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Clean technology: change that Europe can believe in

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Cleaning up the act…
with solutions we can believe in

Extreme droughts, floods, and icebergs the size of Luxembourg breaking off the Antarctic shelf are climate change realities that we, as humans the world over, must deal with. The European Union is committed to cutting its greenhouse gas emissions by 20 %, raising renewable energy's share of the market to 20 % and reducing overall energy consumption by 20 % by 2020. Since 2003, the EU-27's emissions have been on the decline overall.

The EU is on track to meeting those targets thanks in part to the innovation of European researchers and scientists. The European Commission has increased climate-relevant research by EUR 9 billion. As a result, EU-funded projects are producing a whole new range of technologies that will make our air cleaner, our transport more energy efficient, and our fragile ecosystems healthier. A planet with a rich biodiversity is a future we all want and need.

So-called 'clean technologies' are finding their way into our homes, workplaces and transport options. Work is also underway to develop new types of engines, alternative fuels and energy sources, more efficient structures and designs, sustainable transport systems, and more. We thought it would be a good idea to highlight some of these solutions in this edition of research*eu results supplement, *where we focus on 'Clean technology: change that Europe can believe in'.*

We also have projects working on how to reduce energy consumption. Transport accounts for 26 % of all energy used in the EU. And buildings alone consume an astonishing 40 %.

In this issue, the biology and medicine section leads with a new device that uses gas sensing technology to identify infections.

The energy and transport section leads with an article on how biogas can help Europe meet its renewable energy targets. Researchers hope that one day biogas will fuel vehicles and contribute to the energy grid.

The top story in the environment section looks at the Beacon project where researchers are working to provide Europe with a sustainable integrated transport system that aims to protect the environment as transport develops.

In our IT and telecommunications section, a consortium of European researchers is developing ambient intelligence systems that will help computers 'read' the human being by interpreting body language.

Our lead story in the industrial technologies theme showcases how one man's rubbish is another robot's energy source. A team of EU-funded scientists has constructed a series of robots that run on food waste and raw materials using an innovative microbial fuel cell technology.

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*

The editorial team

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Frequent acronyms

ERA	European research area
FP5/6/7	Fifth/Sixth/Seventh Framework Programme of the European Community for research, technological development and demonstration activities

ICT	information and communication technologies
IST	information society technologies
R & D	research and development
SMEs	small and medium-sized enterprises

Electronic nose sniffs out bacteria

Early treatment of infection in burns patients is critical. A European consortium has designed a point-of-care instrument that can identify types of bacteria from the tiny amounts of volatile gases they emit.

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Patients admitted to hospital with serious burns often have infected wounds that must be treated quickly. Yet it can take three days for microbiological tests to identify the bacteria present and allow doctors to select the appropriate treatment.

Old-time medical students were taught to recognise bacterial infections by their characteristic odour, so could modern analytical technology do the same?

That was the question posed to Professor Krishna Persaud of Manchester University's School of Chemical Engineering and Analytical Science. Doctors at the burns unit of the university hospital wanted to identify infections faster. 'They were anxious to treat people as soon as possible without having to wait for the microbiological results to come back,' he says.

Prof. Persaud had worked in odour detection for a long time and built up several contacts across Europe. He discovered that colleagues in Lithuania had already identified about 200 hospitals eager for a similar solution.

Three types of bacteria

He put together a consortium of clinicians, researchers and technology companies in Germany, Italy, Lithuania and the UK and the EU-funded Woundmonitor project was born. Their aim was to build an instrument to identify bacteria in infected wounds by the volatile gases they produce.

The first step was to work with hospitals to investigate the kinds of infections being treated in burns patients. 'We narrowed it down to about three major types of bacteria: *staphylococcus, streptococcus* and *pseudomonas*,' Prof. Persaud says. 'They account for about 80 % of the bacterial infections that we found in burns patients. The other 20 % were a number of different types of bacteria — some of these were mixed infections which can be quite difficult to treat.'

The Woundmonitor team chose about seven strains of bacteria within each group and cultured them in the laboratory. They then identified the volatile chemicals given off as the bacteria multiplied.

Next, they took swabs and dressings from burns patients to see if the same chemicals could be detected. It turned out that each strain had its own distinctive markers. 'We were lucky enough to identify a few compounds that were quite unique in terms of the bacterial strains we were interested in.'

Chemical fingerprint

With this knowledge the team designed an instrument containing eight gas sensors, each tuned to detect a different family of compounds. The pattern of responses from the sensors constitutes a 'fingerprint' characteristic of the chemicals present.

To amplify the low concentrations of volatiles expected, only a few parts per billion in air, the team used a process known as solid phase microextraction, to concentrate the gases onto an absorbent polymer fibre. The fibre is then placed in the detector for analysis.

'We can distinguish the three main families fairly easily,' Prof. Persaud says. The team thinks they can also identify some of the strains but they do not yet have enough samples to do so with confidence. They have not yet been able to identify MRSA, a bacterium of particular concern in hospitals.

The instruments have been tested in hospitals in Manchester and in Kaunas in Lithuania.

'As we get the clinical data in we've been able to cross-validate against microbiology and also against PCR-type assays to identify bacteria,' says Prof. Persaud. 'So the results from our instruments have been corroborated independently by other laboratories and methods of analysis. The instrument is not able to do everything but it can do [it] about 80 % of the time.'

This is not the first time that gas sensing technology has been used to identify infections but earlier products have failed commercially because they were too complex for point-of-care use.

Results in minutes

'In our case we've put together a system that is fairly compact — about the size of a large book. It's rather simple to operate, it connects to a small PC and gives an output which you can interpret as a "yes" or a "no".' It could be set up in a room adjoining a hospital ward and give results in a matter of minutes.'

