



European Commission

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**Special feature****Science, technology, materials and the nano-revolution**

Interview with Andrew Richardson of Lancaster University's Centre for Microsystems Engineering

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Editorial coordination

Evi Ford-Alexandraki

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A nano-revolution in the making?

Nanotechnology is a science of size and number whose potential to improve the quality of life throughout the world has captured the imaginations of many. Despite having been conceived in the late 1950s, nanoscience remains nascent and is a field whose boundaries have yet to be fully delineated. But therein lies a great opportunity as well as a few unanswered questions for European-funded researchers to take up.

*It is for this reason that 'Science, technology, materials and the nano-revolution' is the focus of this edition of research*eu results supplement. We look at a cross-section of some of the latest achievements from EU-backed research consortia, including organic nano-wires and tiny sensors for food quality. Then we take you along on an in-depth and revealing discussion with Professor Andrew Richardson, director of the Centre for Microsystems Engineering at Lancaster University, UK.*

Also in this issue, the biology and medicine section leads with a story about EU-funded researchers who have developed a breakthrough technology that will make cervical cancer screening both inexpensive and rapid.

The energy and transport section leads with an article on a novel magnetic sensor system that could vastly improve airport and airfield surveillance systems. The ingenious system is able pinpoint the exact location and course of an aircraft or vehicle without interference from the surrounding environment.

The top story in the environment section looks at how understanding the forces behind the loss of genetic diversity in Baltic seaweed could provide greater insight into how species adapt to their changing environment.

In our IT and telecommunications section, scientists have applied a new cognition approach and theory that gets robots to learn how to think through action. The concept helps engineers to design software and hardware which allow robots to think about actions in terms of objects, and what can be done with them.

Our lead story in the industrial technologies theme showcases the safety of smart materials, like shape memory alloys (SMAs), in medical devices. SMAs are commonly found in implants, guide wires for catheters, and blood vessel stents.

The issue then ends with a list of exciting events and upcoming conferences in the field of research and technology.

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

We hope you have enjoyed reading our magazine in 2010. We have some exciting themes, covering a wide range of EU research initiatives, planned ahead for 2011. In the meantime, we wish you a Happy New Year!

The editorial team



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Thank you to Prof. Andrew Richardson of Lancaster University for his contribution to the 'special' dossier in this issue



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Frequent acronyms

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

Breakthrough technology offers quicker, cheaper cancer screening

Time-consuming and expensive cervical cancer screening will become a thing of the past thanks to breakthrough technology developed by EU-funded researchers. Their discovery will allow large-range screening by non-medical personnel with almost immediate results and at a much lower cost than is possible with existing technology.

The work is part of the 'Automatic detection of disease related molecular cell activity' (Microactive) project, which was funded under the 'Information society technologies' thematic area of the EU's Sixth Framework Programme to the tune of EUR 1.6 million.

Cervical cancer screening is currently carried out via molecular assays that are cumbersome, expensive and time-consuming and require highly-trained technicians. The researchers said their breakthrough technology tackles all these drawbacks and promises a revolution in diagnostic instrumentation. They used state-of-the-art micro-fabrication and micro-fluidic technology to create desktop 'laboratories', which offer all the advantages of traditional molecular analysis with none of the disadvantages.

Microactive focused on screening for cervical cancer caused by specific strains of the human papillomavirus (HPV). 'It was a good test in that you have a symptom that could be caused by one of seven different viruses, or even two of them, and you want to know which ones,' said Liv Furuberg, researcher at the Foundation for Scientific and Industrial Research (Sintef) and coordinator of the project. She explained that there are over 100 strains of HPV, and the human immune system effectively deals with 97% of them. However, the other 3% are deadly, and so doctors must know the specific strain and whether the virus is active.

Microactive's new laboratories, each of which is about the size of a desktop PC (personal computer), reduces a process that typically takes 20 manual steps down to just 2 and can be carried out by anybody who receives some basic training. There are many possible methods for molecular diagnostics, but Microactive focused on messenger ribonucleic acid (mRNA) as a marker for an active virus. The current dominant testing technology is cell-based tests, but these return false positives at a rate between 50% and 75%. By testing for specific protein-coding mRNAs, Microactive avoided the risk of this problem.



The test is extremely simple. A cervical smear sample is taken in the usual manner and the sample is added to a mixing agent in a syringe, which is then added to the first 'laboratory' in the process. Here the sample is extracted from the syringe, prepared and applied to a disposable micro-fluidic chip, which allows liquids to be transported at very small scales. Once the sample is prepared, the chip can be transferred to the detection module. The first step in the detection process is nucleic acid sequence based amplification (NASBA), used to create a large number of markers. Next biomarkers — lab-developed molecules that only bind to specific nucleic acid strands — are introduced.

'In our tests we looked at just two different markers, because it was [enough] to prove the concept,' said Dr Furuberg. 'But there are eight channels in our disposable chip, and each channel can test for two viruses at a time, so we could test for up to 16 different markers.'

The biggest challenge facing the project was getting a sufficiently high-quality sample for amplification. 'We studied every aspect of the process in detail, even before the cervical smear sample was taken, to try and develop the cleanest approach possible, and it was a series of refinements that allowed us to achieve the level of quality required,' explained Dr Furuberg. The team's dedication paid off; in tests against the current gold standards for HPV detection, the Microactive system performed very well, either matching or exceeding the current state of the art.

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<http://ec.europa.eu/research/infocentre> > search > 18453

Chips for drug trials

Testing drugs can be a long, drawn out and expensive process. A European project is aiming to remedy this by incorporating cell components and drugs on trial onto a biosensor chip.

For a drug to be effective it must first target the appropriate cells and normally gain access to the inside of the cell. The route taken is through the cell membrane — the outer protective cover

made of protein and lipid combined (proteolipid).

The cell membrane filters what passes in and out the cell. Proteins act like

an immigration control mechanism determining what the membrane allows in or not. Not surprisingly then, 50% of all drugs target these biochemical entry gates.

The primary aim of the EU-funded Asmena⁽¹⁾ project is to accelerate the time taken for pharmaceuticals to go from the lab to the chemist's shelf. One way to do this is to increase knowledge



of membrane proteins and how exactly they interact with the drug.

Currently, drug screening relies on markers that fluoresce so its progress can be tracked throughout the cell. However, there is a potential problem in that the marker itself may affect drug performance.

The Asmena scientists are aiming to dispense with label-free testing and replace it with assays placed on a chip. Working in a nano-environment on a chip creates a number of challenges. However, the Asmena scientists are finding appropriate answers during the progress of this project, due to finish in November 2011.

So far, the results are very promising. The proteolipid membranes self-assemble onto the chip and are stabilised with special nano-porous materials. The membranes can be equipped with many different proteins which are then bom-

barded simultaneously with a variety of potentially therapeutic molecules.

The researchers can also follow the fate of the drug after it attaches itself to the membrane protein. A new sensing technique based on fading light detects protein-mediated transport across membranes.

The miniaturised system provides a detection limit comparable with state-of-the-art macroscopic sensors. At the same time, it is as close to single protein molecule detection as sensors based on a single nano-particle.

Combining several assays on a chip will create a versatile platform where many drugs can be tested against different types of membrane protein. Honing drug testing shortens the drug development process by more efficient screening. Moreover, the biosensor chip may remove the need for animal testing and clinical trials on humans will involve fewer risks.

(1)'Functional assays for membrane protein on nanostructured supports.'

Funded under the FP7 programme Cooperation under the theme 'Nanosciences, nanotechnologies, materials and new production technologies.'

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Taking cell research one molecule at a time

A prototype workstation integrating several advanced microscopy techniques is expected to propel molecular biology research to the next level. The first experiments addressing immunology and cancer research have already begun.

The scale at which bio-research is working has shrunk considerably. Molecular biology has been swept up in the race to the nanometre scale along with many other scientific disciplines. Today several different techniques allow scientists to examine life at the sub-cellular right down to the molecular level.

The idea behind 'Single molecular workstation' (SMW), an EU-funded research project, is to combine several different analytical techniques into one piece of equipment. By doing so, the industrial partners and academic institutions involved in the project hope to open up new horizons of cell-based research.

A prototype has been developed that incorporates inverted light microscopy (ILM) and atomic force microscopy (AFM). The atomic force microscope works by 'feeling' the surface of the subject with a mechanical probe. This fusion of technologies allows researchers to simultaneously examine both the distribution and surface topography of living cells at the nanometre level.

Further to successful testing of the prototype, work is now underway to include optical tweezers (OT) in the SMW. This complementary module uses a laser beam to trap molecules to measure microscopic forces and therefore track movement within cells.

A major challenge tackled by the SMW consortium was the design and implementation of a flexible graphical user interface (GUI). It needed to efficiently manage and modify the various measurement protocols in real time. Both the software and hardware components of the system will be optimised as the project moves forward.

The versatility and sensitivity offered by the workstation will enable the research community to better investigate the relationship between structure and function in living cells. Experiments targeting the improved detection of cancer cells have already been carried out with the SMW prototype.

Funded under the FP7 programme Cooperation under the theme 'Nanosciences, nanotechnologies, materials and new production technologies.'

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The researchers found the answers to their questions through genetic juggling tricks on the fission yeast designed to indicate whether a gene is working or not. One of these was to use analog-sensitive genes that are specially mutated. As such, they won't work like the original genes and their function can be worked out retrospectively.

Fission yeast has slightly more than 100 kinase genes and humans have around 500 that modify up to 30% of all human proteins. Identifying the role of different kinases will most likely unlock many of the cell's biochemical secrets.

Success of the project, which has just finished, is undeniable as the project laboratory is now a source of new

analog-sensitive kinase genes that can be used freely by other researchers. As cell division is the very basis of growth and life itself, NPKM research will no doubt feature in the design of therapies at the cell level.

Funded under the FP7 specific programme People (Marie-Curie actions).

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Scientists piece together egg and sperm fusion puzzle

Researchers in Sweden have cracked the mysteries behind the fusion of egg and sperm at the beginning of fertilisation, successfully describing the 3D structure of an egg receptor.

The results, published in the journal *Cell*, help fuel our understanding of infertility and could lead to the development of new types of contraceptives. The research was funded in part by the 'ZP domain structure'⁽¹⁾ project, which clinched EUR 40 000 in a Marie-Curie actions — Human resources and mobility grant of the EU's Sixth Framework Programme (FP6).

For centuries, people have been fascinated by the encounter of gametes, namely the egg and sperm, whose union results in the creation of a new organism. Scientists have understood that during this process, sperm binds to proteins in the extracellular coat of the egg called zona pellucida (ZP) in mammals and vitelline envelope (VE) in non-mammals. Until now, the molecular details of this fundamental biological event have remained obscure, but this is all set to change thanks to this latest study.

Led by Luca Jovine from the Karolinska Institutet in Sweden, in collaboration with Professor Tsukasa Matsuda from Nagoya University in Japan and Dr David Flot from the France-based European Synchrotron Radiation Facility (ESRF), the researchers found the 3D structure of the receptor molecule that binds sperm, called ZP3. The detailed structural information, based on data collected at the ESRF, makes it possible for scientists to begin exploring at the molecular level how the egg interacts with sperm at fertilisation, according to the team.

'Thirty years after ZP3 was identified, this work yields structural information on an egg protein region directly recognised by sperm at the beginning of fertilisation,' the authors wrote. 'Combined with mutational and *in vitro* binding studies, the structure provides insights into many aspects of ZP3 biology, ranging from secretion and polymerization to interaction with sperm.'

The study suggests which parts of the receptor are likely to be directly contacted by sperm and provides new insights into how the sperm receptor is assembled and secreted from the egg. 'The results give a remarkable picture of the female side of fertilisation,' said Dr Jovine. 'But this is, of course, only half of the story. The next step will be to tackle the corresponding molecules on sperm that allow it to bind to the egg.'

The findings have important implications for human reproductive medicine, as they may be able to explain how mutations in the sperm receptor gene could cause infertility, according to the researchers. Past studies have already shown that antibodies against ZP proteins can be 'powerful tools for inhibiting the fertilisation of domestic animals and wildlife, including

primates'. Any advances in this domain would be welcomed with an estimated one in seven couples worldwide having problems conceiving.

The research could also potentially lead to the design of non-hormonal contraceptives specifically targeting egg-sperm interaction, the team said. Such contraceptives could be an attractive alternative to the traditional birth control 'pill' that was developed 60 years ago, potentially having far fewer adverse effects.

Some women who take the 'pill' complain of mood swings and nausea and are at higher risk of blood clots and high-blood pressure. The researchers highlighted that 'no completely novel contraceptive method has been introduced in the last 50 years to address the continuous growth of the world population'.

(1)'Structure determination of the zona pellucida domain by X-ray crystallography'.

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‘We used information from our previous genotyping of the JIC pea germplasm collection to identify exotic lines where we would most likely find rare alleles of Mendel’s gene,’ Prof. Ellis said. ‘Finding a rare second allele was important for independent confirmation of the identity of the gene.’

He went on to say that that was ‘the fourth of Mendel’s seven genes to be characterised at the molecular level: it is also the second where JIC has been involved.’

So what’s next for the researchers? The JIC in particular is now looking into

the germplasm collection for genes and traits that could be used to make peas higher-yielding or of better quality. Peas are able to fix nitrogen from the air through symbiotic relationships with bacteria housed in nodules in their roots. This makes them less dependent on the addition of nitrogenous fertilisers which are a major economic and environmental cost associated with farming because they require high levels of energy for their production. Their use is also a major source of nitrous oxide, a potent greenhouse gas, which along with carbon dioxide and other gases, is blamed for contributing to global warming.

The increased production of peas and other legumes is a good way of ensuring future food security with low-environmental cost, according to the researchers.

Plant scientists from the Biotechnology and Biological Sciences Research Council (BBSRC) in the UK, New Zealand’s plant & food research, unité de recherche en génomique végétale (URGV) in France and the US Department of Agriculture’s (USDA) agricultural research services contributed to the study.

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Study finds noise pollution affects marine life

European and US scientists believe they have discovered a revolutionary way of understanding the effects of high-intensity sounds on marine mammals including whales and dolphins.

Increased shipping, petroleum exploration and production, and military exercises have amplified noise levels in the ocean in recent years, according to the researchers. As much of their work focused on the use of sonar, they hope that naval forces will use their software in the future in order to decide when and where it is safe to use sonar. The findings were recently published in the *Public Library of Sciences (PLoS) ONE* journal.

The researchers from the University of California, San Diego (UCSD) in the US and Kolmården zoo in Sweden have developed a method of moni-

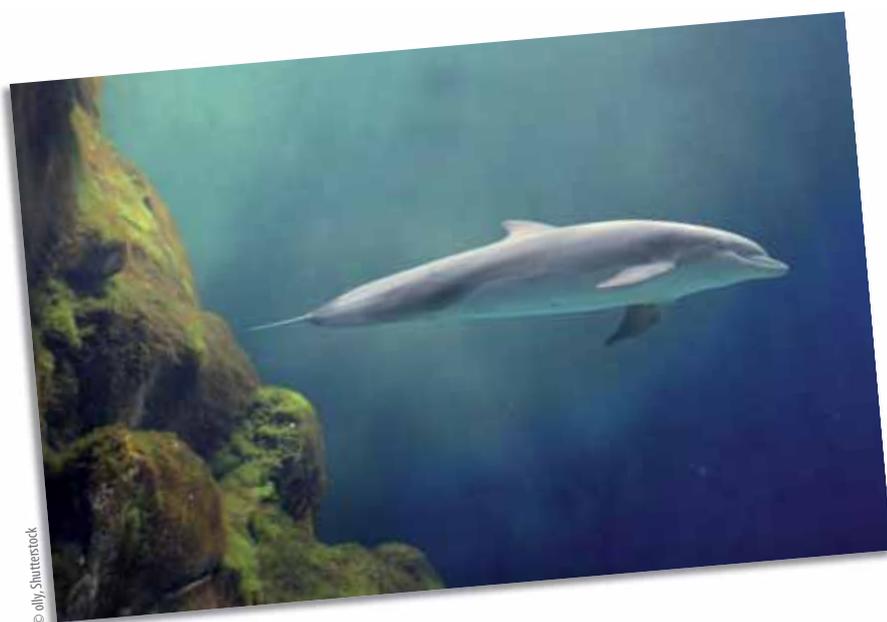
toring the effects of sound on marine mammals that integrates advanced computing, X-ray computerised tomography (CT) scanners, and modern computational methods.

This technology allows scientists to simulate sounds propagated through the virtual specimen and reveal the interactions between the sound and the mammal. It also offers them the opportunity to study a 3D picture of the inside of the head of those mammals, such as Cuvier’s beaked whale, which is known to be affected by noise pollution such as sonar.

‘Our numerical analysis software can be used to conduct basic research into the mechanism of sound production and hearing in these whales, simulate exposure at sound pressure levels that would be impossible on live animals, or assess various mitigation strategies,’ explained Professor Petr Krysl, a UCSD structural engineer who developed the computational methods for this research. ‘We believe that our research can enable us to understand, and eventually reduce, the potential negative effects of high intensity sound on marine organisms,’ he added.

‘Humans introduce considerable amounts of sound and noise into the oceans of the world’ and this can cause serious problems as ‘many marine organisms make acute use of sound for their primary sensory modality because light penetrates so poorly into water,’ Prof. Krysl explained. He pointed out that the researchers focused their work on the Cuvier’s beaked whale because ‘some have stranded and died in the presence of navy sonar’ and ‘the discoveries we made with regard to the mechanisms of hearing in the beaked whale also apply to the bottlenose dolphin and, we suspect, to all types of toothed whales and perhaps other marine mammals.’

Prof. Krysl insisted that the project ‘significantly advances our knowledge of the basic biology of marine mammals’ since ‘hearing is an essential sensory ability for life under water where sound is used for hunting, navigating, and social interaction’. However, he added



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that the team's research had particular significance concerning the navy's need to use sonar.

According to the UCSD researcher, the navy needed to be able to answer questions such as 'is sonar safe to use and under what conditions' and 'can we minimise the impact on marine life and how?' He insisted that this was 'not possible without a basic understanding of biology

and acoustics of the ocean inhabitants' and hence the importance of his research.

