineers.

For further information, please visit:
http://spie.org/photonics-europe.xml

Conference on the European RTD Framework Programmes

A conference entitled 'The European RTD Framework Programmes: from economic recovery to sustainability' will be held in Valencia, Spain, from 13 to 14 April 2010. The conference, held under the auspices of the Spanish Presidency of the Council of the EU, will be the core of the 'FP7: European innovation and RTD transforming sectors' week'.

The conference will also be the key public event in launching a series of new public private partnerships (PPPs) as a corner-

stone of the smart investments of the 'European economic recovery plan':

- Factories of the future (FoF)
- Energy efficient buildings (EeB)
- Green cars (GCI)
- Future internet (FI)

The 'European economic recovery plan' seeks a new deal on vital new and traditional industrial sectors in order to foster economic growth and creation of employment, as well as maintaining our high standards of quality of life. Knowledge, technology, innovation and new markets have complementary roles for reaching these goals.

The first day, 13 April, will be devoted to EeB PPP and FoF PPP, and 14 April will cover GC PPP and FI PPP. Side events within the week include meetings of the Energy Efficient Buildings (E2B) association and European Factories of the Future Research Association (EFFRA) on 12 April, the '4th future internet assembly' on 15 and 16 April and other co-located events organised together with the European Commission.

For further information, please visit:
http://www.r2sconference.eu

Forum on frequency and time

The '24th European frequency and time forum' (EFTF 2010) will be held from 13 to 16 April 2010 at the Space Research and Technology Centre of the European Space Agency (ESA/ESTEC) in Noordwijk, the Netherlands.

The event is a yearly conference and exhibition providing information and exchanges on recent advances in the area of time and frequency scientific research, industrial development and end-user applications.

EFTF 2010 will start with a plenary session reviewing the status and development of major space missions with relevance to time and frequency applications. This will be followed by two and a half days of parallel technical and poster sessions.

The event will be preceded by a series of tutorials on 12 April, and concluded with a visit of the ESTEC laboratories and space facilities on 16 April.

For further information, please visit:
http://www.eftf2010.org

European conference on antennas and propagation

The 'European conference on antennas and propagation' (EUCAP) 2010 will take place in Barcelona, Spain, from 12 to 16 April 2010.

EUCAP 2010 will combine plenary sessions with invited keynote papers, discussion sessions, workshops, short courses, posters and an exhibition. The event aims to be a place for the exchange of scientific and technical information at the academic and industrial levels.

For further information, please visit:
http://www.eucap2010.org/?pid=114

Conference on e-health, telemedicine and health ICT

The 'International e-health, telemedicine and health ICT forum' (Med-e-Tel) will be held from 14 to 16 April 2010 at the Luxexpo exhibition and congress centre in Luxembourg.

The three-day event will cover a number of sub-events, programmes, and discussions dealing with the sector. Thematic sessions on such topics as telenursing and space technologies for healthcare will be held throughout the conference. Featured presentations include: successful business cases, research activities, pilot projects and practical experiences from health care providers.

The conference programme is divided into education, networking, and business events. Stakeholders from these fields will be able to share and learn from the latest developments and research and explore new opportunities to launch potential business partnerships.

For further information, please visit:
http://www.medetel.eu/index.php?rub=home&page=defaut

European conference on energy

The 'European energy conference' will be held in Barcelona, Spain, from 20 to 23 April 2010.

The conference aims to promote cooperation and thereby stimulate communication and synergy in the fields of physics, chemistry and material sciences, to support technology and engineering in responding to the urgent requirement of secure, ecologically acceptable and sustainable energy systems.

The conference will cover chemistry, physics and material sciences related to energy technologies. In addition to plenary keynote presentations on diverse energy themes, parallel sessions will deal with energy sources, storage and conversion of energy and end-use including energy conservation.

The event is sponsored by the European Science Foundation, European Materials Research Society, European Association for Chemical and Molecular Sciences and the European Physical Society.

For further information, please visit:
http://www.e2c-2010.org

European conference and exhibition on biomass

The '18th European biomass conference and exhibition' will be held from 3 to 7 May 2010 in Lyon, France.

The conference will be a platform for discussing the outcome of the United Nations climate change conference in Copenhagen and national energy strategies.

Topics to be discussed at the event will cover a range of bioenergy issues: resource availability, conversion technologies, demonstration projects, integration in the energy system, environmental impact and market deployment, as well as the need for policy initiatives.

Presenters and participants will also have the opportunity to see practical applications of biomass for high-quality materials and bioenergy systems in the exhibition part of the conference.

The EU's Joint Research Centre (JRC) is taking part in the technical organisation of the event.

For further information, please visit:
http://www.conference-biomass.com/Welcome.404.0.html

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