Although the instrument was designed with burns patients in mind it could have applications for other kinds of wounds, such as chronic ulcers, and other areas of medical and environmental diagnostics.

There have also been some unexpected spin-offs. One of the Italian partners, Biodiversity, is marketing real-time PCR (polymerase chain reaction) kits from the Woundmonitor project for identifying bacteria. Some of the pattern-recognition software developed in the project may be marketable and prototype sensors used in the instrument could also be commercialised.

Two companies have shown an interest in the instrument itself, though it needs further investment to obtain regulatory approvals before it can be used in hospitals. Prof. Persaud is confident that it could make a real impact where rapid diagnosis is critical and well as boost Europe's medical devices industry. 'The problem we're addressing is worldwide, it's not unique to Europe.'

Woundmonitor received funding from the ICT strand of the EU's Sixth Framework Programme for research.

Botanists find genetic noise fuels hybrid vigour

Researchers at the John Innes Centre in the UK have discovered that a degree of variation in gene activity gives plant hybrids the boost they need to become more vigorous. The research, funded in part by a Marie Curie grant for early stage training, sheds light on the mystery of why hybrids outpace their parents most of the time. The results of the study were recently published in the **Public Library of Science (PLoS) Biology** *journal.*

One of the biggest questions puzzling botanists today is why hybrids between species exhibit two opposing features. While hybrids are usually more vigorous than their parents — what scientists call 'hybrid vigour' or 'hybrid superiority', some are less vigorous and fertile than their parents, a phenomenon known as 'hybrid inferiority'. Over time, scientists have offered their views about why two opposing features exist.

In this latest study, the researchers investigated how variation affects gene expression in two species of snapdragon. They found a kind of genetic 'noise' that is triggered by a degree of variation in gene activity. Some of the variation in gene activity is wiped out when the hybridisation of species occurs, which in turn results in greater vigour.

'This is the first study that analyses the consequences of variations in gene expression on conserved traits in closely related species,' explained co-author Professor Enrico Coen of the John Innes Centre.

The team said they succeeded in showing that the activity of specific genes 'may be free to vary during evolution within particular bounds by measuring this variation and its effect on phenotype', adding that, 'although such variation may have little phenotypic effect when each locus is considered individually, the collective effect of variation across multiple genes may become highly significant'.

By demonstrating just how these effects could potentially trigger both hybrid superiority and inferiority, they effectively offer fresh information about hybrid performance.

Led by Prof. Coen, the researchers assessed the trait that causes flower asymmetry in two closely related species of snapdragon. By measuring the activity of two key genes along with its impact on flower asymmetry, the team determined that while the variation ('noise') has a minimal effect on a species for a single gene, the collective effect for several genes could be extensive, thus dwindling performance on the whole.

According to them, while natural selection may fail to eliminate the identified noise, hybridisation could prove effective in blocking out the noise to some extent.

Hybrids show potentially increased performance in basic traits including growth, but in the long term they also show decreased performance in other traits such as sexual reproduction.

'Gene expression levels are free to drift around during evolution within particular bounds,' Prof. Coen pointed out. 'But the cumulative effects of variation explain the conflicting phenomena of hybrid superiority and inferiority.'

Both natural species and domesticated varieties are covered by the researchers' hybrid vigour finding. 'Breeders already know there is no magic hybrid vigour gene, otherwise they would have used it by now,' Prof. Coen said. 'What our study shows is how and why hybridisation can have such a strong impact on performance.'

Rewarding research excellence

Two young scientists have received the first ever 'Excellent paper in neuroscience award', an initiative of the 'Network for European funding for neuroscience research' (Neuron).
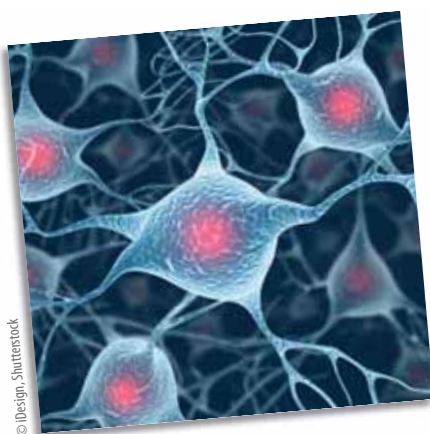
Neuron received EUR 2.7 million under the ERA-NET scheme of the EU's Sixth Framework Programme (FP6) to better coordinate national research funding programmes and funding activities in Europe in the field of disease-related neurosciences.

Dr Heidi Nousiainen from the National Institute for Health and Welfare in Finland and Dr Asya Rolls from the Weizmann Institute of Science in Israel were announced as winners at the Seventh Forum of European Neuroscience Societies (FENS) held in Amsterdam, the Netherlands, in July 2010.

The 'Excellent paper in neuroscience award' acknowledges outstanding scientific publications by young researchers in the field of disease-related neurosciences. Drs Nousiainen and Rolls were selected out of a 2009 nominations list of seven candidates.

Neuron coordinator Dr Marlies Dorlöchter, from Projektträger im Deutschen Zentrum für Luft-und Raumfahrt in Germany, explained that the achievements of the winners characterises Europe's

high standards in neuroscience research. Dr Dorlöchter added that both scientists have contributed significantly to knowledge of the disease and injury of the nervous system, and to the development of new therapies.

Dr Nousiainen won the award for the paper 'Mutations in mRNA export mediator GLE1 result in a foetal motoneuron disease', published in *Nature Genetics* in 2008. The paper identifies the gene (GLE1) underlying two fatal nervous system diseases (LCCS1 and LAAHD). The study contributes significant new information on the molecular background of foetal motoneuron disease, and on the essential mechanisms for the development, maturation and functioning of motoneurons.