The study was partly sponsored by the US chief of naval operations (CNO) and Prof. Krysl said his team would continue its 'current line of research on the beaked whale and conduct validation experiments with the bottlenose dolphin'. He added that the team also planned 'additional modelling refine-

ments that will allow them to investigate the entire sound pathway from the sea water to the entrance to the cochlea and said that these projects address several primary objectives in the navy's plan to understand demographics, acoustic exposure thresholds, and mitigation strategies for living marine resources.

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Cell interactions unveil the mysteries behind immunity

White blood cell interactions or crosstalk may help reveal how immune reactions and inflammation work, leading to better understanding of the immune system.

Enhancing the immunity of the general population has been the dream of many a scientist. Immunity protects people — and mammals in general — against most infections. European scientists are now mapping how the interaction or 'cross-talk' between different innate immune cells strengthens immunity in the early stages of an immune reaction.

The EU-funded project 'Innate immunity crosstalk in immunoregulation' (Innate_crosstalk) has been investigating the interactions between natural killer (NK) cells and neutrophils. NK cells are a specific type of white blood cell that combat viral infections and tumours, while neutrophils are the most common type of white blood cells that appear first at the site of an infection.

Monitoring the interaction between the two helps in understanding adaptive immune responses and how the body deals with inflammation. Although it is known that NK cells kill specific kinds of cells under certain

circumstances, it is important to find out whether NK cells are also toxic to neutrophils, despite both being white blood cells that bolster immunity.

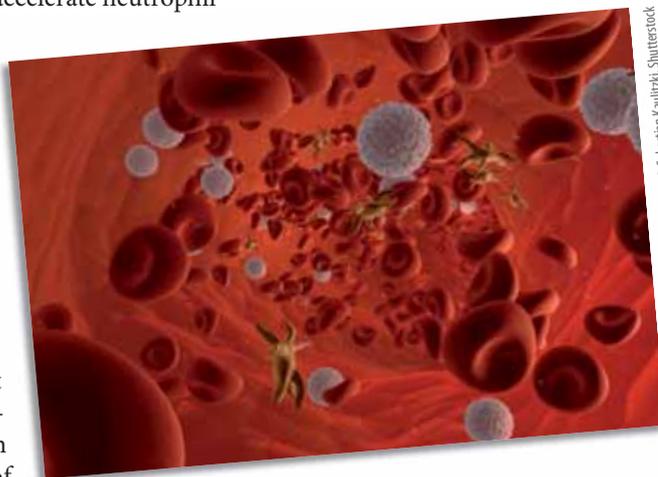
After extensive laboratory testing, results revealed that NK cells do indeed have a detrimental effect on neutrophils, although a limited one. Human NK cells killed certain neutrophils *in vitro*, but only those with innate cell-death programming — or apoptosis. Researchers also concluded that NK cells may accelerate neutrophil death through direct cell-cell interactions.

Project research also tested how this plays out *in vivo*, on human skin, not just in the laboratory. Ongoing research beyond the project will almost certainly shed light on the implications of

NK-neutrophil interactions and the role they play in reducing inflammation. More laboratory studies through enhanced European collaboration is also set to clarify further how these interactions affect the immune system.

The mid- and long-term results are bound to add a piece to the puzzle regarding the adaptive immune response. They may eventually help design better treatment techniques and more intelligent drugs to combat infections and boost immunity.

Funded under the FP7 specific programme People (Marie-Curie actions).
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Watch this space!

Coming up in issue 31 of *research*eu results supplement* a special dossier on 'Education, training and edutainment'.

From 'serious games' to social networks, we delve into what research and digital technologies are doing for Europe's education scene.

EU study identifies genetic variants for asthma

An EU-funded study has identified several genetic variants that substantially increase susceptibility to asthma and which scientists claim will help them develop better therapies for the illness.

The Gabriel⁽¹⁾ project received just over EUR 11 million under the 'Life sciences, genomics and biotechnology for health' thematic area of the Sixth Framework Programme (FP6). The findings of the study were published in the *New England Journal of Medicine*.

The research team, led by scientists from Imperial College London in the UK, analysed deoxyribonucleic acid (DNA) samples from 10 000 children and adults with asthma, and 16 000 non-asthmatics. They then performed more than 500 000 genetic tests on each subject, covering all the genes in the human genome. The study, with contributions made by 164 scientists from 19 European countries plus Australia and Canada, pinpointed seven locations on the genome where differences in the genetic code were associated with asthma.

While some 300 million people worldwide have asthma, with 30 million of these living in Europe, the causes of the disease are poorly understood with genetic and environmental factors

thought to play roughly equal roles. This study suggests that allergies are probably a consequence of asthma, rather than a cause of the disease, and that genetic testing would not help predict who is likely to develop the disease.

For example, childhood asthma, which affects boys more than girls and can persist throughout life, is often linked to allergies, and it has been assumed that these can trigger the condition. However, the study found that genes controlling the levels of antibodies that cause allergies had little effect on the presence of asthma.

The new variants linked to asthma were found in more than a third of children with asthma. The gene with the strongest effect on children did not affect adults, and adult-onset asthma was more weakly linked to other genetic differences, implying that it may differ biologically from childhood-onset asthma.

'Asthma has often been considered a single disease, but our genetic findings suggest that childhood-onset asthma may differ biologically from asthma that is acquired in adult life,' said Professor David Strachan from St Georges, University of London, co-author of the study. The team 'is now investigating whether the causes of asthma differ between people with and without these newly discovered genetic variants.'

'As a result of genetic studies we now know that allergies may develop as a result of defects of the lining of the airways in

asthma,' said Miriam Moffatt, professor of human genetics at Imperial College London. 'This does not mean that allergies are not important, but it does mean that concentrating therapies only on allergy will not effectively treat the whole disease.'

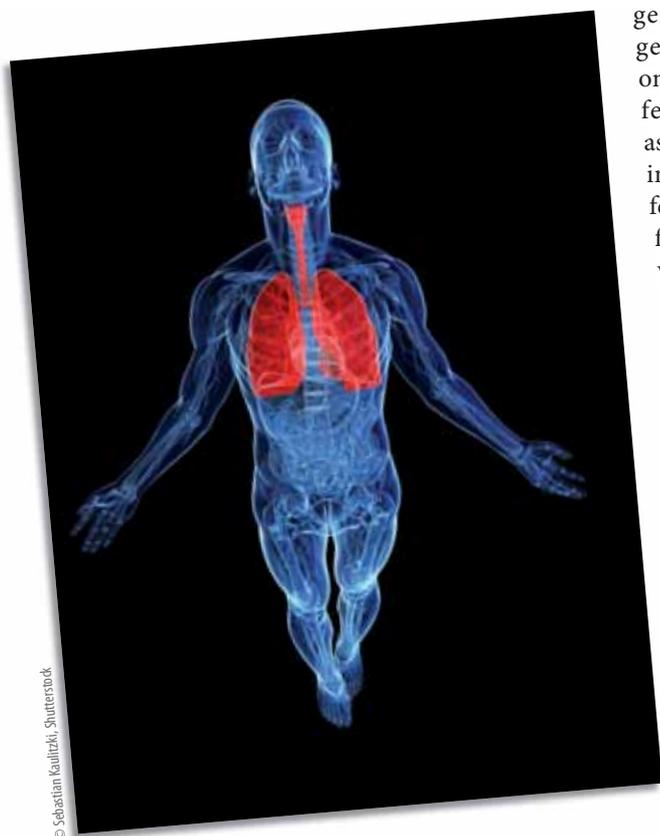
As a result of genetic studies we now know that allergies may develop as a result of defects of the lining of the airways in asthma

Some of the genes identified are involved in signalling pathways that tell the immune system when the lining of the airways has been damaged. Other genes appear to control how quickly the airways heal after they have been injured. Identifying these genes should help direct research into new treatments for asthma, according to the researchers.

The study also found that the genes associated with asthma did not have strong enough effects to be useful for predicting early in life which children might develop the disease. This indicates that environmental factors likewise play an important role in causing asthma to develop.

Co-author Professor Erika von Mutius at the University of Munich explained that the team was investigating the environmental causes of asthma 'particularly by dissecting the strong protective effects of living on a farm. In the next year we will be combining the results from the genetic and environmental wings of the Gabriel study, and we are greatly looking forward to what we may find.'

(1)'A multidisciplinary study to identify the genetic and environmental causes of asthma in the European Community.'

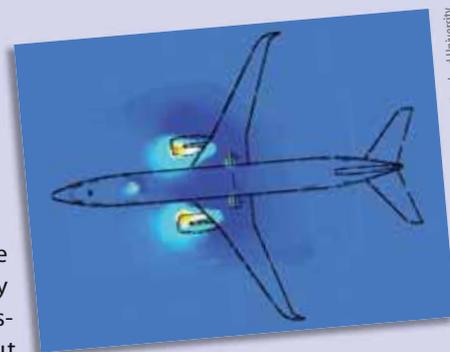


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Next-generation air transport systems

The next generation of airfield surveillance systems is already upon us thanks to the ground-breaking work of European researchers in the Ismael⁽¹⁾ project. Their work on magnetic sensor systems has got the air transport sector's full attention.



Bad weather, poor airfield design, human error and outdated or ineffective ground radar systems can lead to accidents and deaths. One indicator of airport safety problems is the number of near misses between planes, and between planes and ground vehicles — runway incursions.

In 2008, the number of runway incursions at airports under the US Federal Aviation Administration's (FAA) watch hit a record high of 1009. Last year, saw a slight drop (951 incursions) which now looks like being reversed with nearly 900 incursions already recorded in the first nine months of 2010. With air traffic set to increase for the foreseeable future, something needs to be done to improve airfield surveillance before a major accident happens.

This was the overriding rationale of the Ismael research consortium, led by the University of Saarland in Germany, which focused on delivering 'Intelligent surveillance and management functions for airfield applications based on low-cost magnetic field detectors'.

By monitoring tiny fluctuations in the Earth's magnetic field caused by a moving object, like a plane or refuelling truck, Ismael developed an innovative system to increase airport safety even in the worst weather conditions and where other monitoring systems struggle.

Ismael's detector system is designed for use within so-called advanced surface movement guidance and control systems (A-SMGCS). It can improve existing A-SMGCS installations at large airports, but the simple ingenuity of the system means it is suited to smaller airports which usually can't afford complex installations and systems.

The novel approach, tested at three airports in Germany and Greece, relies on an array of small, cheap sensors monitoring the so-called 'magnetic fingerprint' of planes — the slight influence the aircraft's metallic body has on earth's magnetic field.

The technology provides information on the type of vehicle/aircraft and its position, speed and direction. As such, it stands to improve the overall 'situational awareness' in air traffic control, helping airport operators meet future traffic demands while minimising delays and service delivery costs to acceptable levels.

Saving lives and more

Saving lives is the central goal of the safety improvements investigated by Ismael. But the team is also keen to point out the significant economic benefits of their system. For example, by being able to pinpoint the exact location and course of an aircraft or vehicle, airports would be able to keep throughput levels at capacity even during periods of bad visibility.

Ismael's system also boasts several technological plus points. The small size of their sensors and their modular design

means they can be installed quickly and relatively easily in just about any location, they require less energy to power, and they are easy to maintain and upgrade. Ismael's system uses 'passive detection', so needs no secondary transponders placed somewhere on the vehicles being monitored. The technology doesn't rely on radio waves so there is no interference with other systems like aircraft radio.

What's more, 'the sensor is completely unaffected by buildings, other aircraft, road traffic or anything else that can interrupt the line of sight of existing equipment', note the researchers.

Reliable, viable

Since ending the EU-supported part of its work in 2007, Ismael partners have kept the three test sites running to gather important data on the reliability of their system. In the meantime, other airports and companies have expressed interest in trying Ismael's sensors, says the project's co-coordinator, Uwe Hartmann.

'Also, I recently hosted two visitors from the MITRE corporation — a US public consultancy used by the FAA. MITRE is doing a study on "remote tower technologies" and Ismael will definitely be recommended as the most suitable technological improvement for small- and medium-sized airports,' he notes.

In the test sites in Frankfurt and Thessaloniki, the information generated by Ismael's sensor installations has now been combined with other data sources like radar, flight data and transponder signals. While the technical capabilities of Ismael's system have been fully demonstrated, more effort is needed to establish its operational credentials on the market, suggests Mr Hartmann.

Introducing novel technologies into airports takes time and patience, he suggests, which is why he and his colleagues take every opportunity to get the word out about Ismael to relevant organisations and authorities.

'The process seems to be slower than in other technological areas, presumably mainly because of the considerable safety requirements,' he stresses. 'Presently, we are much closer to establishing the Ismael technology in the US than in Europe.'

Ismael was funded under the 'Information society technologies' (IST) strand of the Sixth Framework Programme (FP6) for research.

⁽¹⁾ 'Intelligent surveillance and management functions for airfield applications based on low cost magnetic field detectors'.

EU-funded researchers target innovative methods to cut emissions

The Technische Universität Darmstadt in Germany has set up a pilot plant to test two innovative methods for carbon dioxide (CO₂) capture that require less energy and lower operating costs than earlier approaches.

The scientists are investigating the so-called 'carbonate looping' and 'chemical looping' methods for CO₂ capture. EU support for the project amounts to EUR 1.1 million under the research fund for coal and steel.

It is well documented that the combustion of fossil fuels, such as coal, fuel oil or natural gas, liberates large quantities of CO₂ that significantly contributes to global warming. Carbon capture and storage (CCS) is being touted as one of the key technologies that could reduce emissions and lead to more environmentally friendly power plants. Environmentalists claim that CCS might be able to reduce CO₂ emissions from fossil fuels used by industry to near zero and thereby help reduce greenhouse-gas emissions.

However, as the researchers noted, early approaches to CO₂ capture required expending significantly more energy and entailed bigger operating costs, therefore raising questions about their efficiency and acceptance. The two new methods for CO₂ capture being investigated by the TU Darmstadt Institute for Energy Systems and Technology's pilot plant will allow CO₂ emissions

to be nearly totally eliminated, require virtually no additional energy input and entail only slight increases in operating costs, according to the researchers.

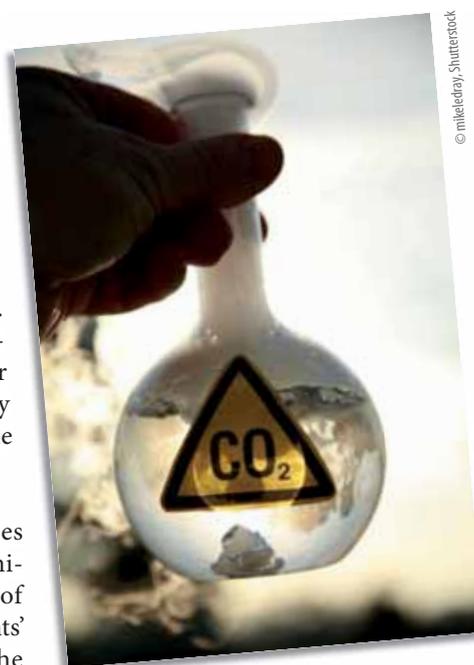
Dr Bernd Epple and his 26 colleagues are putting the 'carbonate looping' and 'chemical looping' methods for CO₂ capture through their paces. TU Darmstadt has built a new, 20-metre high experimentation hall on its Lichtwiese campus to house the pilot plant, which took 20 months to build.

Both methods being tested use natural substances and reduce the energy currently needed for CO₂ capture by more than half, the team explained. Dr Epple said, 'These methods represent milestones on the way to CO₂ free power plants. They might allow coal-fired, oil-fired, and natural-gas-fired power plants to reliably and cost-effectively generate power without polluting the environment.'

The carbonate looping method uses naturally occurring limestone to initially bind CO₂ from the stream of flue gases that transit the power plants' stacks in a first-stage reactor. The

resultant pure CO₂ is re-liberated in a second reactor and can then be stored. The advantage of the carbonate looping method is that even existing power plants can be retrofitted with it, the researchers said. They added that, on new power plants, the chemical looping method will even allow CO₂ to be captured with hardly any loss of energy efficiency. Under this method, a dual-stage, flameless, combustion yields a stream of exhaust gases containing only CO₂ and water vapour. The CO₂ can then be captured and stored.

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Faster, cheaper and more realistic emission tests

Vehicles operating on European roads undergo periodic testing, but it is highly desirable for them to be checked more frequently, without inconveniencing the driver and incurring unnecessary costs.

Remote sensing has been identified as the best way to address this challenge, as it represents a highly effective tool for measuring pollutant emissions under real-life conditions. Motor vehicles produce a range of gaseous emissions, which can have a significant environmental impact and promote global warming. The emissions, which include carbon monoxide (CO), carbon dioxide (CO₂), and nitrogen oxides (NO_x), are also linked to respiratory disease and other health issues.

Both reduced vehicle usage and improved car engines have been employed to minimise emissions from vehicles. However, measurements based on actual vehicles used for normal day-to-day operations are required to properly assess base-line measurements used for determining the effectiveness of emission reduction techniques.

The 'Remote measurement of vehicle emissions at low cost' (Reveal) project was set up to investigate different meas-

uring protocols and the instrumentation required to support them. Results indicated a link between the level of exhaust emissions and factors such as vehicle type, age and the way the vehicle was driven.

Researchers conducted field trials which showed that instrumentation developed by the Reveal project was suitable for monitoring car fleet emissions. The equipment also supported impact assessments of urban traffic management by identifying the worst polluters. The use of Reveal technology for conducting roadside checks helped inspectors to determine which type of vehicles should be stopped and examined.

The remote sensing technology developed through the project can be widely applied by local authorities and other regulators. The Reveal consortium produced a cost-efficient device that can be made widely available, thereby improving the health and quality of life for citizens in the EU.

Funded under the FP5 programme Growth
(Competitive and sustainable growth).

Collaboration sought: further research or development support.

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Robots to the rescue

Fire crews and emergency services save lives by making split-second decisions in highly dangerous situations. Making the right decision depends on having as much available information as possible, in order to properly assess and execute the best course of action.

Recent developments in robotics have been made that could provide some valuable help in this instance. Important tasks like firefighting and minefield clearing operate within the smallest margins of error. The need for effective information management is a priority. 'If there is a big incident for the fire services here in the UK, there are three different levels: bronze, silver, gold,' explains Jacques Penders, head of the Centre for Automation and Robotics Research (CARR) at Sheffield Hallam University.

'These situations involve different actors, and one of the problems of a constantly evolving situation is lost information,' he continues. 'Firefighting teams are usually the first to arrive,

are able to see what is happening and can call for more people if needed. If the incident then gets referred to a higher level, there isn't exactly the time to sit down and discuss the situation for two hours, so information is inevitably lost.'