Dr Rolls received the award for the paper 'Two faces of chondroitin sulfate proteoglycan in spinal cord repair: A role in

microglia/macrophage activation', published in the *Public Library of Science (PLoS)* in 2008. The study addresses the issue of why the body invests so much energy in scar formation after traumatic spinal cord injury (SCI) only to inhibit spinal cord repair. Dr Rolls found that the CSPG protein performs a critical role in recovery, and that this role could provide new avenues in the treatment of SCI.

The World Health Organisation estimates that more than 1 billion people suffer from disorders of the central nervous system. Along with the increase in life expectancy (thanks in no small part to modern science and medicine), there has been a considerable increase in the incidence of neurodegenerative conditions, such as Alzheimer's disease and Parkinson's disease. These conditions impact the quality of life of sufferers, as well as their friends and family, and place significant financial pressures on society.

The Neuron ERA-NET is a collaboration between national research funding programmes and funding activities in the field of disease-related neurosciences in Europe (Germany, Spain, France, Italy, Luxemburg, Austria, Poland, Sweden and the UK) as well as Canada and Israel. Since 2006, it has provided a structure in which members can coordinate their programmes and develop joint strategies for funding neuroscience research.

The ERA-NET scheme, first introduced as a highly innovative component of FP6 (2002-06), continues to bolster its support to structuring the European Research Area and enhancing the scale of Europe's research efforts under FP7 (2007-13).

Tracking down neuromuscular diseases

Neuromuscular diseases (NMDs) are chronic and so far incurable conditions that gradually affect patients' muscles, leading to potentially severe disabilities. Biomedical researchers in Europe are busy looking for the diseases' Achilles' heel.

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Rising to meet this challenge head on are scientists from the EU-funded 'Identifying and validating preclinical biomarkers for diagnostics and therapeutics of NMDs' (BIO-NMD) project, which was granted more than EUR 5.6 million under the health theme of the Seventh Framework Programme (FP7) to identify new biological markers for future clinical trials.

Sometimes also called 'neuromuscular disorders' or 'muscular dystrophies', NMDs are a diverse group of conditions. All NMDs affect the muscles or nerves that control the muscles, but different conditions affect different muscles such as in the limbs or heart. NMDs include diseases such as Duchenne muscular dystrophy or Bethlem myopathy. Some disorders of this group are genetic and transmitted within a family.

Gradually, NMD sufferers lose mobility. This decline can be more or less severe and more or less slow, depending on the patient and on the disorder. Some NMDs are very rare, while others are more widespread.

Although there is no cure available at the moment, years of biomedical research have brought important insights into NMDs. Researchers understand much better the onset of the diseases and potential targets for new drugs. However, scientists still need a lot of fine-tuning, in particular to find reliable markers, i.e. specific parameters they can measure to detect, follow and hopefully treat these diseases.

Launched in 2009 and due to end in 2012, BIO-NMD is searching for reliable biomarkers to monitor the progression of a disease and the response to a given drug, and guarantee a well-targeted, efficient treatment. Eventually, these markers can be validated in both animal and human samples, before being used in clinical trials.

At the crossroads between molecular biology and the latest advances in computing, the budding -omics sciences open up new perspectives for identifying such

markers. The suffix 'omics' refers to the comprehensive analysis of a whole biological system or whole organism, for instance a whole set of genes (genomics) or proteins (proteomics). Instead of studying a gene or protein one by one or within a small group, researchers screen a complete set all at once. In so doing, they get a snapshot of the system at a moment in time, and can better understand how genes express themselves.

In the case of NMDs or other diseases, scientists try to identify which gene cor-

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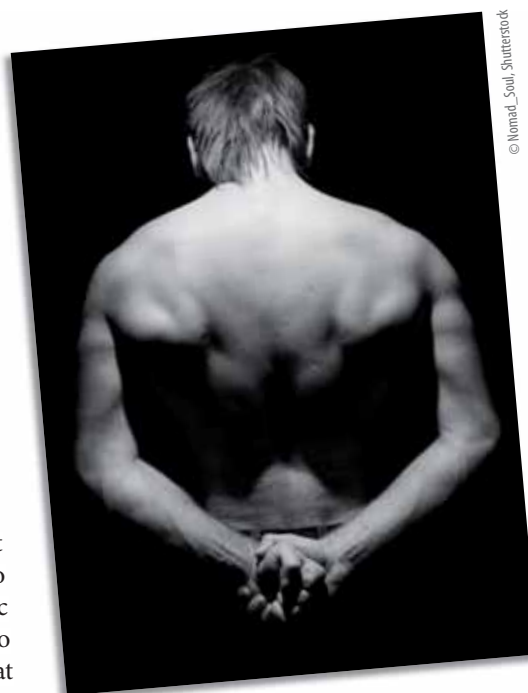
responds to which step and characteristic. Eventually, -omic sciences should allow scientists to better predict the development of a disease and its response to a treatment.

Coordinated by the University of Ferrara in Italy, the BIO-NMD project brings together 10 institutions from 7 European countries, including the French National Institute of Health and Medical Research (INSERM), University College London in the UK and the US-based company Ariadne Genomics that produces a visualisation software called Pathway Studio®. Ariadne will process and interpret large sets of -omic data, allowing the BIO-NMD consortium to spot key facts from large collections of documents, and build focused databases. The project's scientists will use this knowledge to refine and test hypotheses regarding different aspects of NMD research, be they disease modelling, drug action or biomarker discovery.

Fighting cancer with greater accuracy

Breast cancer is the most widespread form of cancer among women. Experts suggest that some 350 000 European women will be diagnosed with it this year. European researchers believe that early detection is currently the most effective defence against breast cancer, and are developing ways to make more accurate diagnoses.

The EU-funded project 'Highly accurate breast cancer diagnosis through integration of biological knowledge, novel imaging modalities, and modelling' (HAMAM) has been funded EUR 3.6 million under the information and communication technologies (ICT) theme of the EU's Seventh Framework Programme (FP7).

Until the causes of breast cancer are better understood, early detection and accurate diagnosis is the best defence, experts believe. The sooner breast cancer is detected, the sooner treatment can be provided, and the more likely a successful outcome.

Modern medicine offers several tools for breast cancer diagnosis including mammogram and ultrasound screenings, and biopsies. New or improved diagnostic tools (e.g. x-ray tomosynthesis, magnetic resonance imaging, positron emission mammography, automated three-dimensional ultrasound) also contribute to identifying and characterising the morphology and function of a suspicious breast lump.

Despite the enormous technological strides, however, a single solution for breast cancer detection is still out of reach. Additionally, existing diagnostic methods are not foolproof, and tumours can often go undetected (even biopsies of cancerous lumps can produce inaccurate readings).

If breast cancer is diagnosed, the current challenge in distinguishing between those cancers that do not pose a risk to health with those that do means some women are forced to undergo arduous therapy such as surgery, radiotherapy and chemotherapy, unnecessarily.

The issue at stake is one of accuracy: how can technology help us make more informed, early and precise breast cancer diagnoses? The answer, according to the HAMAM team, is to draw on all the benefits of the diagnostic tools currently on the market, and integrate these seamlessly into one clinical workstation.

The project follows in the footsteps of two EU-funded projects: 'Development of a soft-copy reading environment for digital mammography in breast cancer screening' (Screen) and 'The screening mammography soft-copy reading trial' (Screen-Trial). Both were funder under the user-friendly information society' strand of the Fifth Framework Programme (FP5) and contributed significantly to the field of European breast cancer diagnosis.

Launched in September 2008, the HAMAM team has already produced a prototype workstation. The system allows a doctor to view multiple sources of information simultaneously, including a patient's history and other information, alongside different diagnostic images. The workstation will eventually be connected to an extensive database capable of providing access to other images and clinical data in order to help guide a clinician on the best way forward for their patient.

HAMAM is led by the European Institute for Biomedical Imaging Research (EIBIR) in Austria. It is a collaboration between scientists, clinicians and information technology experts from seven European institutes, and a team from the Boca Raton Community Hospital in the US.

Commenting on how the EU-US partnership is a good way to combine different perspectives on the disease, EIBIR's Sonja Guttenbrunner said: 'Breast cancer is a worldwide issue, both epidemiologically and economically, but handled differently in Europe than in the US.'

German industrial partner Mevis Medical Solutions is expected to market the workstation when the project formally concludes in 2011.

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Protein in Huntington's linked to neurogenesis

EU-funded scientists have discovered that a mutated protein inherent in Huntington's disease (HD) performs an unforeseen role in neurogenesis. The finding could lead to a better understanding of HD, an inherited neurodegenerative disorder that is characterised by severe psychiatric, cognitive and motor defects, and neuronal death in the brain.

The work was supported by 'Cell polarisation in Drosophila' (Cepodro), a project that received EUR 1.159 million under the European Research Council's starting grant scheme. Findings from the study are published in the journal *Neuron*.

Past studies have demonstrated that mutation of the protein known as huntingtin (HTT) is associated with HD. In this latest research, scientists from Belgium, France, the UK and the US have found that the same protein performs a role in the process by which neurons (cells that transmit information) are created.

Senior study author Dr Sandrine Humbert from the Institut Curie in France explained that because of the obvious neurological signs and striking neuronal death in HD most studies on HTT function tend to focus on adult neurons. 'However, although HTT is not restricted to differentiated neurons and is found at high levels in dividing cells, no studies have investigated a possible role for htt during cell division.'

Known as mitosis, cell division occurs when a single cell divides into two new and identical cells. The process is complex and takes place at various well-defined stages. One of the stages involves a structure called the mitotic spindle.

Two proteins — dynein and dynactin — interact with the spindle. Since HTT is known to be linked to the activity of these proteins, the objective of the current research was to determine whether HTT was present during mitosis.

Indeed, the scientists demonstrated that HTT is essential for control of mitosis, and that the protein is localised at spindle poles during this cell division. HTT is, in fact, required to bring dynein and dynactin to the spindle.

'Our findings demonstrate a previously unknown function for htt protein and open new lines of investigation for elucidating the pathogenic mechanisms in HD,' Dr Humbert noted. 'Our work also identifies htt as a crucial part of spindle orientation and neurogenesis.'

In addition to offering new information on HD pathology, the findings from the research have the potential to fuel our understanding of the dynamics of the human body. The authors write: 'These findings reveal an unexpected role for huntingtin in dividing cells, with potential important implications in health and disease.'

HD causes uncontrolled movements, emotional disturbances, and severe mental deterioration. Unfortunately, the mechanisms leading to the disease are not fully as yet understood.

With up to 100 cases of HD for every 1 million people, Europe has a relatively high prevalence of HD in its population, according to the Huntington's Outreach project for Education at Stanford University in the US. The prevalence of HD is consistent across almost all European countries; only Finland has a notably smaller statistic of around six cases per million.

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Increase in human population killed off cave bears

European scientists have discovered that human expansion rather than climate change was the chief reason why cave bears became extinct in Europe around 24 000 years ago.

The researchers claim that increased competition between humans and bears for land and shelter — in particular for the caves used by the bears for hibernation during the winter months — triggered the decline in cave bear population levels. Conversely, the brown bear has survived until today because it did not depend so heavily on the cave habitat. The findings were published in the journal *Molecular Biology and Evolution*.