This is one reason why effective information systems are vital. On-the-ground crews need access to accurate and reliable information to enable them to function. Firstly, information must be gathered effectively, and secondly, it must be processed as efficiently as possible. It is important, for example, that vital data is passed on quickly to the incident commander, while irrelevant data is not.

This was the starting point of the 'Vision and chemi-resistor equipped web-connected finding robots' (View-Finder) project, for which Dr Penders was project coordinator. He and his research associates were interested in finding out how robotics could be applied to existing structures of information gathering and dissemination for the emergency services, and ultimately improve on-site

operations. Initial discussions were held between potential end-users, organised by the royal military academy in Belgium and involved various first responders including firefighter and civil protection services.

The EU-funded project ran from 2006-09 and examined the use of semi-autonomous mobile robot platforms to establish ground safety in the aftermath of fire incidents. It also examined how robotic automation could be incorporated into a more comprehensive response system. 'With this project we didn't solve all the problems,' says Dr Penders. 'But we made big steps forward, and convinced end-users that there is a future in robotics. Firefighters don't necessarily know much about robotics — it is not exactly their field — but this project was about providing them with information about what was possible.'

On the ground

For gathering data, the project looked at integrating a wide array of optical and chemical sensors on mobile robots, capable of sending data and images from a fire incident site back to a base station. Individual robot-sensors developed by the View-Finder project were also designed to operate autonomously within the limits of the task assigned to them.

Robots were developed that could plan their path and avoid obstacles whilst inspecting the area. The idea of the project was also that human operators could monitor the robots' processes and send task requests through easy-to-use controls at the base station.



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The project focused on two possible scenarios — indoor and outdoor — with a corresponding robot platform developed for each scenario. The indoor scenario used a robot equipped with two laser range finders, one of which was attached to a tilt unit for providing 3D images. It also featured a front sonar array, a pan-tilt-zoom camera, a long-range wireless communication device and a chemical sensor array.

Two types of chemical sensors were used to detect low concentration and high concentration of volatile organic chemicals (VOCs) and toxic gases. A quartz crystal microbalance (QCM) sensor array was built to provide a base for pattern recognition of different VOCs, while a metal-oxide semiconductor (MOS) sensor was also used.

The outdoor robots needed to be able to deal with a completely unstructured environment, and be capable of navigating autonomously. Another key feature of the outdoor robots was their ability to determine for themselves the suitability of the terrain around them. 'A more robust robot was needed for outdoors,' says Dr Penders. 'Also, the intensity of light is constantly changing outside, which can also complicate things.'

Back to base

The next step of the project was to ensure that data collected by the robots reached the base station as quickly as possible, and could be easily interpreted and acted upon. The bandwidth required for sending sensor data from the robot to the base station was an important consideration, and this was performed by mailman, a high-performance messaging service offering quality of service for wireless networks. This base station combines gathered information with information retrieved from large-scale global monitoring for environment and security (GMES) information bases. The combined data is then transmitted to an operational command point and to first responders, such as the emergency services.

Touch screen interaction methods were developed for the base station. It was foreseen that most of the operator's time would be dedicated to monitoring robot activities resulting in a rather low frequency of user inputs. Sporadic interaction was suited to the nature of touch screen interaction.

'It is important to understand that View-Finder was a research project, and we did not expect to end up with a

finished product,' says Dr Penders. 'But while the project as a whole may not be continuing, further research, such as data processing and stereo vision are being developed. We were also approached by the local police in South Yorkshire to take things forward.'

This project illustrates the huge potential of applying robotics to emergency service response. The local police, who use trained dogs in situations where firearms may be used, were interested in finding out if a robotic replacement was feasible.

'The police try to send in a dog with a camera attached to see if fire arms are present,' explains Dr Penders. If they lose a dog, it is expensive, so the South Yorkshire police force was keen on the idea of sending in robots.

'It is not necessarily the case that the robots will perform better, but it is better to lose a robot than a dog. Robotics is making progress, but compared to living beings, there is still a big difference,' concludes Dr Penders.

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Harmonising traffic in central and eastern Europe

Setting off on a long road trip takes careful planning. Some use trusty paper maps, others rely on GPS navigational systems. Both have their uses. But drivers also need real-time knowledge of road and traffic conditions in countries they are driving into and across.

Every year in the EU, the lives of 5 000 motorists could be saved through the use of harmonised intelligent transport systems (ITS). ITS manage traffic by reducing congestion, informing travellers and by providing other relevant travel services. This in turn helps keep the highways traffic free and is especially important given that roads account for 80 % of transport in Europe. And that is expected to increase. Already, congestion alone costs nearly 1 % of Europe's GDP.

Connect⁽¹⁾ is an EU-funded project which carried out extensive research and implementing programmes that

make existing ITS systems in eight participating countries interoperable. The result is coordinated traffic management and control as well as high-quality traveller information services on some of the most important east-west road corridors. The countries involved include the Czech Republic, Germany, Italy, Hungary, Austria, Poland, Slovenia and Slovakia.

Connect ended in 2009 and was then absorbed into the ongoing 'Linking Europe in a harmonised way' (Easyway) umbrella project. Easyway's overall aim is to make a positive impact on traffic flow, safety and the environment

by 2020 throughout 22 participating European countries. Each European area in Easyway focuses on a different region of the EU. Though Connect may have ended as a singular project, its research and work continues to focus on central and eastern European countries under Easyway.

'The exchange of information on technologies is one key aspect of harmonised services for the European traveller. This ensures that deployments in eastern Europe are... state of the art, and the newest technology is used. Similar to the internet (where broadband deployment is done as starting technology by skipping elderly technologies) immediately modern concepts can be installed,' says Martin Böhm, Connect project secretariat.

The problem

Europe has numerous ITS services designed to implement specific tasks. These include providing real-time trip

traffic and travel information to an individual via roadside information (e.g. via variable message signs) or broadcasted information in digital (e.g. as input for navigational devices) or audio (e.g. radio broadcast) format. This information can focus on guiding the driver to alternative routes, as well as informing her about accidents and incidents (e.g. wrong-way driver warnings) and warnings on critical weather situations (e.g. slippery road surfaces caused by black ice). But these services are often isolated both regionally and nationally. In other words, one service provider does not provide traffic information about its neighbour. Yet millions of commuters or journeys cross into or through neighbouring countries every day.

For instance, the highways that link Slovenia and Italy are experiencing heavy congestion due in part to a lack of synchronised traffic information. Those coming from Slovenia may not be aware that major works are underway in the area of Trieste. Around Trieste the motorways are experiencing dense traffic flows. At peak times, this slows to a crawl and even a standstill. Connect partners in both countries have been working vigorously to mitigate the situation. They have since coordinated a comprehensive exchange of traffic information which enables travellers to assess routing opportunities.

The consequences of inaction are obvious. More time spent in cars, more fuel burned, and more traffic accidents. Such issues of cross-border traffic

pose serious challenges to sustainable mobility as well as dangers to motorists. Making ITS interoperable and ensuring that they work where ever one may be is therefore imperative.

With the close cooperation of other Euro-regional projects, Connect was able to improve road safety in these countries. It also implemented traffic information and management services, installed advanced traffic and weather monitoring systems and promoted the use of new ICT and ITS technologies and applications.

Ultimately, this means working out decision guidelines and concepts as a basis for harmonised systems implementations. In Austria, that meant setting up the 'Austrian road weather information system'. In the Czech Republic, it meant setting up a new service, eCall, which is a pan-European in-vehicle emergency call system. And Germany established a system for the visual monitoring of accidents and traffic conditions throughout the country.

The solution

To harmonise ITS services across so many countries, Connect first had to identify four domains of activity: traveller information; traffic control and management; freight and logistics; and efficient ICT infrastructure. Each country had varying levels and degrees of ITS services but implemented differently.

For instance, many trips go beyond national borders but services in each country are limited because they provide only information on short- and medium-range trips. A driver coming from Germany and arriving in the Czech Republic needs to know traffic and road conditions in real time and in a language she can understand. As such, each domain required international and regional coordination so that partners could establish divergences and similarities among the services.

A management committee was then put together and charged to oversee the operational side of the project. They worked alongside expert groups who helped identify best practices and know-how between all partners. A European study domain was also set up to report on progress and problems.

Milestones

Austria, for instance, built on existing traffic-information services that it had installed from earlier projects. The primary mode of disseminating traffic information is by radio. However, the Austrian partners then came up with entirely new concepts for mobile traffic information and warning services. Visual interfaces were mounted via well-known and broadly used and accepted broadcasting media. So instead of only listening to a spoken radio announcement, a driver could also see the information. This includes providing info-screen services at shopping centres or other areas where large masses of people gather.

'The innovation behind Connect is the coordination of deployment activities between countries. This ensures the roll-out of cross-border services. One example, which is valid not only for Connect but as well for the other European regional project, is the roll-out of traffic message channel (RDS-TMC). The TMC-tables and the coding of traffic messages was harmonised and a single traveller will receive with her TMC-ready navigational device real-time traffic information in Germany, Austria, or Slovenia. All countries used the same technology and methodology which ensures interoperability and cross-border services,' adds Mr Böhm.



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Until recently, the Czech Republic had no plans for a special public information service for long-distance journeys. Nearly 20 % of car trips made in the country are over 100 km in distance. Now they are running a pilot test that will demonstrate the viability of a public information service internet application and database for cross-border trips at both the national and international levels. The system will make use of real-time information gathered from a tolling system and the unified system of traffic information services. People could then access this information via the internet or through terminals posted at borders, major service stations, or public transport hubs. The Czech part-

ners also plan on providing and uploading a platform based on geographical information systems (GIS) with meta-information access to national and local public transport and road options. This should also allow for door-to-door long-distance trip planning.

Making in-roads

Real-time traffic information across borders allows for better route planning and reduces delays caused by heavy congestion. Most people who have ever driven can sympathise with efforts to reduce heavy traffic congestion. The noise, the idling engines, and CO₂ emission are issues everyone can do without.

Brno upgrades public transport ticketing system with EU-funded tool

Travelling by public transport in Brno, the second largest city in the Czech Republic, is now a quick and efficient process thanks to the introduction of a new system of ticket vending machines in the summer of 2010.

The innovative system is an outcome of the Civitas-elan⁽¹⁾ project, which received almost EUR 18 million under the 'Sustainable surface transport' (SST) theme of the EU's Seventh Framework Programme (FP7).

The work involved mayors of the cities of Ghent in Belgium, Zagreb in Croatia, Porto in Portugal, and Brno, Ljubljana in Slovenia who agreed a common mission statement to 'mobilise our citizens by developing with their support clean mobility solutions for vital cities, ensuring health and access for all'.

The five cities decided to put this statement into action on the basis of a clear set of common objectives, based on the principle of putting the citizen first. For each of the Civitas-elan policy fields a common set of objectives and project goals has been agreed and the cities have developed a programme of 69 measures.

At the end of July 2010, two months ahead of schedule, the Brno public transport company (DPMB) finished installing a new system of ticket vending machines in the city that officials claim has improved the quality of the service for all public transport users. Brno has a population of nearly 370 000 people

and is an important tourist centre for those wanting to visit or use the city as a starting point to explore the natural and cultural beauties of the south-Moravian region. Because the public transport system is used heavily, an efficient service should be available.

To bring the machines up to date, officials added the diagnostic system to all 153 ticket vendors in the city. This means that any problem relating to the machines is relayed directly to DPMB, allowing the company to rectify the situation immediately. The system is based on the transfer of data between ticket vending machines and the control centre using wireless general packet radio service (GPRS) technology. In the control centre, the data is displayed on the computers with special software.

The ticket vending machines are specially equipped with modules that include communication modems. They communicate with all parts of the vending machine and collect data that are sent on-line to the control centre for further analysis.

Detailed information about a problem is included in the message from the ticket vending machines. The operator in the control centre interprets the received

According to the European Commission, ITS can substantially reduce road-sector CO₂ emissions and help recover the 1 % of Europe GDP lost to congestion. Granted, this figure concerns the whole of the EU-27. But taken on the whole with participating Easyway projects, Connect is making advances and in-roads for a better, safer, and more environment-friendly EU highway system.

(1)'Co-ordination of concepts for new collective transport'.

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data and acts to immediately send a serviceman to resolve the issue.

During the pilot project, only 10 ticket-vending machines were equipped with the system, which was left unattended 24-hours a day. The operator read messages only between the working hours of 6 a.m. to 2 p.m., the average time necessary to eliminate a fault was already about six hours less than before the introduction of the system. This proves how much more efficient the system is now that all machines are equipped with the new technology.

Experts from Austria, Belgium, Croatia, the Czech Republic, Germany, Portugal and Slovenia participated in the EU project.

(1)'Mobilising citizens for vital cities Ljubljana, Ghent, Zagreb, Brno, Porto'.

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Spanish engineers offer new formula to calculate reduction in road accident deaths

A team of engineers from the University of Almería (UAL) in Spain has developed a methodology to help meet the EU's ambitious target to significantly reduce the number of road deaths.

The EU's White Paper on Transport, adopted in 2001, calls for the number of deaths in road accidents to be halved by the end of 2010. The study was presented in the journal *Accident Analysis and Prevention*.

Alfredo Tolón, a co-author of the mathematical formula and an engineer in UAL's Engineering Projects Department, said the methodology was 'novel', but 'easy to apply'. It makes it possible 'to calculate the weighted coefficients for reducing accident rates in various geographical areas by using an inverse logarithmic formula', he explained.



Dr Tolón said the weighting was carried out for 25 of the 27 EU Member States and for 50 Spanish provinces, based on the understanding that the greatest effort to meet the 2010 objectives is required in those countries and provinces that reported the highest mortality rates in 2000. In that year, 52 536 people died in road-traffic accidents in Europe, of whom 4 295 were Spanish. The researchers also compared the real evolution of road death data between 2000 and 2006 in order to check the validity of the methodology.

They found a high correlation between the series of real data and that indicated by the model. Both showed that countries like Denmark, France, Luxembourg, Malta and Portugal have exceeded their assigned percentage and already taken successful steps to reduce road deaths.

However, other Member States still need to make a concerted effort to solve this problem. Estonia, Lithuania, Hungary and Slovakia showed the worst results 'and the projections don't give much cause for optimism about them meeting the European objective', according to Dr Tolón.

Given this outlook, the team has also calculated the weighted

accident reduction rates for the 25 EU Member States in 2015, based on data from 2006, in order to obtain an overall reduction of 60 %.

As far as Spain is concerned, the scientists concluded that the provinces least likely to meet the targets on reducing road deaths were Huelva in the southwest of the country, Salamanca in the west and Malaga in the southern region of Andalusia. The northern province of Vizcaya was the only one in which the number of victims in 2006 fell by more than the figure proposed by the study, hence a drop of 61 % compared to the 44.4 % forecast. Other provinces making 'significant progress' were Guipúzcoa, Tenerife, Navarre, Soria, Barcelona, Álava and Madrid.

'Over recent years, however, there has been evidence of important progress in Spain, and by 2010 we may not be far off achieving the right level of reduction in road accident deaths,' said Dr Tolón.

Data from the Spanish directorate general for traffic (DGT) showed that 2 181 people died on Spanish roads in 2008, a significant improvement compared to the 4 295 who lost their lives eight years earlier. But even if much of the work has already been done, the Spanish engineer stressed the importance of this kind of study 'in order to open up the debate about the need for weighting in the application of global policies and to establish pragmatic objectives for reducing road accident rates.'

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Breaking barriers to trans-European freight corridors

The ongoing work on the adoption of common railway legislation has fundamentally transformed the supply of rail services and the rules of competition in Europe.

However, the findings from the 'Implementing change in the European railway system' (Reorient) project revealed that, in terms of change at a national level, there is still some way to go

before the interoperability legislation is adopted in spirit.

Intermodal rail-freight services come in the form of semi-trailers and con-

tainers carried by rail in coordination with road and water transport operators emerged within a few railways in the 1930s. Inspired by these early ventures, there is hardly a country in Europe that has not decided to shift some of the flow of goods from road to rail.

Rail services and intermodal transport seem to have become the darlings of policy-makers. However, operating companies everywhere are complaining about the lack of suitable infra-



structure. The aim of the Reorient project was to assess the process of transforming European railways from nationally fragmented into internationally integrated systems.

Project partners produced data on how new European legislation is transforming the freight industry so that newcomers from the rail and logistics industry can find business opportunities. These massive changes are taking place amidst a transformation of the transport industry as a whole, when older solutions are rapidly becoming obsolete.



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Rail corridor respects Europe's natural treasures

A transport corridor stretching from Scandinavia to the southern Balkans will help integrate Europe's freight rail system.

The 'Implementing change in the European railway system' (Reorient) project will let the train take the strain by using railways rather than roads to transport freight, helping to preserve the natural environment.

Researchers monitored Natura2000 protected sites between Szczecin near Poland's Baltic coast and Vienna, Austria, in order to identify areas of potential environmental conflict. The 11 designated or proposed Natura2000 sites represent some of the most seriously threatened natural habitats and vulnerable species across Europe. The study was in addition to the project's environmental impact assessment of rail freight.

Findings revealed that although rail is more environmentally friendly than road transport, problems can still arise, particularly at rail terminals. One ex-

The Reorient researchers contrasted the adoption of rail deregulation directives between old Member States in the Nordic region with the more recent Member States in central and south-eastern Europe. A clearly polarised picture was unearthed. Furthermore, multiple types of barriers were identified, which hinder the seamless rail operations in trans-European freight corridors.

Technical barriers arise from the lack of functional and network-related interoperability between the European countries. For example, different traction voltage, signalling and traffic management systems, maintenance standards for rolling stock and information transfer cause significant disparities in safety requirements.

ample was the harbour at Swinoujście, which is close to a Natura2000 special protection area around the Szczecin lagoon.

Negative effects included noise and freight traffic disturbing wildlife, while activities related to the terminal's expansion could degrade the natural habitat. However, increasing the volume of freight traffic along the corridor itself did not lead to a noticeable increase in negative impacts.

The Reorient project showed that rail operators must be made fully aware of issues related to environmental protection and Natura2000 sites. Furthermore, national governments should help train operators to develop less noisy rail terminals. Operators must also be aware of potential

These barriers are exacerbated by legal hindrances, such as outdated inter-governmental agreements on management of international rail traffic. In addition, market barriers are produced by inconsistent infrastructure changes or the lack of willingness to invest in its upgrading.