To discover why the numbers of cave bears *(Ursus spelaeus)* started to decline in Europe, a team of scientists led by Dr Mathias Stiller from the Max Planck Institute for Evolutionary Anthropology in Germany studied mitochondrial deoxyribonucleic acid (DNA) sequences from 17 new fossil samples and compared them with the modern brown bear *(Ursus arctos)*. The fossils were found in European deposits in Siberia (Russia),

Ukraine, central Europe and Galicia on the Iberian Peninsula.

The scientists carried out a Bayesian analysis of statistical probability on the DNA sequences and found that human expansion, rather than climate change, was responsible for triggering the decline of the cave bear, a fearsome creature weighing on average 500 kilograms.

'The decline in the genetic diversity of the cave bear began around 50 000 years ago, much earlier than previously suggested, at a time when no major climate change was taking place, but which does coincide with the start of human expan-

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sion,' said Dr Aurora Grandal-D'Anglade, researcher at the Institute of Geology at the University of Coruña in Spain and co-author of the study.

Meanwhile, radiocarbon dating of the fossil remains revealed that the cave bear ceased to be abundant in central Europe around 35 000 years ago, and definitively became extinct in most regions around 24 000 years ago. It should be noted, however, that it held out for a few thousand years longer in a few areas such as the north-west region of the Iberian Peninsula.

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Dr Grandal-D'Anglade confirmed that the species' extinction could be 'attributed to increasing human expansion and the resulting competition between humans and bears for land and shelter'.

The scientists also made comparisons between the cave bear and its cousin, the modern brown bear, by analysing 59 cave bear DNA sequences from between 60 000 and 24 000 years ago, and 40 sequences from the brown bear, dating from between 80 000 years ago to the present day.

They concluded that climate change did have some bearing on the decline of the cave bear, whose definitive extinction broadly coincides with the last cooling of the climate during the Pleistocene period between 25 000 and 18 000 years ago. The researchers suggested this alteration in temperature may have led to a reduction in shelter and the vegetation that the animals fed on; the cave bear was largely a herbivore.

However, they deemed this change and the subsequent impoverishment of eco-

systems merely the *coup de grace* for the cave bear, noting that it was 'already in rapid decline'. They noted that the present day brown bear did not suffer the same fate and has survived until today as it did not depend so heavily on the cave habitat. 'Brown bears rely on less specific shelters for hibernation,' explained Dr Grandal-D'Anglade. 'In fact, their fossil remains are not very numerous in cave deposits.'

Helping the elderly regain autonomy

Approximately 80 million Europeans are disabled. Seventy percent of them are over 60. Every day they are confronted with the stark realities of mobility. Moving about, even in the home, is limited to an architectural design often tailored to those without physical disabilities.

Over time, we will begin to lose sensory, motor, and cognitive functions. The simple act of going to the kitchen or climbing the stairs can be a struggle, and sometimes even an insurmountable obstacle. Lack of access translates into a lack of autonomy. Losing one's autonomy and independence is both a physical and a psychological exertion. Coupled with the strain on human resources to assist an expanding elderly population and a conversely shrinking work force, the importance of finding viable solutions to achieving greater autonomy is pressing.

To help address the problem, the EU-funded project SHARE-it([1]), developed a novel technology that will aid 'elder patients preserve their autonomy and live in their preferred environment for a longer time.' This includes any-

one who may be impaired. For many, home is where one finds peace of mind, where the body can relax, and heal. To provide those in need with a more flexible mobility regime helps unlock their independence and can potentially improve their well-being and quality of life.

Ambient intelligence
The innovative technology behind SHARE-it's research has succeeded in developing and integrating ambient intelligence (AmI) systems and sensor devices into four different mobility platforms. AmI is a systems technology that is able to observe and interact — independently, proactively and rationally — with its environment and those in need. While AmI has been around for some time, SHARE-it was able to get its systems to also learn and adapt.

SHARE-it demonstrates how AmI can help elder citizens with cognitive and/or physical disabilities to better cope with daily activities, suggests Professor Ulises Cortés, the project coordinator.

The mobility platforms SHARE-it built include the Rolland IV, Carmen, Spherik, and i-Walker. All but the i-Walker are wheelchairs. Sensors, either worn on the user or placed in the area enable the platforms to make any necessary adjustments, locate and monitor the user.

The platforms function with traditional human/computer interfaces, such as a joystick or pad, or more sophisticated voice commands for those who are more severely impaired. Biometrical sensors in the platforms also monitor, for instance, the user's heart rate. This work was conducted under the supervision of Prof. Kerstin Schill at Bremen University.

The vehicles also supply data on the state of the hardware, navigation and route planning, as well as battery power levels. The platforms have to simultaneously process all the different input and execute

complex decisions. To manage all these variables, SHARE-it developed a multi-agent system that provides so-called 'assistive services to the users.'

'From our side, SHARE-it represents an innovative approach to the treatment and support of our patients because it contains in a single instrument the answer for two problems: motor and cognitive. In fact, these two problems usually are treated separately,' says Dr Roberta Annicchiarico, SHARE-it's medical coordinator.

The research team tested its devices with actual patients in real settings. For instance, the Casa Agevole is a house entirely fitted with sensors, and was used as a staging ground for experiments and tests. The house is also designed so that anyone, regardless of their physical condition, can have easy access. The positive results propelled SHARE-it's overall objective to help develop a new generation of intelligent and semi-autonomous welfare technology integrated into homes, hospitals, geriatric institutions and other places. Welfare technology is an emerging area of research to help the elderly and physically impaired.

i-Walker

At first glance, the i-Walker looks like any conventional walker. But a closer inspection will reveal engines, sensors and several wires wrapped neatly by a central unit at its base. This central unit conceals a technology that not only communicates with the user, but also makes decisions, and reacts to obstacles and conditions present in the immediate surroundings. A voice-activated system which allows the individual to speak out commands was designed by a team of

researchers from the Technical University of Catalonia (UPC). Led by Prof. Cortés and Antonio B Martínez-Velasco, the researchers developed the i-Walker to aid people in multiple settings and for medical rehabilitation. Medical advice for this development came from Dr Fabio Campana (CAD) and Dr Annicchiarico.