There are however clear signs of progress. Effective competition has emerged on the international freight corridors stretching from Scandinavia to Greece. Competition in this railway pipeline has encouraged innovation of undertakings and operational efficiency to reach business objectives.

It appears likely that the efficiency and quality of service of rail freight will improve over the coming years under the impact of greater competition. More importantly, it is possible that the scene has been set for very major changes over the next few years.

Funded under the FP6 programme Sustdev
(Sustainable development, global change and ecosystems).
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problems arising from maintenance and expansion activities.

The transport corridor will help integrate and standardise Europe's railway system and support EU policy for transporting international freight by road rather than rail. Thanks to the Reorient project the European economy will get a boost, while protecting the region's natural heritage.

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Effect of global warming on genetic diversity

Genetic diversity within a single species is known as intraspecific diversity and may hold the key to understanding how a species can adapt to changes in their environment.

To predict the effects of global warming scientists must know if low genetic diversity is due to adaptation to the local environment, or some other form of selective pressure.

Extreme environments such as the Baltic Sea are expected to strongly favour those organisms best adapted to the region's enormous ranges of temperature and salinity. A recent review highlighted that many species living in the Baltic Sea demonstrated lower intraspecific diversity than in the North Sea or Atlantic. Therefore, the question arises whether genetic diversity decreases due to environmental stress or if marginal populations have the lowest levels genetic diversity.

With funding from the EU, the IDA⁽¹⁾ project is investigating the selective forces behind the loss of genetic diversity in bladderwrack (*Fucus vesiculosus*) a common seaweed and key species in the Baltic. Project partners are also conducting laboratory-based experiments on *F. vesiculosus* to determine the fitness of different genomes. Temperature and salinity influence successful germination of the species, with sensitivity to temperature varying among genotypes.

Scientists searched for genetic polymorphism, the existence of two or more different forms within the same species, in *F. vesiculosus* by examining its response to herbivore activity. The researchers investigated the genetic basis of anti-

herbivore defence, when the seaweed produces metabolites in response to attack by sea snails. The results will help prove that an eco-functional genomics approach can be used to achieve new insights into the defence mechanisms of seaweed.

Data collected by the IDA consortium will, therefore, help determine just one of the many expected effects of global warming on species — genetic diversity.

(1)'Intraspecific diversity and adaptability of *fucus vesiculosus* at range limits'.

Funded under the FP7 specific programme People (Marie-Curie actions).

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Lifewatch — keeping an eye on biodiversity research

Lifewatch is a European-wide science and technology infrastructure initiative for supporting biodiversity research and policy-making.



The project provides infrastructure for biodiversity research that can help improve our understanding of the natural world and improve the sustainable management of environmental resources.

The Lifewatch initiative brings together a system of marine, freshwater and terrestrial observatories, enabling access to huge amounts of information residing in databases and monitoring sites. The project provides computational

resources and tools in virtual laboratories together with training support and a programme for public services. Legal, financial, technical and operational service planning are being carried out together with the setting up of a database. Guidelines for national initiatives are also helping to drive the process.

Project partners are creating a plan for supporting users through training and capacity building programmes. Cost analysis is being conducted to provide a reference point for financial contributions, which are used for developing infrastructure. The initial versions of the masterplan Lifewatch and the Lifewatch construction database are providing valuable data for partners during the construction phase.

Work conducted by Lifewatch will give researchers more integrated data, which can be assessed much faster in user-friendly virtual environments. The infrastructure created will give scientists a much clearer picture of Europe's biodiversity and the state of its natural systems. These results will make a major contribution to sustainable development and ecosystem-

based land-use planning. It will make use of agricultural and biotechnological innovation.

Lifewatch can help mitigate the effects of climate change by improving the management and protection of the terrestrial, coastal and marine environments. The project can also help support sustainable agriculture,

thereby combating desertification. The biodiversity research infrastructure developed by the project will open up new research opportunities for improving our understanding of the natural world.

Funded under the FP7 specific programme Capacities under the theme Infrastructures.

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The environmental impact of megacities

The worldwide trend towards urbanisation has led to a growing number of megacities springing up of 10 million inhabitants or more. These have brought about new environmental problems that impact on local and regional surroundings, which are being investigated by an ongoing project.

Megacities are a hotspot for higher greenhouse gas emissions that can have a devastating impact on the wider environment. An ongoing study called 'Megacity — zoom for the environment' (Cityzen) is looking into the effect that air pollution has on the local, regional and global environment using satellite and on-site observations. Sixteen partners in 11 countries in Africa, Asia and Europe are involved in the project, which is headed by the Norwegian Meteorological Institute.

Several sites around the world have already been chosen as places to carry out intensive case studies: the east Mediterranean around Athens, Cairo and Istanbul, the Po Valley (Italy), the Benelux region and the Pearl River Delta (China). The project is also looking at the effects of climate change on air quality within megacities.

The study has several linked objectives which aim to act as a scientific basis for air quality legislation and city planning in the future. By understanding air pollution around meg-

cities, the partners hope to estimate the future impact of changes in emissions in relation to increasing urban populations.

The project hopes to gain a better understanding of how megacities influence and are responding to climate change. By analysing the options available to them, the partners hope to diminish the effects of urban air pollution on human health. The partners want to harness the results and methodologies applied during the course of the project and put them into operational use.

Furthermore, by assessing the results of the project the partners want to make suggestions to policy-makers on which mitigation options exist to reduce environmental problems associated with megacities.

The project has already made a number of observations based on global satel-

lite pictures of air pollutants. On-site measurements in the Pearl River Delta, London and Athens are ongoing with a new measurement network being set up in Turkey.

The project has been successfully communicated to the wider public through a number of different platforms, including the project's own website, newspaper articles, conference lectures, various publications and an assessment of megacities being drawn up by the world meteorological organisation and the 'International global atmospheric chemistry' (IGAC) project.

Funded under the FP7 specific programme Cooperation under the theme Environment.

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Better global water management for better environmental and economic benefits

Rivers that serve 80 % of the world's population are threatened by agricultural runoff, pollution and invasive species, according to a new international study.

Riverthreat was funded in part by the EU's 'Evolution of trees as drivers of terrestrial biodiversity' (Evoltree) project, which received just over

EUR 14 million under the 'Sustainable development, global change and ecosystems' thematic area of the Sixth Framework Programme (FP6). The findings

were recently published in the journal *Nature*.

Researchers, led by the City College (CCNY) of the City University of New York (CUNY) and the University of Wisconsin, studied the effects of a variety of environmental stressors on water systems. They found that, in addition to threatening human lives, pollutants also endanger the biodiversity of 65 % of the

world's river habitats and put thousands of aquatic wildlife species at risk. The team produced a series of maps documenting these negative impacts using a computer-based framework.

'We can no longer look at human water security and biodiversity threats independently,' said Professor Charles Vörösmarty from CCNY, one of the authors of the study. He noted that the two needed to be linked, saying 'the systematic framework we've created allows us to look at the human and biodiversity domains on an equal playing field'. He and his team believe the framework 'offers a tool for prioritising policy and management responses to a global water crisis'.

'We've integrated maps of 23 different stressors and merged them into a single index,' explained Professor Peter McIntyre from the University of Wisconsin. 'In the past, policy-makers and researchers have been plagued by dealing with one problem at a time. A richer and more meaningful picture emerges when all threats are considered simultaneously.'

The researchers found that the security of human water supplies was highly threatened in both developed and developing nations, but insisted that the expensive engineering schemes used by rich western countries trying to solve such prob-

lems were untenable for poorer nations, and called for a global, more economic approach to water security.

'In the industrialised world, we tend to compromise our surface waters and then try to fix problems by throwing trillions of dollars at the issues,' Prof. Vörösmarty remarked. 'We can afford to do that in rich countries, but poor countries can't afford to do it.'

The team said causes of degradation in many of the developing world's most threatened rivers bore striking similarities to those in wealthy countries and suggested there were cost-effective solutions to these problems.

For example, Prof. Vörösmarty argued it would be more cost effective to ensure that river systems are not impaired in the first place by better land-use management, better irrigation techniques and greater emphasis on protecting ecosystems. Healthy ecosystems provide many valuable, and free, services to society through clean water, flood control, and food supplies.

One of the study's goals is to support international protocols that can be used for water system protection. The researchers believe an international approach is critical since more than 250 river basins cross international borders.

'It is absolutely essential to have information and tools that can be shared across nations,' stressed Prof. Vörösmarty. 'Our knowledge of these systems is progressively worsening as nations fail to invest in basic monitoring. How can we craft protocols on biodiversity protection and human water security without good information?'

Researchers from Australia, France, Germany and Switzerland contributed to the study.

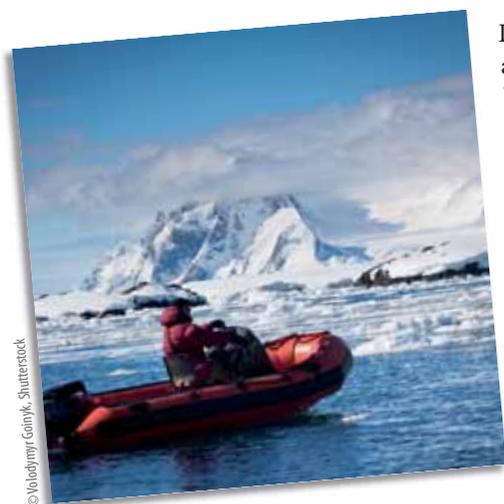
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Robust ocean monitoring and forecasting

The world's oceans are vast and changing. Undaunted, European researchers have taken on the challenge of collecting and processing these vast amounts of ocean data so we can learn more about ocean physics, biochemistry and ecosystems.



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Developing robust ocean monitoring and forecasting systems calls for a broad range of research and development (R & D) activities to ensure that they operate on firm scientific and technical grounds. At least this is how the 'Marine environment and security for the European area' (Mersea) project approached the challenge back in 2004 when it started with EUR 14 million of EU funding in hand.

The Mersea project tackled the full range of tasks, from ocean

data collection, R & D and systems development to user products, applications and even outreach programmes. For example, on the data side, Mersea focused on improving the retrieval algorithms required to determine geophysical parameters, such as ice concentration and drift and levels of suspended matter.

The FP6 integrated project included nearly 40 partners from all over Europe, among them the UK's MET Office, technology firms and leading academic centres. It was led by the French Research Institute for Exploitation of the Sea (Ifremer). The data and results they produce help shed light on a number of important changes taking place in and around the world's oceans, from seasonal weather forecasting to longer-term climate and ecosystems



indicators (biogeochemical analyses). Its work also contributes to the EU's Inspire Directive for more informed environmental policy.

Mersea put in place a network of Monitoring and Forecasting Centres (MFCs) and Thematic Assembly Centres (TACs). Today, the MFCs cover the global ocean and the main European seas (Arctic, north-east Atlantic, Baltic and Mediterranean), while the TACs process the data from satellite remote sensing (sea ice, ocean colour, altimetry, and

sea surface temperature), and from global networks in the field.

At present, the centres offer these data as a standardised service to a range of end-users. The partners invested a lot of effort into upgrading the Monitoring and Forecasting Centres using, for instance, better software models, and providing faster and more frequent analyses which boost overall performance. Maritime operators can use Mersea's ice drift forecasting, for example, to improve their ship routing, while the

petroleum industry can use the data to predict oil spill drift.

Where accurate ocean data is needed, systems like Mersea's are highly valued. Further research and development would help keep the systems up to date and in tune with the target users' potentially changing needs.

Funded under the FP6 programme 'Aeronautics and space'.
Collaboration sought: further research or development support.
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Ocean depths hold the answers

Deep-ocean observatories based in the Mediterranean and north-east Atlantic have been upgraded to facilitate their work in monitoring the effects of climate change.

Eurosites⁽¹⁾ is part of an integrated network comprising nine deep-ocean observatories positioned off the continental shelf in waters deeper than 1 000 metres. The observatories host scientific equipment that measures a range of different factors throughout the water column, from the seafloor to the surface. The network is coordinated by the National Oceanography Centre based in Southampton, UK and includes 13 partners from across Europe and the Cape Verde Islands.

The project has two main objectives. The first is to improve the existing deep-ocean observatories and form an effective network that can describe time-dependant properties of the ocean system. The second is to carry out a number of specific scientific activities that will help develop new and improved approaches to monitoring the deepwater environment.

Improvements to observatories have included the use of sensors to measure oxygen (O₂), carbon dioxide (CO₂), chlorophyll and nitrates in real time. Sensors and samplers have been employed to improve ability to measure properties in the ocean associated with the climate. This has included the deployment in both coastal and open sea of equipment for studying the biological carbon pump, mainly algae, which will provide ground-breaking insights into the ocean's role in the carbon cycle.

Zooplankton abundance and diversity is a key factor to understanding the carbon cycle within the ocean and marine scientists are now testing a long-term sampling device.

Acidification of the world's oceans as a result of climate change is of growing concern. Therefore, Eurosites researchers are monitoring pH levels to determine the impact of acidification and have developed, and are now using, a new type of pH sensor.

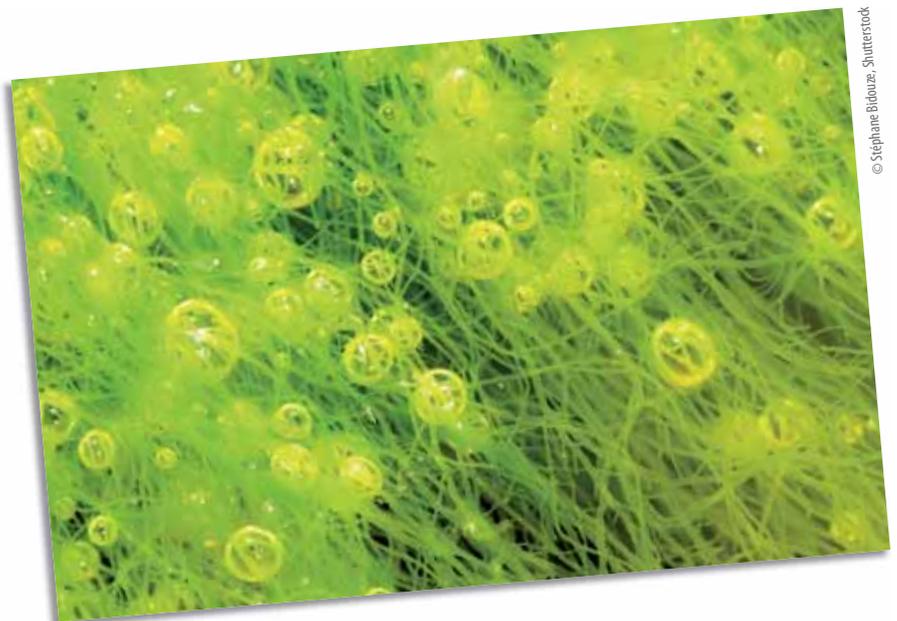
Two autonomous seafloor platforms have been established in the Mediterranean. One monitors fluid flow and pore pressure to determine slope

stability, while the other acts as a tsunami early-warning system. Additional activities carried out in both the Atlantic and Mediterranean include monitoring communities of bottom-dwelling organisms and associated biogeochemistry as indicators of climate change.

Each of the nine deep-water observatories now possesses enhanced systems that allow them to conduct a wider range of activities even more effectively. The data from the sites will give EU scientists a clearer picture of changes taking place in our seas as a result of global warming and ocean acidification.

(1)'Integration and enhancement of key existing European deep-ocean observatories'.

Funded under the FP7 specific programme Cooperation under the theme Environment
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Seeking iron ligands in the marine environment

Iron (Fe) plays an essential role in many key biochemical processes in the marine environment including respiration and DNA synthesis. Although it is extremely abundant in the Earth's crust iron remains scarce in the oceans.

But the EU-funded project, 'Iron binding organic ligands' (FEBOL), have devised ways to track it down.

Levels of Fe in the sea are limited by the element's low solubility and rapid uptake and use by phytoplankton. Nearly all iron in seawater is complexed with organic ligands, ions or molecules that bind to a central metal atom. Understanding the role of ligands is of major importance as they control the availability of trace elements to phytoplankton, thereby influencing carbon and nitrogen cycles in the oceans.

A better knowledge of ligands can enable scientists to predict how trace metals cycles will be affected by changes in the ocean due to global warming. Therefore, it is extremely important to determine the best way of incorporating data on ligands with trace metals in global ocean models.

Metal-binding ligands appear to facilitate bioavailability and uptake of iron, however, although they are found throughout the ocean, their composition and origin and ultimate fate are largely unknown. This lack of knowledge is holding back advances in the field of trace metal biogeochemistry. FEBOL was established to address this challenge and further research into the

distribution of organic metal-binding ligands and their incorporation into biogeochemical models.

Studies suggest that organic ligands are of biological origin, the most likely source being siderophores, molecules secreted by micro-organisms that bind with iron. However, only one marine siderophore found in blue-green algae has ever been previously identified. Therefore, the FEBOL consortium has developed new methodologies for isolating and identifying iron-ligand samples from the open sea.

Marine scientists have combined liquid chromatography with mass spectroscopy techniques to detect natural iron-ligand complexes with a new technique that is both rapid and highly sensitive. The new method can be used to test cultures and seawater for iron ligands of a biological origin.

Research conducted by the FEBOL project can provide a tool to explore the production, cycling and fate of iron ligands in the world's oceans. The resulting data can be used for producing better models for predicting the effects of global warming in marine ecosystems.

Funded under the FP7 specific programme People (Marie-Curie actions).

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Discovery of nano-sized diamonds proves comet struck earth 13 000 years ago

An international team of scientists has discovered nano-sized diamonds in the Greenland ice sheet, according to a study presented in the Journal of Glaciology.

The diamonds, which number in the trillions and are so tiny that they can only be observed with special, highly magnifying microscopes, add credence to the controversial hypothesis that fragments of a comet struck North America and Europe approximately 12 900 years ago.

'There is a layer in the ice with a great abundance of diamonds,' said co-author

James Kennett, Professor Emeritus in the Department of Earth Science at the University of California (UC) in Santa Barbara, US. 'Most exciting to us is that this is the first such discrete layer of diamonds ever found in glacial ice anywhere on earth, including the huge polar ice sheets and the alpine glaciers,' added the scientist, who is considered by many of his peers to be an early founder of marine geology and paleoceanography.