An accelerator enables the i-Walker to automatically detect possible falls. The device also adjusts and corrects itineraries, helps the user turn corners, and controls braking. For those trying to regain their strength and improve motor skills, the i-Walker measures the efforts made by the user, the distance travelled, and the calories burned. This data, under the trained supervision of a medical practitioner, can then be analysed over time.

Wheelchairs

Most wheelchairs are either manually operated or assisted by motors. What sets SHARE-it's wheelchairs apart is that they can perform any number of tasks in a dynamic environment without continuous human guidance. All three wheelchairs are designed to cooperate with human mobility so that people retain or even improve their residual capabilities.

The Spherik wheelchair, for instance, is designed to be used indoors. Its spherical wheels allow for maximum manoeuvrability within a limited space. Rolland IV, on the other hand, looks more like a standard wheelchair. However, it is equipped with an electric differential-drive, two laser scanners, odometry sensors, and an embedded PC that executes proprietary software. This work was led by Dr Thomas Röfer at DFKI-Bremen. This soft-

ware, like the Safety Assistant, the Driving Assistant, the MultiModal Driving Assistant, and Route Assistant has also been partially developed for i-Walker.

The Carmen wheelchair offers an unprecedented shared control with the user. Both the individual and the integrated robot collaborate at all times. Carmen has a frontal laser sensor, onboard computer and a Wi-Fi router that connects to external software. However, at any time, the operator can override the wheelchair. For instance, if the wheelchair detects an imminent collision it will automatically employ a reactive algorithm to avoid the obstacle. The wheelchair operator can then take over manually. This work was led by Dr Crisitina Urdiales at University of Malaga (UMA).

A step forward

SHARE-it's technology is being used in different settings and institutions. The Fondazione Santa Lucia (FSL), a hospital for the neuro-motor rehabilitation of patients, in Rome, plans to introduce the project's results in patient treatment.

'At FSL, after some preliminary tests, we are planning a clinical trial on our patients in order to assess the efficacy of i-Walker in rehabilitation practice,' notes Dr Annicchiarico. 'Based on the results we obtain, we will consider the possible introduction of i-Walker as a part of the treatment. But let me clarify that at this stage the i-Walker cannot be used as a diagnosis tool.'

Several other SHARE-it project partners have also expressed interest in possible joint ventures and other business opportunities. Throughout the month of August, SHARE-it's results were showcased in the Italian pavilion at the Shangai World Expo 2010.

The end result will be a net improvement in the lives and well-being of the physically disabled. The SHARE-it project received funding from the EU's Sixth Framework Programme for IST research.

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EU researchers investigate biogas potential

Convinced that biogas can help the EU meet its commitment to produce 20 % of its energy from renewable sources by 2020, EU-funded researchers are investigating which technologies and regulatory frameworks are best suited for widespread but sustainable biogas production in Europe.

EU support for the 'Sustainable and innovative European biogas environment' (SEBE) project, totalling EUR 2.6 million, came from the EU Central Programme which is financed by the European Regional Development Fund (ERDF).

Biogas is one of the most versatile energy carriers; it can be used for generating electricity and heat, for cooling purposes, it is a potential vehicle fuel and it can be upgraded to biomethane to be fed into the national gas grid. 'Biogas production makes use of a naturally occurring anaerobic process and supplies a controlled technical environment that allows for the catching and utilising of the gases produced,' explain the SEBE researchers.

'The anaerobic biological process degrades and stabilises organic material by microorganisms and leads to the formation of methane and inorganic products including carbon dioxide. Methane gas is an energy carrier and can therefore be used to generate energy.'

They highlight that this energy 'has the potential to displace other energy sources such as fossil energy, this reduces greenhouse gas emissions and contributes towards a more sustainable energy concept'. In short, 'anaerobic digestion (AD) with biogas production has a major role to play in meeting the 2020 goal', they insist.

Germany, for example, has grasped this potential and already installed nearly 5 000 biogas plants, with potential for further installations. However, other European countries remain to be convinced, questioning in particular the economic viability of biogas plants. SEBE is determined to answer the doubters by establishing a common understanding of biogas across central Europe, its possibilities and the policies and frameworks needed to make it a successful renewable energy provider.

The project is being carried out under the leadership of the Internationalisierungscenter Steiermark (ICS) in Austria; it is also playing particular attention to regions in the Czech Republic, Hungary, Poland, Slovenia and Slovakia. Know-how transfer into these countries is one of the project's main aims.

However, in order to do this, the project is initially trying to understand what makes AD schemes work across Europe and identifying areas which need further development and harmonisation. According to the researchers, they are investigating a broad range of issues including 'different operating environments (legal, economical, logistical and technical), the availability of qualified personnel, and current and potential resources'.

In addition, they are elaborating 'guidelines and a transnational strategy for future education and training in the biogas sector' and are carrying out 'regional development consulting'. Biogas experts from different institutions are looking at different subjects; for example, the chair for Waste Management and Emissions of the Institute for Sanitary Engineering, Water Quality and Solid Waste Management (ISWA) at the University of Stuttgart in Germany is studying the role of decentralised micro-gas networks.