This discovery supports earlier published evidence for a cosmic impact event nearly 13 000 years ago, Prof. Kennett explained. Last year, the scientist reported the discovery of nano-sized diamonds in a layer of sediment exposed on Santa Rosa Island, off the coast of Santa Barbara in California in two papers published in the journals *Proceedings of the National Academy of Sciences* (PNAS) and *Science*.

A high proportion of the nano-sized diamonds in the Greenland ice sheet exhibit hexagonal mineral structure, and these are only known to occur on earth in association with known cosmic impact events, he said. This layer of



diamonds corresponds with the sedimentary layer known as the Younger Dryas Boundary, dating to 12 900 years ago.

Prof. Kennett explained that the layer containing nano-diamonds on Santa Rosa Island and those in the Greenland ice sheet appear to correspond closely to the time of the disappearance of the Clovis culture, the earliest well-established and well-accepted human culture living across North America.

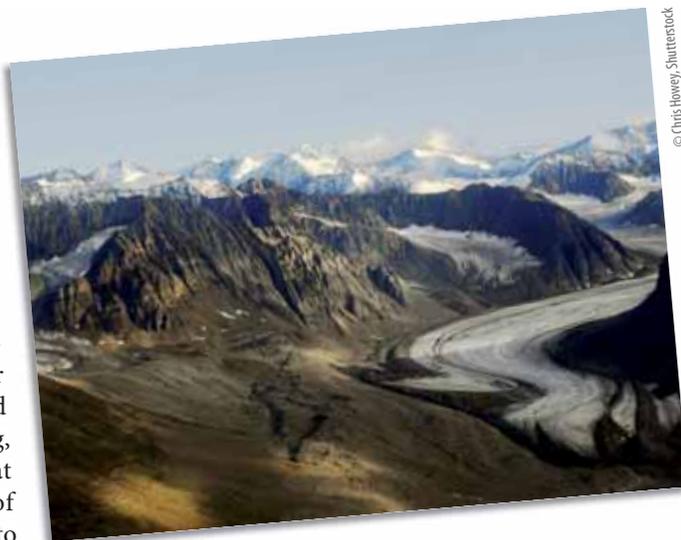
The event also corresponds with the time of extinction of many large animals across the region, including mammoths, camels, horses, and the saber-tooth cat. Moreover, there is evidence of widespread wildfires at that time and an associated sharp climatic cooling called the younger dryas is also recorded widely over the northern hemisphere, according to Prof. Kennett. The cause of this cooling and the cause of the animal extinctions and human cultural shift have long been debated.

Prof. Kennett pointed out that these findings merely represented a 'preliminary study' and that while the discovery of a potential postglacial peak in nano-diamonds in the Greenland ice

sheet was 'exciting', he acknowledged that several 'unanswered questions' had arisen.

He said he was presenting this research now 'to stimulate further investigation and debate', suggesting, for example, that different types of sampling needed to be used in further studies. 'This study was undertaken using Greenland ice samples taken at relatively coarse resolution, and, to significantly refine the findings presented here, higher resolution sampling is needed,' the authors said in their paper.

Further areas of potential exploration should include more precise dating, more detailed geochemical time-series measurements including for the elements osmium and iridium, and the use of improved diamond-extraction procedures 'to minimise acid-resistant amorphous carbon,' which they noted



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'currently limits available analytical procedures'.

Expanded analyses of diamond allotropes, via, for instance Raman spectroscopy, a technique used to study vibrational, rotational, and other low-frequency modes, should also be carried out in the future, they noted.

Led by the University of Maine in the US, scientists from Denmark, Japan and the US also contributed to the study.

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Air archaeologists isolate 'pure' aerosol particles

EU-funded environmental engineers have isolated aerosol particles in near-pristine pre-industrial conditions in the remote Amazonian basin in Brazil.

They claim the findings will help us understand cloud formation, chemical differences between natural and polluted environments, and regional and global climate change. Published in the journal *Science*, the research is an outcome of the 'European integrated

project on aerosol cloud climate and air quality interactions' (Eucaari) project, which received EUR 10 million under the 'Sustainable development, global change and ecosystems' thematic area of the EU's Sixth Framework Programme (FP6).



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The air above the Amazon rainforest is cleaner than almost anywhere else on earth, thus allowing the team to measure particles emitted or formed within the rainforest ecosystem that are relatively free from the influence of anthro-

pogenic or human activity. The environmental engineers or 'archaeologists of the air' hope the study will further their understanding of cloud formation, which affects levels of precipitation and the ability to grow crops and plants, as well as climate change.

'We basically had two "travel" days worth of pure air movement over 1 600 kilometres before the air came to our measurement site,' said lead author Scot Martin, who is 'Gordon McKay Professor' of environmental chemistry at the Harvard School of Engineering and Applied Sciences (SEAS) in the US.

Prof. Martin explained that by 'sampling from a 40-metre high tower and using a range of techniques, the researchers detected and imaged atmospheric particles' and found that 'particles in the submicron size regime most relevant to climate could be traced to the atmospheric oxidation of plant emissions, or so-called secondary organic aerosol droplets'.

He described this as 'a kind of liquid organic particle' and said it was the first time that anyone has ever imaged one of these particles in isolation 'because in the northern hemisphere and other anthropogenic regions, when you collect a particle it is a mess and filled with soot, nitrates, and other pollutants'.

In the pristine Amazon basin the researchers were able to detect aerosol particle number concentrations of a mere several hundred per cubic centimetre (cm^3) — in heavily industrialised cities, particles concentrations are in the tens of thousands per cm^3 , making it impossible for climate scientists to measure any net change when additional particles, either natural or artificial, are added.

However, it is essential that scientists manage to measure such changes, as

Prof. Martin highlighted. 'Those particles are affecting cloud formation and cloud formation is affecting precipitation which is affecting the plants,' he said. 'This is what we call the great tropical reactor. Everything is connected and in our research we finally had a real glimpse of natural aerosol-cloud interactions'.

Lead co-author Ulrich Pöschl, a scientist at the Max Plank Institute for Chemistry in Germany, said: 'The new insights and data help us and our colleagues to understand and quantify the interdependence of the cycling of aerosols and water in the unperturbed climate system'. He added that 'a thorough understanding of the unperturbed climate system is a prerequisite for reliable modelling and predictions of anthropogenic perturbations and their effects on global change'.

As the Amazon basin is going through a period of development, co-author Paulo Artaxo, a professor of physics at the University of São Paulo in Brazil, highlighted that scientists will now have an opportunity to watch the influence of human activity on the atmosphere in real time. 'In Brazil, we now have even more solid science to support sustainable development in the Amazonian region,' he noted.

'Looking ahead, we hope to clarify the mechanisms of how vegetation interacts with the atmosphere and elucidate the main natural feedbacks. Doing so will give us a way to monitor atmospheric change accurately in light of ongoing deforestation.'

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<http://ec.europa.eu/research/infocentre> > search > 18073

Dairy cattle to produce less nitrogen

High levels of nitrogen produced by the dairy industry can have a negative impact on the environment. Scientists have addressed this problem by developing feeding strategies that enable cattle to metabolise nitrogen more efficiently.

Dairy farming plays a significant role in European agriculture, but intensification of farming practices has resulted in higher levels of nitrogen compounds entering groundwater, surface water and the atmosphere. The pollution caused by excessive nitrogen can be reduced by better management of nutrients and animal waste that goes beyond normal good practice.

The EU-funded Rednex⁽¹⁾ project is developing new, practical methods for reducing the amount of nitrogen excreted by dairy cattle. A greater understanding of cattle rumen function and the role of dietary nitrogen in milk production can help scientists improve the supply and efficient uptake of amino acids in cows. This can help reduce nitrogen intake in cattle

without a significant drop in nitrogen output in consumable proteins in milk and its products.

Researchers are developing mathematical models for amino acid metabolism in dairy cows, thereby allowing the nitrogen loss for an entire herd to be predicted. Natural biomarkers found in urine, plasma or milk can enable the nitrogen supply from the rumen to the animal to be examined. The resulting information can be used to create improved feeding strategies that stimulate nitrogen recycling within the cattle while reducing total nitrogen inputs.

Developing and expanding the predictive models of nitrogen output at both the individual cow and herd levels can help estimate nitrogen output from Europe's dairy farms. Making widely available information regarding nitrogen management on dairy farms and creating a participatory framework to facilitate dialogue between researchers and stakeholders will benefit end-users.

(1)'Innovative and practical management approaches to reduce nitrogen excretion by ruminants'.

Funded under the FP7 programme Cooperation under the theme 'Knowledge based bio-economy'.

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Robots 'think' with their hands

Action-centred cognition is a ground-breaking concept in robotics where robots learn to 'think' in terms of what actions they can perform on an object. This new trend in cognition theory opens exciting new vistas.

Actions speak louder than words, particularly if you are a robot. At least that is the theory proposed by a major European effort to develop a wholly new approach to robotic cognition.

The Paco-plus⁽¹⁾ project sought to test a ground-breaking theory called object-action complexes (OACs, pronounced oaks). OACs are units of 'thinking-by-doing'. Essentially, this approach designs software and hardware that allows the robot to think about objects in terms of the actions that can be performed on the object.

For example, a robot can look at anything. If an object has a handle, the robot can grasp it, too. If it has an opening, the robot can potentially fit something into the opening or fill it with liquid. If it has a lid or a door, the robot can potentially open it.

Thus, objects gain their significance by the range of possible actions a robot can execute upon them. This opens up a much more interesting way for robots to think autonomously, because it fosters the possibility of emergent and complex behaviours which arise spontaneously as a consequence of quite simple rules.

Absurdly simple complexity

Our universe demonstrates astounding complexity from a handful of universal constants and DNA consists of just four bases from where all life emerges. Paco-plus researchers hope to imitate to some degree that level of complexity that arises from the absurdly simple.

In some respects, their approach imitates the learning processes of young infants. As they encounter a new object, infants will try to grasp it, eat it, or bang it against something else. As they learn from trial and error that, for example, a round peg will fit into a round hole, the range of actions enlarges.

Watching other people, too, adds to a child's understanding and next the child starts using actions in combination, such as grasping a door handle and then twisting it, to accomplish a more complex goal.

Paco-plus takes advantage of all these proven strategies to enable robots to teach themselves by learning from their observations and their experiences. As a key part of that strategy, Paco-plus conducted most of its work with humanoid robots.

'Humanoid robots are artificial embodiments with complex and rich perceptual and motor capabilities, which make them... the most suitable experimental platform to study cognition and cognitive information-processing,' explains Tamim Asfour, head of the humanoids research group at the Institute for Anthropomatics at Karlsruhe Institute of Technology (KIT) Germany, and co-coordinator of the Paco-plus project.



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I am therefore I think

'Our work follows on from Rodney Brooks who was the first to explicitly state that cognition is a function of our perceptions and our ability to interact with our environment. In other words, cognition arises from our embodied and situated presence in the environment.'

Mr Brooks, who published his most influential work in the 1980s, believed that moving and interacting with the environment were the difficult problems in biological evolution. Once a species was able to move and interact with the environment, it became relatively easy to evolve the high-level symbolic reasoning of abstract thought. Mr Brooks believed that disembodied intelligence was an impossible problem to solve.

This reverses the approach taken by artificial intelligence (AI). AI asserts that if you develop enough intelligence, machine thought will be able to perceive and solve problems. Robotic cognition posits that if you develop useful perception and interaction, intelligence will emerge spontaneously.

The jury is still out on who is right, but the robotic cognition school has biology on its side, and now it has the work of the Paco-plus project, too.

While progressing, there are no genuine *I, Robot* candidates on the scene yet. That Hollywood interpretation of Isaac Asimov's novel is still a ways off, but the applications and demonstrators built by Paco-plus show that we are now, perhaps, on the right track.

The Paco-plus project received funding from the ICT strand of the EU's Sixth Framework Programme (FP6) for research.

(1) 'Perception, action and cognition through learning of object-action complexes.'

Promoted through the ICT Results service.

<http://cordis.europa.eu/ictresults/index.cfm?section=news&tpl=article&id=91453>



Platform for responsible development of nanotechnology

Nano-sciences and nanotechnologies (NS&T) have the potential to transform our lives more dramatically than any other technology in history. However, we need to be aware of any possible harmful effects that could arise through their use.

Appraising the risks arising from nanotechnology requires a new, multi-dimensional approach in order to provide a clear understanding of the factors involved and to facilitate debate among stakeholders. This challenge has been addressed by the Framingnano⁽¹⁾ project, which is developing a governance model based on social, political and technical criteria. The resulting Framingnano governance platform (GP) can provide guidance on regulation and control, stakeholder engagement and other important issues.

Project partners are creating a website and a newsletter dedicated to issues concerning the responsible development of NS&T. Other outputs include a report on NS&T regulation and governance, a survey identifying EU stakeholders and a series of consultations and workshops.

The website, newsletters and workshops can be used to disseminate the governance plan and to determine the reactions and opinions of stakeholders.

The proposed governance model is based on a permanent panel of experts representing stakeholders and a decision-making body. Consisting of representatives from institutions and competent authorities, they deal with regulatory issues in the different fields affected by NS&T. The model has been shown to provide an effective approach in dealing with the issues arising from NS&T research. Different EU Member States can adapt the model according to their own cultural, legal and regulatory needs.

Framingnano is using an inclusive approach to promote multi-stakeholder dialogue on the subject of NS&T. The

resulting platform is proving to be highly successful for tackling the complex current and future challenges facing NS&T governance. The governance model developed by Framingnano will also help to provide a valuable driver for economic growth in the EU and for the benefit of society as a whole.

(1) 'International multi-stakeholder dialogue platform framing the responsible development of nanosciences and nanotechnologies (NS&T).'

Funded under the FP7 specific programme Capacities under the theme Science in Society
<http://cordis.europa.eu/marketplace> > search > offers > 5780



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European photonic research sees the light

A network of excellence (NoE) has been established to help Europe maintain its lead in photonic integration research through better use of its financial, technical and human resources.

Photonics involves products and technologies that operate using light energy, including ICT, sensors and biomedical applications. The Epixnet⁽¹⁾ network is dedicated to the restructuring of the EU's photonic integration research community. The shift is from a model based on independent research to a model based on sharing technology and know-how.

Epixnet has successfully established technology platforms that provide shared access to both costly technol-

ogies and state-of-the-art computer facilities, resulting in a range of joint research activities. Support has been provided for researcher exchanges and PhD studies, which have built up a core of skilled workers in the field of photonic integration.

Thanks to these far-sighted initiatives Europe is now considered the world-leader in photonics research. Photonic technologies require significant investment, requiring greater integration of research at the international level, thereby enabling a large number of researchers to contribute their complementary skills.

Three main objectives characterise the Epixnet initiative. They include restructuring the research community, promoting training and educational activities, as well

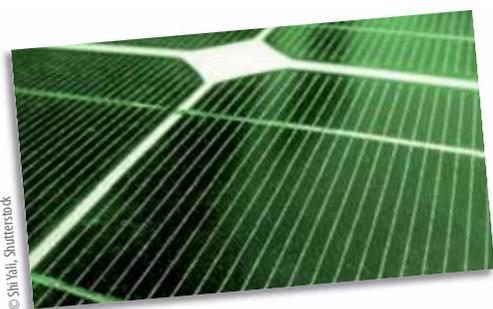
as creating new opportunities for photonic integration in a whole spectrum of applications.

Progress can be measured by the number of research activities, which range from basic enabling technologies to advanced uses. The activities focus on five main themes: photonic integration technology, nano-photonics, advanced semiconductor materials, ultra-fast light sources and ultra-fast signal processing.

Epixnet can help build long-lasting relationships enabling partners to concentrate on their core competencies while accessing other partners to make use of their available resources and infrastructure. This will enable European research to maintain its dominance in the field of photonic integration.

(1) 'European network of excellence on photonic integrated components and circuits.'

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Silicon hybrids for better optics and electronics

Researchers have developed silicon-based hybrid technologies for the optical systems used in telecommunications, data transfer, metrology and sensor applications. The innovations feed the development of smaller, better-performing products.

Photonic networks (those relying on the passing of light) are widely used in telecommunications, electronics and many emerging technologies. A key priority in these areas is the demand for greater functionality in ever-smaller devices. This means that optical components must be able to combine increasing complexity and compactness. Lowering costs of production is another over-riding concern in these highly competitive markets.

A group of European researchers collaborated on the project 'Merger of electronics and photonics using silicon based technologies' (Mephisto) to help meet these requirements. During the four-year project which ended in 2008, they developed new silicon-on-insulator (SOI)

hybrid integration platform concepts that can cover optical, optoelectronic and electronic functions.

SOI is suitable for these types of applications as it can accommodate optical waveguides and related devices of widely varying dimensions and is suitable for use with high-speed electro-optical modulators. Another advantage is compatibility with complementary metal-oxide-semiconductor (CMOS) technologies widely used in integrated circuits.

The work continued the rapid progress made in recent years in using compound semiconductors for telecommunication applications. These materials enable active and passive optical functions for components and electronic devices — compared to traditional 'monolithic' approaches which use one common material for different devices to be integrated.

With hybrid integration, different device chips are attached to an optical waveguide board using micro- and nano-assembly techniques, combining different material technologies to optimise performance and versatility.

The project team created and demonstrated a new distributed feedback (DFB) laser structure using these material technologies that achieved lower device costs and easier mounting possibilities. Their design offers several advantages over conventional approaches including low-beam divergence, high-slope efficiency, high-single mode yield, high stability and superior feedback sensitivity.

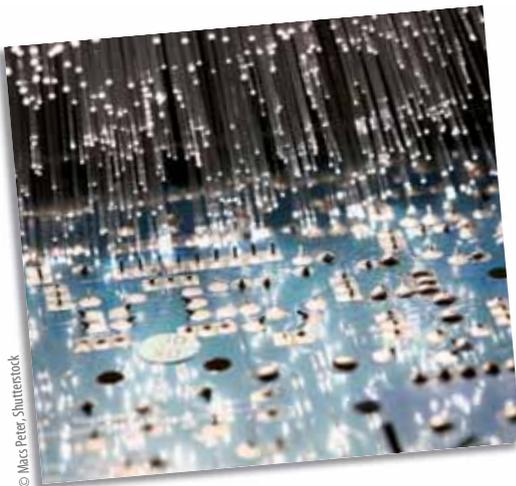
The laser system has been granted European and German patents and is being used in various research and development projects. Project coordinator, Henrich Hertz Institut (HHI) in Munich, Germany is using the Mephisto device as its preferred laser source for polymer PLC-based hybrid integration technology.

Project partners Freescale also developed 10Gb/s laser driver circuits based on low impedance silicon-germanium (SiGe) Bicmos integrated circuit technologies. This innovation has the potential for future commercial exploitation.

The project has enhanced the cost-effectiveness of SOI products and proved their viability, opening up their adoption by new customers and applications.

Funded under the FP6 programme IST
(Information society technologies).

Collaboration sought: further research or development support.
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Solutions for faster internet

All internet users have at some time or another complained about slow surfing speeds or a tiresome wait for a video to load.

A group of European engineers from Spain, Hungary and Sweden decided to try to counter such problems by monitoring traffic and tailoring services to meet demand. A number of leading communication companies have already taken up the newly developed methodology used for traffic measurements. Eureka, the European platform for research and development (R & D) funding, supported the research study.

The internet is a complex 'beast', made up of different networks that are managed by various service providers, who manage the data being sent and monitor the amount of traffic being used. When the data traffic on a network is too dense bottlenecks can occur, slowing the delivery of information to a computer and resulting in a slower internet experience.

The 'Traffic measurements and models in multi-service networks' (Tramms)

project tried to solve this problem using experiences gained after monitoring internet networks in Spain and Sweden over a three-year period. This gave them excellent insight into user behaviour, enabling them to accurately measure network traffic so that, in the future, service providers will know how much capacity is needed and can avoid any jams.

The research team pointed out that the project was successful because, contrary to the norm, they were allowed access to very sensitive data on internet traffic measurements. 'Internet traffic measurements are very difficult to find if

you are not an operator,' said Andreas Aurelius, coordinator of the project and senior scientist at Swedish R & D company Acreo, one of the project partners.

Previous research in this field has normally been limited to campus networks, and limited to a geographical area, but Mr Aurelius highlighted that this study used 'data in access networks, not campus networks'.

The project monitored internet protocol (IP) traffic (the flow of data on the internet), routing decisions (the selection of which path to send network traffic), the quality of service (giving priority to certain applications such as multimedia) and available bandwidth. Indeed, the team managed to collect an astonishing 3 000 terabytes of data over the three-year period. This was important as it allowed them to study trends and changes over an extended period of time amid a continuous influx of information.

The researchers used the information to develop new tools that measured traffic which gave a complete picture of a network and will therefore make web browsing considerably faster. 'For everyday users, this means better quality for multimedia services over the internet, like streaming for example,' said Mr Aurelius. He said the project's timing was somewhat auspicious colliding with the economic downturn, but it seems to have had few long-term effects on the outcome. 'The economic recession hit us hard, and many partners dropped out or slowed down their cooperation,' said Mr Aurelius, but he admitted that 'ultimately [the project] was very successful — better than we could have imagined'.

Mr Aurelius is now working on a follow-up project entitled 'IP network moni-

toring for quality of service intelligent support' (IPNQSIS), which deals with the quality of experience in network services, such as voice over IP (VoIP), video-on-demand (VoD) and IP television (IPTV). These are sectors where network service providers are expecting huge revenue opportunities.

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<http://ec.europa.eu/research/infocentre> > search > 18553



Putting your trust in database management

Databases drive everything from e-commerce and internet search to the critical systems managing our buildings and roads. But can we trust them?

New prototypes by European researchers will make all-important data replication easier, helping to prevent the horror scenario — data loss. Database management systems (DBMS) are at the heart of new-generation information systems beating life into on- and off-line activities affecting daily life — what and how we buy things, how we get around, our interaction with one another and with service providers.

But with all this responsibility, databases have sometimes struggled to keep up, and the cost and effort to maintain reliable systems has spiraled. All this means a growing demand for DBMS which help to safeguard our data in the event of a major failure — ranging from the irritating failed attempt to book a holiday to the disastrous crashing of railway routing systems.

The experts call it 'database replication' and it has been tipped as a key technology for the long-term competitiveness of business today. Effective replication is not as simple as just backing up the day's transaction on tape, and it affects the bottom line of almost all organisations.

The EU-funded 'Open replication of databases' (GORDA) project tackled these issues head on. The team from Finland,

France, Portugal, Sweden and Switzerland saw database replication as a way of addressing the challenges of trust, integration, performance, and cost in current database systems underpinning the 'information society'.

According to the partners, 'A major effort has been put in the refinement of a simulation infrastructure for evaluation and benchmarking of both communication and database replication protocols.' This helped implement the publicly available prototypes of the replication protocols and to develop one of the industrial partners' main commercial product, Sequoia.

As for group communication, the consortium proposed the 'GORDA group communication service specification' (GCS) as a draft standard and promoted its dissemination and adoption. The team also delivered a demonstration of a running prototype of several GORDA replicated databases which are available for testing. GORDA welcomes feedback on these, in particular from those interested in future R & D ties.

Funded under the FP6 programme IST
(Information society technologies).

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Grid users reassured about the origin of data

Keeping track of applications running within a grid environment is a difficult task. Researchers with the EU-backed Provenance⁽¹⁾ project have released open source software which will make it possible for the first time to trace the origins and authenticity of the data generated.

The grid consists of a very large number of hardware and software. To be able to deal with such a complex environment, users usually see the grid through a portal or some other user interface. However, the hidden complexity may be a source of unexpected and unwanted surprises.

In light of this, the Provenance project investigated a concept which is well understood in the study of fine art and refers to the trusted, documented history of an art object. Given that documented history, scholars can understand and appreciate its importance relative to other works of art.

The same concept was applied to data and information generated within grid systems. The ultimate aim was to transform the applications that produce data and information into so-called provenance-aware applications that produce a detailed description of their execution.

Such descriptions will be stored in a provenance store, which is a repository for the storage and management of all process documentation. Making grid systems provenance aware would enable users to trace how a particular result has been arrived at by identifying the individual and aggregated applications that produced a particular output.

In support of this vision, the Provenance partners designed an architecture that allows applications to interact with each other by exchanging mes-

sages. This is achieved by decomposing applications into actors that perform a specific functionality and have access to information.

The interactions between application actors are mapped out, revealing the information flow through the application. This approach was used by the Provenance partners to develop provenance aware systems for handling patient healthcare records.

The distributed and heterogeneous nature of healthcare institutions results in disconnected information islands which hinder the treatment of patients. It is not uncommon for doctors to depend on the patients themselves in order to find and include relevant data from previous treatments and tests.

Making healthcare services provenance aware enabled medical professionals to easily find the reason why certain procedures were followed in a treatment. The new technology helped manage the information needed to guarantee improved healthcare services for the increasing senior population requiring personalised assistance.

This software implementation of the new architecture has made it possible to capture and exploit provenance. The Provenance partners' hope is that this architecture will facilitate the growth of grid-based applications by explicitly tackling the problems of trust, accountability and compliance.

(1) 'Enabling and supporting provenance in grids for complex problems'.

Funded under the FP6 programme IST (Information society technologies).

Collaboration sought: further research or development support.
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Smart tracking for life

The seamless tracing of a product along the entire supply chain, from its conception to its final destination, is important to ensure more efficient production and customer safety and satisfaction.

But businesses are now interested in moving beyond this concept in order to trace a product throughout its entire lifecycle. An EU-funded project developed technology to make this a

reality. The initiative, called 'Product lifecycle management and information tracking using smart embedded systems' (Promise) aimed to produce embedded information devices along

with tools to enable decision-making based on data gathered throughout a product's lifecycle.

Some 23 partners from 8 EU Member States and 3 Swiss partners, from sectors such as railway and heavy construction equipment, participated in the project. Promise's work creates value by transforming information to knowledge at all phases of the product

lifecycle. In order to accomplish this, the project began by looking at current research activities in information systems modelling, smart embedded systems, short- and long-distance wireless communication technologies and data management. It then attempted to integrate research cluster activities covering the main research challenges of the proposal.

This resulted in a prototype Promise product lifecycle management (PLM) system capable of covering applications in the automotive, railway,

heavy load vehicle and white goods sectors. The closed-loop PLM system allows actors who play a role during the lifecycle of a product — managers, designers, service and maintenance operators, recyclers, etc. — to track, manage and control product information at any phase, at any time and in any place in the world.

This technology promises businesses a number of advantages. With knowledge gathering throughout the entire product lifecycle, companies have the

opportunity to develop better products with extended lifecycles and to find ways of minimising pollution and cutting energy consumption. The comfort, safety, security and satisfaction of the product user, either the operator of a product such as the driver of a truck, or the user of a service such as the passenger of a bus can also be taken into account. The technology will also allow producers to increase their capability and capacity to offer high-quality after-sales services.

The development of product embedded information devices to enable product lifecycle management and real-time data monitoring throughout the product supply chain is expected to progress rapidly because of the huge potential benefits for both businesses and consumers.

Funded under the FP6 programme IST
(Information society technologies).

Collaboration sought: further research or development support.
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Scientists develop techniques to trace cocaine hidden in alcohol

Researchers from Switzerland and the UK have developed two techniques aimed at thwarting drugs smugglers: cocaine dissolved into bottles of wine or rum can be identified quickly.

These techniques will help customs officials uncover which bottles are being used to smuggle cocaine without the need to open or disturb the container. The new techniques were recently presented in the journal *Drug Testing and Analysis* (DTA).

Imaginative techniques aimed at smuggling cocaine, one of the most widely used drugs, through border controls have been used in recent years, including dissolving cocaine in liquids. A UK man died last year after unknowingly drinking from a contaminated bottle of rum. However, it is currently impossible for customs to check alcohols for cocaine without opening and damaging the bottle, particularly for large or expensive alcohol shipments. The researchers said a non-invasive approach also has the advantage of not arousing the smuggler's suspicions,

thus allowing investigators to track the recipient of the drugs.

The UK team, led by scientists at the Universities of Bradford and Leeds,

used raman spectroscopy (RS), which employs laser light to identify molecules, to identify the cocaine in alcoholic substances. With a portable scanner, they tested cocaine dissolved in ethanol and several branded light and dark rums, in a variety of coloured glass containers including clear, brown, light green and dark green. They found that the cocaine was detectable in all liquids tested and through all of the glass colours.



'Until now it has been difficult to detect cocaine in liquid form in these environments,' said Dr Tasnim Munshi, a lecturer in inorganic chemistry at the University of Bradford. 'However our study shows that using an analytical technique such as raman spectroscopy we can successfully detect the presence of these drugs without removing specimens from their containers.' She said that her team believed that 'a portable raman instrument will prove vital in the fight against illegal drug smuggling by allowing for the fast and effective screening of different solutions over a very short space of time.'

Meanwhile, researchers led by Dr Giulio Gambarota from the Swiss Federal Institute of Technology Lausanne, used

magnetic resonance spectroscopy (MRS), the technique behind clinical MRI scanners, to test wine bottles contaminated by cocaine. A MRI scanner is not portable, but can test large cargos at once in a few minutes, including set up and evaluation of the results. The team found that it was possible to detect cocaine in wine in a scan time of one minute.

'By fostering collaboration between police or customs officials and a local medical department, this technique can be used to evaluate large numbers of bottles in a short time, giving information not only that there is another substance in the alcohol as with current scanning techniques, but exactly what that substance is,' said Dr Gambarota, adding that 'this method could also be used in other sorts of smuggling where

drugs are dissolved into liquids, so there are many further opportunities for use.'

Despite this positive conclusion, the researchers acknowledged in their paper that the detection limit could be degraded by the presence of metal. They said this problem could arise if, for example, the suspect wine bottles were surrounded by a metallic net, had a metal cap or were stored in aluminium-coated containers. They also pointed out that while such investigations can be performed in any hospital that has a MRI scanner, the experiment would have to be carried out by MRS-trained staff in order to ensure the data acquired was accurate.

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New technology mirrors ultra-fast fibre lasers

Ultra-fast, high-power lasers that generate pulses lasting less than one trillionth of a second are now being applied to fields as diverse as micro-machining, non-intrusive surgery and security.

Until recently high-power, ultra-fast radiation could only be achieved using cumbersome, solid state lasers that are both expensive and unreliable. Thanks to a new type of laser that is significantly smaller, less expensive and more reliable the market for high-energy pulsed optical systems is now growing. Nowadays short-pulse fibre lasers can offer size and cost savings of up to 10 times compared to equivalent bulk-laser systems.

Physicists working under the auspices of the Uranus⁽¹⁾ project have used optical fibre technology to produce more powerful ultra-short pulses at various wavelengths and increased stability. The consortium has taken ultra-fast fibre laser technology to its limits and commercially exploited the new systems that it has developed.

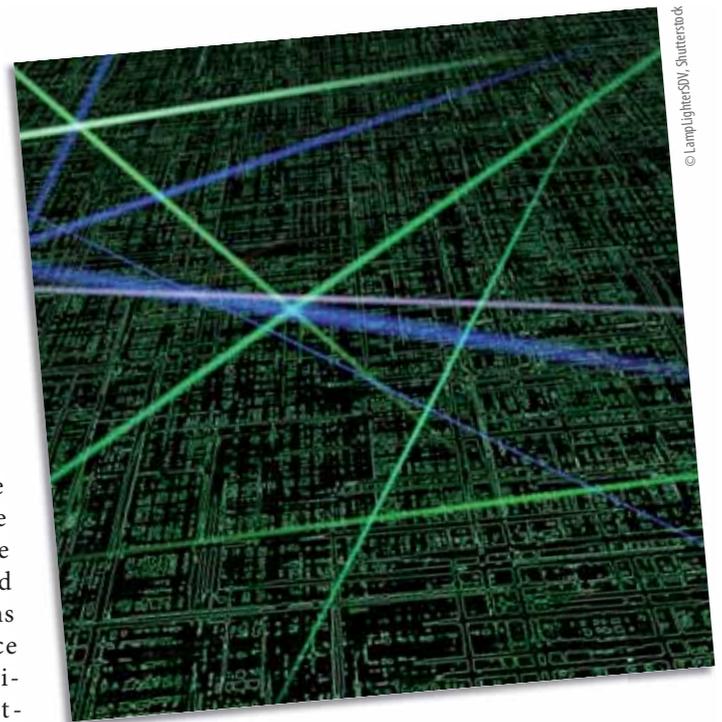
Semiconductor saturable absorber mirrors (SESAMs) play a vital role in generating ultra-short pulses using fibre lasers. Researchers identified the principal mechanism for shaping ultra-short pulses in fibre lasers and set

the SESAMs to operate at 1550, 1060 and 980 nanometres (nm) respectively. A nanometre is one billionth of a metre.

Advanced fibre amplifiers were used to increase power levels and the final systems used to produce broadband radiation in photonic crystal fibres.

This approach was a significant step towards the generation of ultra-fast fibre oscillators and the results have exceeded expectations with regard to average power, spectral density and emission bandwidth.

The work of the Uranus project has helped to put Europe at the forefront of ultra-fast fibre laser research. This will give the EU an economic edge by



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enabling it to develop new cutting-edge technologies.

(1) 'Ultra-fast technology for multi-colour compact high-power fibre systems'.

Funded under the FP6 programme IST
(Information society technologies).

Collaboration sought: further research or development support.
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Tiny sensors for better food quality

An ongoing research effort is taking food production to the microscopic level with the development of sensor systems to help manufacturers improve the quality of their products and businesses.

How can the food industry optimise its processes and improve the quality of its products? A group of researchers believe the key is in greater knowledge of the microstructure of food and are currently collaborating through a major research project to develop sensor systems to do this.

The EU-funded initiative, Inside-food⁽¹⁾, is looking into techniques in several scientific fields — X-ray nano- and microtomography; nuclear magnetic resonance (NMR) spectroscopy; magnetic resonance imaging; optical coherence tomography; acoustic emission and time- and space-resolved reflectance spectroscopy.

Project researchers are combining technologies in these areas to develop sensor systems and tools for the analysis of food microstructure, enabling the optimisation of both the nutritional makeup of products themselves and production processes and design.

Concentrating on three main categories of food products — fresh fruit, processed fruit and cereal products — the team is looking into the effect of microstructure on aspects such as water and solute status, texture and optical properties and internal defects of food. They are using food model systems, such as gels and foams, as well as real food in their testing.

The project started in May 2009 and will run for four years. An initial step was to define and standardise the recipes and

With food such a fundamental product, the potential impact of this initiative is significant — helping to deliver better products for consumers and helping companies to become more competitive.

composition of the food to be used in testing the various technologies. The team also refined the methods and parameters to determine mechanical and acoustic properties of the 'model foods'.