SEBE researchers also want to encourage networking between AD experts via a series of transnational competence knowledge centres. To ensure that the studies reach as wide an audience as possible, they will form a policy advisory board made up of external stakeholders, decision-makers and leaders not directly involved with the project to help communicate project results and enable access to other relevant international and national organisations and interest groups. The researchers hope that these communication channels will last beyond the lifetime of the project which is due to end in 2013.
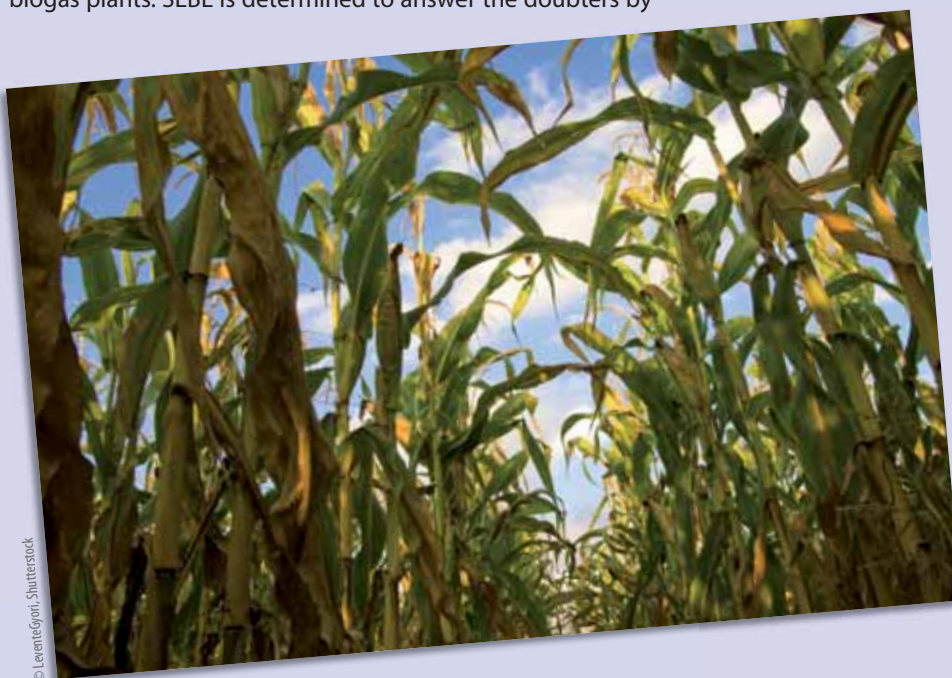
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Research paves the way for a single European sky

Safe flying in the busy airspace of the future will require significantly increased volumes of information exchange. As the current communications system will not be able to support the estimated traffic growth, European researchers have been studying new concepts and technologies.

By 2020 the global air traffic is expected to double, resulting in increasing congestion in the air as well as on the ground, and new requirements for a reliable air-to-ground communication link. With the support of the European Commission, information technology service providers and aerospace companies, through the Aspasia[1] project, have examined the applicability of new satellite communications technologies.

While aircraft satellite communications have been used for many years, they have mostly addressed non-safety-critical communications such as passenger telephone calls and internet connectivity. However, today more than ever before, the implementation of a single European sky is recognised as the only solution to eliminate gridlocks in the air and on the ground.

In this context, satellite solutions can play a key role, thanks to their capability to enable universal access to a common flight information system.

The Aspasia partners went one step further. It seemed of interest to demonstrate the possibility of combining advanced satellite communications technologies with air traffic control (ATC) systems, such as approach management (AMAN) and airborne separation assistance systems (ASAS).

These technologies can offer safety and efficiency often at a much lower cost than a potential investment in new or replacement infrastructure. Their benefits can be exploited when satellites provide the only means of communication — for example in oceanic airspace — but also over the European continent where one can choose between ground and satellite communication links.

During the course of the Aspasia, a dedicated simulation platform was therefore developed to assess the benefits and estimate the cost of satellite communications technologies. A real satellite communication system was also used to complement a simulation environment. It was envis-

aged that in the future these technologies will offer point-to-point navigation as well as higher quality voice and data communication for the needs of ATC.

The Commission has already set targets for satellite communications technologies. ATC must be 50 % less expensive than current services, and it must be able to handle a threefold increase in the volume of information exchanged. When combined with navigation systems like the European Union's Galileo, satellite communications will even contribute to optimising the aircraft trajectories.

Taking the fuel cell bus in European cities

The demonstration of a fuel cell bus operating in a European inner city environment provides hope for more sustainable and environmentally friendly urban transport options.

Fuel cell technology employs state-of-the-art vehicle design to offer many environmental benefits that can be applied to not only cars but also buses. Implementing this technology in Europe would help to promote sustainable transport and lessen dependency on foreign energy sources, which also makes good economic sense.

The 'Fuel cell bus for Berlin, Copenhagen, Lisbon II' project was geared towards establishing the fuel cell propulsion system, unique energy storage systems and a stationary hydrogen refilling infrastructure. These aims highlight the benefits of using zero emission fuel.

As a follow-up to the 'Fuel cell bus for Berlin, Copenhagen, Lisbon' project the

goal was to demonstrate the technology that could not be shown during the first phase. Initially, the aim was to develop, construct and implement an electrical storage system and also a hydrogen filling station. The final step was to demonstrate the bus in an inner city.

In order to achieve these goals a thorough methodology was required, including the comparison and assessment of different energy storage systems. The creation of a public stationary hydrogen filling infrastructure complete with an emergency hydrogen production facility was undertaken.

As a result, an internal combustion engine hydrogen bus and a fuel cell car

for the liquid refilling demonstration were showcased. A detailed safety study was conducted as well as a programme to increase safety measures.

Despite such significant advancements, more applications of mobile fuel cells are sought as is the heightened infrastructure to support the most effective use of the stationary filling station.

Greener aeroengines and gas turbines

New design methods were used to increase performance in turbomachinery by focusing on the change from a smooth laminar to a rough turbulent flow. Computer models were developed and underpinned by experimental testing and applied to new designs for gas turbine blades.