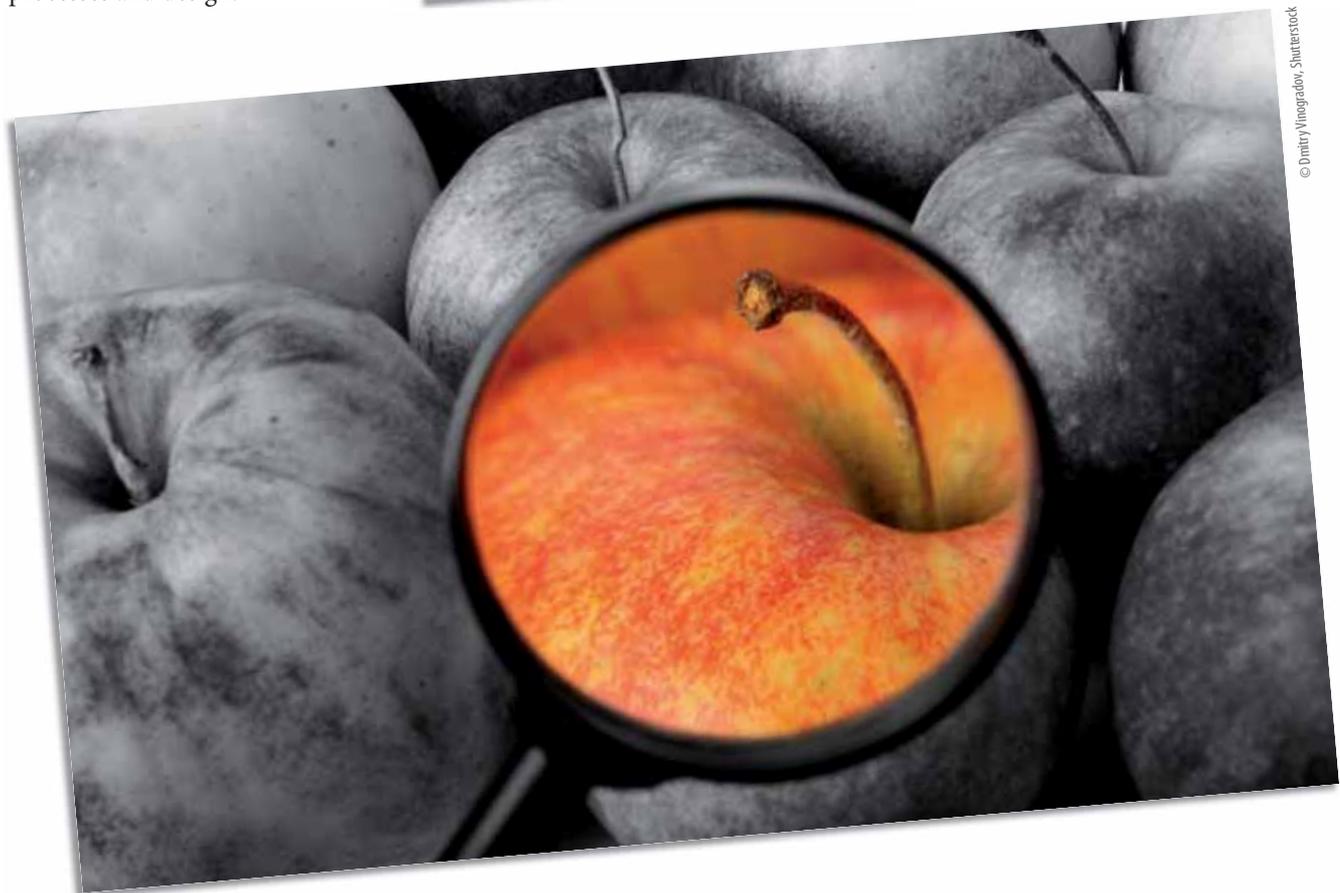
Other parts of the project are concentrating on new 3D imaging methods, 2D NMR relaxometry and optical systems using light penetration models.

The project partners include research institutes with companies from the sensor, ICT and food sectors. Four SMEs and a major food company are participating.

With food such a fundamental product, the potential impact of this initiative is significant — helping to deliver better products for consumers and helping companies to become more competitive.

(1)'Integrated sensing and imaging devices for designing, monitoring and controlling microstructure of foods.'

Funded under the FP7 programme Cooperation under the theme 'Knowledge based bio-economy.'
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Scientists claim smart materials used in medical devices are safe

Contrary to popular belief, modern technological materials such as shape memory alloys (SMAs) that are increasingly used in a wide range of medical devices and implants are entirely biocompatible and should not induce health problems, according to a European team of scientists.

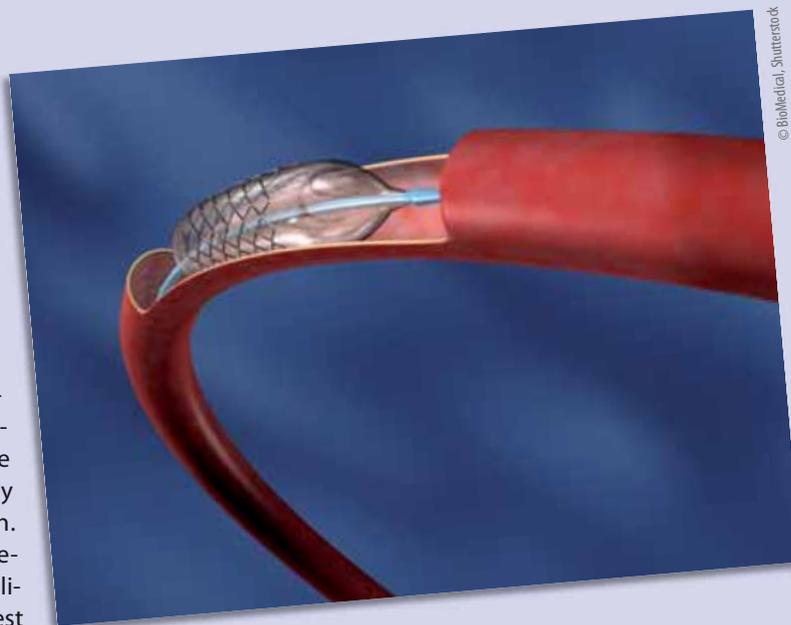
SMAs are favoured for their ability to bend and squeeze into a target body cavity or vessel after which they then revert to their original, working shape. But concerns have been voiced about the toxicity of SMAs which often contain nickel or copper. The findings of the study were published in the *International Journal of Immunological Studies*.

SMAs are frequently used in medical implants, guide wires for catheters, blood vessel stents, filters and actuators. Despite previous tests showing them to be entirely biocompatible, people are still concerned about whether this technology could have harmful effects on a patient's health. Researchers from the University of Maribor in Slovenia, the University of Leoben in Austria and the military medical academy in Belgrade in Serbia suggest that patients can now rest easy in the knowledge that SMAs made from copper-aluminium-nickel (Cu-Al-Ni) and nickel-titanium (Ni-Ti) do not damage the body or trigger cell death.

SMAs belong to a group of functional, smart materials whose unique property is to 'remember' the shape they had before undergoing pseudo-plastic deformation. 'Such an effect is based on crystallographic reversible thermo-elastic martensitic transformation,' the researchers said, adding that 'Nickel-titanium (Ni-Ti) SMAs have been mostly explored and applied in biomedicines because of their excellent flexibility and deformation behaviour similar to that of living tissues.'

'Cu-based SMAs, especially Cu-Al-Ni and Cu-Al-Mn are commercially available too, but their biomedical application has not been thoroughly investigated,' they explained. However, the team acknowledged that the Cu-Al-Ni alloys are much cheaper than Ni-Ti alloys. Currently, they are also the only option if high transformation temperatures are needed given that 'the transformation temperatures of Ni-Ti alloys can be adjusted in the range between 200°C and 120°C, whereas the characteristic temperatures of martensitic transformation of Cu-Al-Ni alloys can lie between -200°C and 200°C, depending on the content of Al and Ni'.

By using a simple screening test it should be possible to identify those individuals who would develop an inflammatory response in contact with a biomaterial.



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Rebeka Rudolf from the University of Maribor, and her colleagues, used immune system cells and human peripheral blood mononuclear cells to demonstrate the relative safety of these products.

The researchers prepared samples of SMAs as thin ribbons using melt spinning and then cultured PB-MNCs from 20 donors in a solution containing a Cu-Al-Ni SMA. They found no significant changes in the production of immune system mediators, known as cytokines, in 18 of the 20 test cultures. However, for two of the donor cells there was a marked immune response that was easily seen as inflammatory cytokines were released by the cells.

The team said its test could provide the medical profession with a quick and easy way to test a prospective patient for biocompatibility of a particular device. 'This is the first report showing the influence of SMA materials produced as thin ribbons by spin-melting technology on human cells,' the researchers noted. 'By using a simple screening test it should be possible to identify those individuals who would develop an inflammatory response in contact with a biomaterial and so predict undesirable reactions before implantation.'

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Interview Sizing up nanotechnology

*Nanotechnology has the potential to have a major impact on society says Professor Andrew Richardson of Patent:dfmm who answers research*eu results supplement's questions this month.*



Prof. Richardson

It wasn't so long ago when nanotechnology seemed more like science fiction than science fact. The ability to engineer functional systems at the molecular level appeared distant, like a wayward dream. But the resilience of science and top-quality research has brought society concrete results and benefits. Decades after its conception in 1959, nanotechnology continues to inspire and awe.

Ultra-thin and molecular-sized devices are now a reality. Special video screens, both thin and flexible, can conceivably be embedded into a standard print magazine or a newspaper. There are even batteries just 0.6 millimetres thick to power such devices.

The potential of nanotechnology stretches across all sectors of society. Today, tiny polymer gears are able to move bacteria. Tomorrow, hybrid biological and micromechanical machines could repair damaged tissue and help heal the wounded. Understanding the intricacies of a field where frontiers have yet to be fully defined is daunting, and trusting in the reliability of the end-products is a major avenue of research. And many technical, socio-ethical and financial challenges still need to be met before Europe reaches its full 'nano-potential'.

For this reason, the theme for this issue of *research*eu results supplement* is science, technology, materials and nanotechnology. We explore some of the latest European research results and bring to you an exclusive interview with Prof. Andrew Richardson from Lancaster University. He was the project coordinator of the EU-funded initiative 'Patent design for micro and nano-manufacture' (Patent:dfmm) whose mission was to grease the wheels for nano-based products and devices ahead of potential prototyping and production. He shares with us his views and insights into nanotechnology and what it means for the future of Europe.

• Our theme this issue is 'Science, technology, materials and the nano-revolution'. What do you understand by this and what part will new materials play in bringing nano-sciences to market?

This is clear, without new materials that can enable and interact with structures at the nano-scale, whether they be organic entities or inorganic assemblies, nanotechnology has no meaning. Materials as a generic term in the context of nanotechnology is analogous to the transistor in the electronics field. Here the transistor is the enabling technology but the ability to integrate these transistors and develop manufacturable products creates the impact — that is, materials and the science of how to manipulate these materials into usable functions is only one of the steps required to bring the technology to market.

So in my opinion, materials technology will be key to the realisation of new functionality, new processes and new integration and assembly technologies. Materials technology is unlikely however to address the problems relating to complexity and the need to interface length scales across nine orders of magnitude. Here a clever function at the molecular level is generally useless unless you can control it from the macro world and manufacture it so as to guarantee its performance and reliability within the system that houses it. To do this, new materials technology needs to be combined with new system-level architectures, signal processing functions, the electronic interface to the physical nano-scale environment and software algorithms that can monitor, compensate, predict, mitigate and reconfigure to ensure reliable and repeatable operation.

• Is the media overhyping the developments in nanotechnology? Is there a risk of the boy crying wolf?

No, I believe the potential for nanotechnology to have a major impact on our societal and professional processes

is indeed extremely significant. It does not take too far a stretch of the imagination to conceptualise consumer products that can diagnose within minutes the virus that is making us ill, create morphing surfaces on wings or moving images on paper. What I believe the media must be aware of is the difficulty of interfacing these new materials and devices to the micro- and macro world. These challenges are engineering based and require significant investments from both public and private sources.

What we have observed over the past few years is that the successes have tended to be where companies have taken risk in significant internal developments around staff and infrastructure to take forward proof-of-concepts developed through public grants — i.e. a mixture of technology push and commercial pull. The danger, as with many other areas, is the engineering resources commanded by emerging economies. Many of the strong manufacturing bases in Far East Asia, for example, are up-skilling and starting to embrace nanotechnology. To compete, we must innovate and add value and bootstrap our engineering base. Without this I believe many impressive material developments will not have the impact within Europe that our politicians hope and expect.

• You mentioned how small labs are looking for ways to generate commercial impact. What's on the horizon to help them? How is the EU helping in this regard? How can it help more?

There are numerous examples of exciting and innovative ideas coming out of small companies, especially those with strong links to the academic world. I believe intellectual property within these companies will be key to future



commercial impact. But how do these companies address the issues of interfacing with the macro world and delivering manufacturable, stable, and reliable products? As I stated earlier, the engineering challenge is extremely difficult here and in general requires significant investment.

The European Commission's Capacities programme is providing a means for small companies to interact with the science base to develop intellectual property (IP) and the Infrastructure programme is attempting to network facilities to provide small companies with the services needed to validate their IP and produce proof-of-concepts. The big question is what happens next: A license to manufacture prototypes in the Far East? Intervention by a venture capitalist who would normally encourage a move to the Far East or partnership with a co-developer in Europe that may not have sufficient critical mass or bandwidth to generate global impact?

I suggest this is where the Commission could help by looking at ways of building on credible private-sector manufacturing facilities to realise extended capabilities that are open to small companies in areas where there is clear competitiveness with low-cost economies and those with substantial existing infrastructure. A barrier would be to give our private-sector manufacturing 'stars' incentives to accept public investment to provide services to the SME base. An opportunity here

is to recognise that the manufacturing base in the Far East is dominated by electronics and the up-skilling process is currently focused within this area. New developments around non-silicon based processes and hybrid technologies — for example silicon-polymer integration — may be key areas as the skill base needed is cross-disciplinary. Here we may have a lead. The risk with this policy is that electronics is pushed down the prioritisation list which we do at our peril as the clever integration solutions and manufacturability innovations are likely to be generated by the electronics design community.

• Your university have been involved in big European networks (and projects) dedicated to the nano-cause. What's coming out of these initiatives that might interest our readers?

We ran a network of excellence in FP6 called 'Design for micro & nano manufacture'. It aimed to bring reliability, testing and packaging engineers together and underpin the associated collaborative work through a design and modelling cluster that engaged with some of the core suppliers of EDA tools. The Commission was also expecting the consortia to offer services. The collaborations worked extremely well and the final review gave us flying colours but there was insufficient time to engineer durability into the network. Universities and research organisations need contracts and public/private investment to maintain collaborative activity so the formal collaboration ceased once the project ended.

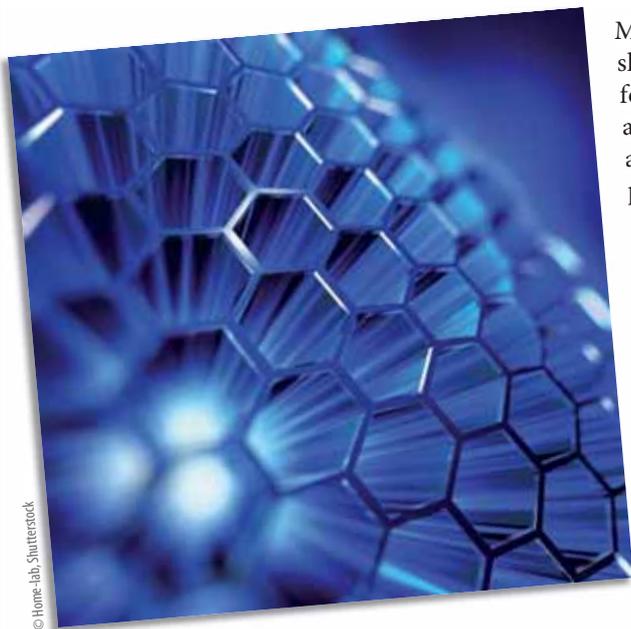
My view is that the project should have been funded for 10 years with mechanisms in place to prevent a closed shop forming. A problem here is that it is always harder to extend public grants than win new ones and the calls favour 'new' innovative ideas (rightly so). There are a number of activities, however, that have spun out of the network with new projects active in such places as Budapest University of Technology and

Economics, Heriot Watt University and the CNRS centres in Montpellier, Paris and Bordeaux which focus around packaging, testing and characterisation. We also assisted a small UK company, BCF Designs, to develop some innovative embedded test technologies that certainly contributed to a radical increase in their value and subsequent buy out by Ultra Electrics. We also did a lot of work with ST Microelectronics who were certainly the key industrial supporter.

I am sure ST will acknowledge that our project contributed to the evolution of their micro-electro-mechanical systems (MEMS) products and commercial success. At Lancaster [University] we are pushing the work we initiated in built-in self test and on-line condition monitoring technologies for mixed-technology systems. Here the pressure from the Commission to launch services was beneficial to us as we secured a major private-sector contract to apply this embedded test technology to miniaturised sensor-based units for monitoring larger systems and structures like health and usage monitoring systems (HUMS). We are also pushing forward our work on using embedded monitoring functions to address the need for eliminating false positives and negatives in bio-fluidic microsystems. We are also now looking at the emerging field of 3D integration in terms of manufacturability and reliability.

• Did you always imagine you'd be a scientist and working in such a field? So much has changed in such a short time: where is the nano-revolution taking us? Will we have new terms or new revolutions to fathom?

Thinking back — and that's hard as it is so long ago — I recall being motivated mainly by the challenge to understand processes that I could not see or feel. I certainly enjoyed practical work but not at the same level as gaining a comprehension of such things as relativity or the response of a high-speed circuit to transitions that are far faster than we can imagine. I guess therefore that I have always worked on that interface between science and engineering and, although I could not have perceived working in a field that engineered devices and materials at length scales of nanometres, it was a natural



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evolution for me. I eventually decided on electronics because it seemed to me in the late 70s the silicon chip was the next big technology to complement the excitement of the space race.

Regarding the future, I believe the importance of the engineering challenges I have outlined will elevate the engineering discipline in this area of technology but I do hope that this will not be at the expense of fundamental science, as I believe the ability of the engineering infrastructure to embrace emerging technologies will also be extremely important. Silicon, as an example, is on borrowed time. Are we ready as a community for a transition to carbon-based technologies or something else?

I also believe that we have become far to risk averse and introverted as a community that will not be helped

by austerity. Wealth creation around nanotechnology will be as much about partnerships, trust and shared visions as it will the core technologies. One of the strengths of Far East Asia is the ability of engineers and business leaders to build personal business relationships and launch initiatives with minimal bureaucracy. Decisions are still based around the wisdom of individuals taking the risk.

In Europe, we need to put more faith in intuitively driven initiatives and research investment based around trust. As nanotechnology emerges, new supply chains will be needed and products will be based more and more around highly cross-disciplinary activities. By insisting on hundreds of pages of due diligence and business plans we will lose the ingredients that deliver success, that is personal relationships. To move forward we need

to re-discover this adventure within our professional activities and investment decisions.

For myself, I intend to continue to focus on reliability and testing but apply my experience to emerging areas. I have also joined EnablingMNT Group and opened a UK office. This is a good example of what I said earlier. My partners Henne and Patric work in different areas that include marketing and process engineering. We did not formulate a business plan, rather we recognised that we all got along, enjoyed a beer together and had complementary skills that together could increase the sum of our individual value. I also trust these guys. I hope that EnablingMNT Group can therefore serve as a credible and effective dissemination route for the experience I have gained and capabilities established over the past 20 years.



Protecting nanotechnology research results

Nano2market⁽¹⁾ researchers provide guidelines for technology transfer, intellectual property rules and license agreements in the development of nanotechnology projects.

Nano-materials for energy production and storage, nano-particles for drug delivery and biosensors for diagnostics — these are some of the emerging nanotechnologies. With applications in almost all sectors, nanotechnology is expected to lead the future of technological development. However, as a relatively new field, the use of research results is still in its early stages with few identified good practices — especially from a multidisciplinary perspective (research centres, venture capitalists and experts in intellectual protection).

Models of traditional technology transfer were mostly unsuitable for nanotechnology. Yet transfer models are essential for any sector related to R & D because they both market and protect the research results. Therefore, it was considered fundamental to conduct a research project that addresses transfer issues relating to nanotechnology.

Intellectual property (IP) rights are applied to different stages of a product's

development, from basic research to commercialisation. The first step, therefore, was to examine the value chains and the appropriate IP model for the technology transfer for 12 selected case studies from 5 industries: electronics, energy, life sciences, materials, and water and environment. Secondly, the Nano2market partners conducted a technology mapping exercise in order to list the areas of the 'nano' innovations. Models and strategies were then validated by a panel of experts.

As a result, the project created a nanotechnology research IP guide. It includes instructions on how to develop guidelines for licensing agreements, consortium, and comments and suggestions to manage IP in nanotechnology projects. The guidelines depend on the type of application, level of development of the research, and the size of the organisation — small

or large research institutions, small and medium-sized enterprises (SMEs) or large enterprises. Organisation size is important because it impacts strategies. For instance, the Nano2market partners found that the lack of funding in smaller organisations meant they used strategies that differed from their larger, well-funded counterparts. People are also generally more confident working, investing and collaborating with larger institutions or enterprises. Smaller ones, on the other hand, must wait until the technology is in a more advanced stage before licensing.



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Nano2market has also designed an interactive toolbox to help companies that wish to collaborate on nanotech projects. The tools are also useful for investors like business angels, venture capitalists and corporate venture capitalists. The toolbox offer best practice reports for businesses and useful information on how to place a development

in the market thanks to an adequate business plan for entrepreneurs.

Coordinated from the Office of International Projects at the University of Alicante, Spain — the 12-month Nano2market project received EUR 700 000 under the EU's Seventh Framework Programme (FP7).



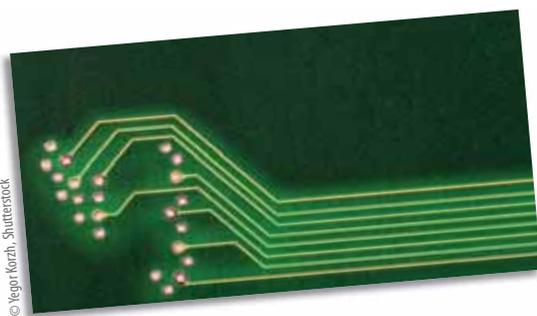
Star results from cross-disciplinary project

The search for new conducting materials at the nano-scale received a boost thanks to the five-star efforts of partners in the European-funded project Hesperus⁽¹⁾.

For centuries, mariners navigated vast, uncharted territory using the stars. Scientists in the EU-funded project Hesperus — 'evening star' or planet Venus — continued the quest, but on a much smaller scale, the nano-scale. The goal is to develop new ways to engineer and even 'grow' reliable next-generation tran-

sistors that can carry a charge through different media, from metallic to organic.

By its nature, this branch of science is cross-disciplinary, involving research that takes in electrical engineering, (supra)molecular chemistry, nano- and materials science and physics.



Hesperus looked into supramolecularly engineered nanostructures (SENs). Taking organic semiconductors the researchers tailored them to fabricate new types of field-effect transistors (FETs), known to function well even with weaker electrical signals.



EU funds research into light capturing antenna

EU-funded scientists have created an antenna that captures light in the same way the device normally captures aerial signals for a television or radio.

They believe the discovery will help develop tools for industrial safety, defence and homeland security. The device, presented in the journal *Nature Nanotechnology*, is an outcome of the 'Bio-inspired molecular optoelectronics' (Bimore) project, which received nearly EUR 3 million under the Marie Curie Research Training Networks mobility scheme of the EU's Sixth Framework Programme (FP6).

Researchers led by condensed matter physicist Doug Natelson and graduate student Dan Ward from Rice University in the US have developed an optical antenna from two gold tips separated by

a nano-scale gap — about a hundred-thousandth the width of a human hair — that gathers light from a laser. The tips 'grab the light and concentrate it down into a tiny space,' explained Professor Natelson, leading to a 1 000-fold increase in light intensity in the gap. He said that he expected the discovery to be useful in developing tools for optics and for chemical and biological sensing, even at the single-molecule scale, with implications for industrial safety, defence and homeland security.

'You can ignore the fact that your car antenna is built out of atoms; it just works,' said Prof. Natelson. 'But when

(1)'Best practices for IPR and technology transfer in nanotechnology developments'.

Funded under the FP7 specific programme Cooperation under the theme 'Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices.'

Article provided by the network of Valencian Universities for the promotion of Research, Development and Innovation.

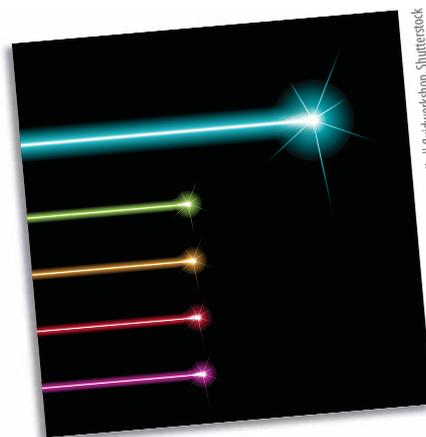
Partners in the project investigated novel materials and methods for engineering FETs from the ground up with significantly better electrical connectivity which can effectively carry more charge. According to the project partners, the core technique they developed 'allows the bridging of semiconducting crystals, without the formation of injection barriers at the connection points.'

Results from the two-year project, which ended mid-2010, could feed into wider efforts to develop faster, smaller, low-power transistors for the burgeoning microchip and electronics sector.

(1)'Hierarchical self-assembly of electroactive supramolecular systems on pre-patterned surfaces: multifunctional architectures for organic FETs.'

Funded under the FP7 programme Cooperation under the theme 'Knowledge based bio-economy.'
<http://cordis.europa.eu/marketplace> > search > offers > 5755

you have tiny pieces of metal very close to each other, you have to worry about all the details. The fields are going to be big, the situation's going to be complicated and you're really constrained.' He pointed out that his team discovered that the key to measuring light amplification was measuring the electrical current flowing between the gold tips.



‘Putting the nanotips so close together allows charge to flow via quantum tunnelling as the electrons are pushed from one side to the other,’ according to the researchers. They could then get electrons moving by pushing them at low frequencies with a voltage, in a highly controllable, measurable way, and get them flowing by shining the laser, which pushes the charge at the very high frequency of the light.

‘Being able to compare the two processes set a standard by which the light amplification could be determined,’ Prof. Natelson said. He noted that the amplification is a ‘plasmonic effect’ — plasmons, which may be excited by light, are oscillating electrons in metallic structures that act like ripples in a pool.

‘You’ve got a metal structure, you shine light on it, the light makes the electrons in this metal structure slosh around,’ he explained. ‘You can think of the electrons in the metal as an incompressible fluid, like water in a bathtub. And when you get them sloshing back and forth, you get electric fields.’

He explained that ‘at the surfaces of the metal, these fields can be very big — much bigger than those from the original radiation.’ But he said that it was hard to measure just how big they were.

‘We didn’t know how much the two sides were sloshing up and down — and that’s exactly the thing we care about,’ he said, adding that by simultaneously measuring the low-frequency electrically driven and the

high-frequency optically driven currents between the tips, ‘we can figure out the voltage zinging back and forth at the really high frequencies that are characteristic of light.’

The scientist commented that the team studied these enhanced fields because a lot can be done with sensors and non-linear optics. ‘Anything that gives you a handle on what’s happening at these tiny scales is very useful,’ he said.

Contributions to the study were also made by researchers from the Karlsruhe Institute of Technology in Germany and the Autonomous University of Madrid in Spain.

Promoted through the Research Information Centre.
<http://ec.europa.eu/research/infocentre> > search > 18233



Organic nano-wires open up possibilities

German and Swiss materials scientists have created simple networks of organic nano-wires for future electronic and optoelectronic components.

The successful approach synthesises the complex and incredibly thin nano-wire structures, and joins them to electrically conducting links (essentially creating an electronic circuit). The result is a culmination of work that began in 2006 under the ‘New photonic systems on a chip based on dyes for sensor applications scalable at wafer fabrication’ (Phodye) project, which was funded EUR 1.92 million under the ‘Information society technologies’ (IST) thematic area of the EU’s Sixth Framework Programme (FP6).

The Phodye project was initiated by Dr Angel Barranco from the Instituto de Ciencia de Materiales de Sevilla in Spain, who invited his former colleagues from the Swiss federal laboratories for materials testing and research (EMPA) to become involved. EMPA is one of eight academic and industrial partners from four European countries (Belgium, Spain, Sweden and Switzerland) currently working on the project.

The aim is to develop a new family of sensor devices that combines dye sensor films and photonic structures. These incredibly sensitive gas sensors (made up of thin films that change colour and fluoresce on contact with certain gas molecules) could

eventually be used to monitor vehicle emissions or to provide warnings of the presence of poisonous substances.

It was during their work on Phodye that EMPA’s Ana Borrás, Oliver Gröning and Pierangelo Gröning, and Jürgen Köble from Omicron Nanotechnology in Germany created the unique methodology for connecting organic nano-wires. The result is a step towards the manufacture of cheaper and more flexible sensors, transistors, diodes, and other components, ranging from the micro all the way to the nano-scale.

The physicists developed a new vacuum deposition process for synthesising organic nano-wires. They discovered how to manufacture nano-wires with largely varying characteristics by appropriately selecting the starting molecule and the experimental conditions. Their method is particularly unusual and surprising because it has generated a perfectly monocrystalline structure by precisely controlling the substrate temperature, molecule flow and substrate treatment.

The team soon discovered that the new process was not only able to provide nano-wires for the gas sensors needed under Phodye, but it opened the door

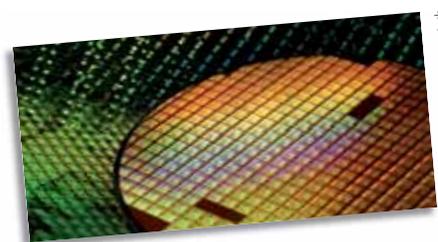
to creating complex ‘nano-wire electric circuits’ for electronic and optoelectronic applications (e.g. solar cells).

The reason being that the range of nano-wires can be used together (as required) to form networks with broadly varying properties. The secret to this lies in having decorated (using a sputter-coating process) the nano-wires growing on the surface with silver nano-particles. Thanks to these particles, more nano-wires can be grown that are in electrical contact with the original wires — the foundation of an electrical circuit on the nano-scale.

Dr Gröning explained that the potential exists for being able to manufacture organic semiconductor materials, which are very attractive candidates for the manufacture of inexpensive, large area and flexible electronic components.

The team has presented the results of their finding in the journal *Advanced Materials*. The Phodye project ended in October 2010.

Promoted through the Research Information Centre.
<http://ec.europa.eu/research/infocentre> > search > 17193



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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>

Declarative aspects of multicore programming

A conference on 'declarative aspects of multicore programming' will be held on 23 January 2011 in Austin, US.

Many chip manufactures are turning to multicore processor designs as a way to improve performance in their desktop, enterprise, and mobile processors. This new trend may not succeed in the long term if mainstream applications cannot be 'parallelised' to take advantage of tens and eventually hundreds of hardware threads.

Multicore architectures differ in significant ways from their shared memory predecessors. For example, the communication to compute bandwidth ratio is likely to be higher, which will positively impact performance. More generally, multicore architectures introduce several new dimensions of variability in both performance guarantees and architectural contracts, such as the memory model, which may not stabilise for several product lifecycles.

This will be the sixth in a series of workshops seeking to explore ideas in declarative programming language design that will greatly simplify programming for multicore architectures, and more generally for tightly-coupled, parallel architectures.

For further information, please visit:
<http://damp2011.cs.uchicago.edu>

Conference on bioinformatics models, methods and algorithms

A conference on bioinformatics models, methods and algorithms will be held from 26 to 29 January 2011 in Rome, Italy.

The field of bioinformatics applies statistics and computer science to molecular biology. Bioinformatics includes the creation and advancement of databases, algorithms, computational and statistical techniques and theory to solve formal

and practical problems arising from the management and analysis of biological data. Scientists working in the field often map and analyse DNA and protein sequences, align different DNA and protein sequences to compare them and create and view three dimensional models of protein structures.

The event will look to bring together researchers and practitioners interested in the application of computational systems and information technologies to the field of molecular biology.

Topics set to be covered include:

- the use of statistics and algorithms in understanding biological processes and systems;
- new developments in genome bioinformatics and computational biology;
- sequence analysis;
- biostatistics;
- image analysis;
- scientific data management and data mining;
- machine learning;
- pattern recognition;
- computational evolutionary biology;
- computational genomics.

For further information, please visit:
<http://www.bioinformatics.biostec.org>

Seventh Atlantic web intelligence conference

The seventh Atlantic web intelligence conference will be held from 26 to 28 January 2011 in Fribourg, Switzerland.

Web intelligence is generally defined as the study and research of the application of artificial intelligence and internet-based information technology in order to develop new products, services and frameworks.

The conference is an annual event which brings together scientists, engineers, computer users, and students. Participants will be able to exchange and share

experiences, new ideas, and research results about all aspects of intelligent methods applied to internet-based systems. This year will have a particular emphasis on 'soft computing'.

Topics will include:

- web information retrieval and filtering;
- semantics and ontology engineering;
- web mining and farming;
- social networks and ubiquitous intelligence;
- knowledge grids and grid intelligence;
- web agents;
- web services;
- intelligent human-web interaction;
- web support systems;
- linked data;
- web intelligence;
- web security, privacy and trust.

For further information, please visit:
<http://awic2011.eia-fr.ch>

Eighth international conference on computability and complexity in analysis

The eighth international conference on computability and complexity in analysis will be held from 31 January to 4 February 2011 in Cape Town, South Africa.

Computability and complexity theory are two central areas of research in mathematical logic and theoretical computer science. The former is the study of the limitations and abilities of computers in principle. Computational complexity theory, on the other hand, provides a framework for understanding the cost of solving computational problems, as measured by the requirement for resources such as time and space

The classical approach in these two areas is to consider algorithms as operating on finite strings of symbols from a finite alphabet. Such strings may represent various discrete objects such as integers or algebraic expressions, but cannot represent general real or complex numbers unless they are rounded.

Most mathematical models in physics and engineering, however, are based on the real number concept. This means that theories on computability theory and the real numbers and more general continuous data structures are needed. Despite remarkable progress in recent years,

many important fundamental problems have not yet been studied, and presumably numerous unexpected and surprising results are waiting to be discovered.

Scientists working in the area of computation on real-valued data come from different fields, such as theoretical computer science, domain theory, logic, constructive mathematics, computer arithmetic, numerical mathematics and all branches of analysis. The conference will be an opportunity for people from such diverse areas to meet, present work in progress and exchange ideas and knowledge.

For further information, please visit:
<http://cca-net.de/cca2011>

Eleventh Dutch-Belgian information retrieval workshop

The eleventh Dutch-Belgian information retrieval workshop will take place on 4 February 2011 in Amsterdam, the Netherlands.

Information retrieval is the practice of searching for documents, information within documents, metadata and information in relational databases and on the internet. While internet search engines are the most visible informal retrieval applications, public and private entities use them for a wide variety of purposes.

The primary aim of the event is to provide an international meeting place where researchers from the domain of information retrieval and related disciplines can exchange information and present innovative research developments. This edition of the annual workshop will put special focus on interaction through poster presentations and designated time and areas to meet and discuss new ideas.

For further information, please visit:
<http://ilps.science.uva.nl/dir2011>

Renewable energy and passive house trade fair

A trade fair for renewable energy and passive house will take place from 10 to 12 February 2011 in Stuttgart, Germany.

In recent years, significant progress has been made in making energy-efficient and environmentally-sustainable buildings and houses. Improvements, though, are often offset by general social awareness of what is available and what can be done. The event will aim to bring together various stakeholders in the sustainable construction sector.

As with earlier editions, participants will be able to visit the trade fair and attend accompanying conferences which will take place at the same time. Topics are set to include:

- photovoltaics in practice for professionals;
- solar thermal energy and heat pumps;
- heat storage for renewable energies;
- plus energy house;
- biomass gasification;
- passive houses in practice;
- the plus energy house;
- energy efficient cities — traffic and mobility;
- energy management;
- hydropower.

For further information, please visit:
<http://www.cep-expo.de/>

Second international conference on exploring services science

The second international conference on exploring services science will be held from 16 to 18 February 2011 in Geneva, Switzerland.

Services science is an interdisciplinary approach to the study, design, and implementation of service systems. Encompassing disciplines not only in management and engineering, it also draws from fields such as social and cognitive sciences, law, ethics and economics to address the theoretical and practical aspects of the challenging service industry and its economy. The goal of the event will be to build on the growing interest in the field, and to further study and understand this emerging discipline. Academics, researchers and practitioners of all disciplines will be among those attending. The conference will have a special structure, and is organised around sessions with contributions from different disciplines working on overlapping topics.

The event takes place within the framework of the European Commission's 'Life-long learning' programme.

For further information, please visit:
<http://iess.unige.ch>

Qualitative computing: diverse worlds and research practices

The qualitative computing: diverse worlds and research practices event will take place from 24 to 26 February 2011 in Istanbul, Turkey.

It will focus on how research practices from diverse fields have interacted with qualitative computing. Individual research practices will be analysed from methodological perspectives and the epistemological roots of specific national ways of conducting qualitative research will also be on the agenda.

The event will take place across three days, and themes will include:

- research cases from various disciplines utilising qualitative methodology;
- opportunities in and challenges of conducting software assisted qualitative research;
- methodological reflections of using software in qualitative research;
- analysis processes that benefit most from qualitative software;
- innovative and new ways of using software tools;
- transparency on reporting software assisted qualitative research;
- experiences and models on teaching qualitative software;
- new software tools and the future of qualitative research;
- research team possibilities in using software;
- online research, ethics and qualitative software;
- integration of quantitative and qualitative data in mixed methods research and emerging inquiry approaches.

For further information, please visit:
<http://www.qualitativecomputing2011.net>

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