The 'Unsteady transitional flows in axial turbomachines' (UTAT) consortium comprised 15 partners from 7 Member States and included major European manufacturers of aeroengines and stationary gas turbines. The project was established to

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reduce the life cycle cost and improve the efficiency and safety of turbomachines, which transfer energy between a rotar and a fluid.

Improvements were achieved by reducing the number of turbine blades to increase the thrust to weight ratio and lower manufacturing costs and time to market. Altering the number of blades can also result in lower fuel consumption and a reduction in carbon dioxide (CO_2) emissions by one fifth over the next 10 years.

Use of design techniques based on unsteady flow improved the performance and life duration of aeroengines and stationary turbines. The phenomenon of transition from a smooth laminar flow to a turbulent flow is not clearly understood, but

directly influences the overall efficiency of turbomachines.

Models that examined the transition to unsteady flow as a result of wakes and surface roughness were developed and tested through a series of experiments. The models were used in the numerical analysis of innovative designs for gas turbine blades and the results collated in a database that will help increase understanding of the transition process.

Data from UTAT will enable researchers to develop aeroengines and gas turbines that are cheaper, more reliable, last longer and have reduced environmental impacts. Therefore, the project enabled European industry to become more competitive by facilitating the development of improved turbomachinery.

Green goods deliveries in urban areas

Goods deliveries in our towns and cities both contribute to and suffer from increased congestion, air pollution and noise. The problem of traffic-choked cities has meant that the way in which freight is transported around urban areas must be re-examined urgently.

Innovative non-polluting forms of transport for delivering goods in urban areas were developed by the 'Freight innovative delivery in European urban space' (Fideus) project. The goal was to help city based businesses and retailers boost their economic activity by using sustainable transport to improve mobility in cities. Consortium members from the car industry, logistics companies and local authority decision makers developed vehicles that provided a new approach for organising freight deliveries.

Researchers developed a series of vehicles that matched high performance with a telematic tool for logistics management. Since there was no 'best' vehicle, the consortium proposed three different types of vehicle, which complemented one another. They included an innovative 'clean' goods carrier, an adapted 3 tonne van and a 12 tonne truck.

The vehicles used a range of advanced technology and equipment to carry out their roles, such as a new type of goods container that increased efficiency and reduced environmental impact. Researchers concentrated on maximising the load capacity, making shipment operations as efficient as possible and integrating deliveries into city traffic.

Technical solutions were supported through effective policies drawn up by local authorities, for example reserving lanes at certain times of the day for freight transport. Another solution was the creation of trans-shipment areas in public spaces where larger vehicles can unload their freight for consequent delivery by small vehicles that can access pedestrianised areas.

The work of the Fideus project will mean less congestion, noise and pollution and

a welcome boost to the local economy. The result will be that Europe's cities will continue to flourish and become healthier, quieter and more pleasant places to live and work.

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Sustainable network for urban freight planning

The transport of goods in crowded cities can reduce quality of life through excessive noise, pollution and congestion. An EU-funded project addressed the problem by helping the spread of best practice for planning freight deliveries in urban areas.

The Bestufs[1] project was an open European network that facilitated cooperation between freight transport experts, research institutions, transport operators and local authorities. The project's purpose was to identify and disseminate best practice for urban freight solutions from around Europe.

The consortium developed a best practice handbook for providing strategies, concepts and activities in Member States. The results provide an overview of current challenges and issues arising from the movement of goods in an urban environment, and freight transport planning by local authorities. A series of workshops were established for exploring innovative ideas and exchanging experience and knowledge of best practice and included the use of the internet and newsletters.

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Important issues surrounding freight transport in an urban setting include establishing cooperation between stakeholders, a coordinated approach to policy and increased use of low emission vehicles. The project also helped in the collection of statistical data concerning freight transport, which was vital for determining which measures were the most suitable. The Bestufs project highlighted the importance of urban freight transport planning, which has been neglected in favour of passenger transport planning.

Exchanging knowledge with colleagues in similar positions based in other towns and cities is enormously useful to those trying to get their own initiatives off the ground. This type of information is based on real-life experiences and often more useful and inspiring than recommendations from external 'experts'. Therefore, the Bestufs project contributed an improved quality of life for urban dwellers by supporting and promoting sustainable urban freight transport in European cities.

Links between urban transport and wider social development

Did you think that having a bus stop near your house or a metro station in your area is a sign of a wider change impacting not only your neighbourhood but your city? That might just be the case and the EC-funded Transecon[1] project set out to prove it.

Researchers examined whether and how urban transport investments and policies impacted societies at a much deeper level than previously believed. These indirect impacts and secondary effects, if properly delineated, could prove useful tools in the hands of local and regional authorities involved in transport policymaking.

Despite the limited data availability, the implications of the project's observations were indeed supportive of the initial hypothesis. Transecon consortium members confirmed that increased socio-economic development, re-urbanisation and even decentralisation can be partly attributed to investments in urban transport infrastructure.

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Urban transport investments can indeed support sustainable development at the community level and should be seen as opportunities for wider changes. Although the efficiency of these investments varies depending on a number of factors, one of the key observations was that there is a 'recipe' for success. Benefits can be maximised through cooperation, willingness of stakeholders to get involved and the existence of a comprehensive transport policy among other factors.

Above all, local authorities must possess the vision and power to see such wide-scale projects through. Transecon's work showed that the benefits are indeed substantial and far-reaching.

Fuel cell technology: more than just a dream

Advancements in fuel cell technology could make the dream car of the future a reality sooner than we think.

In the near future, cars powered by fossil fuels could be replaced by vehicles using fuel cell technology, which is positive news for the environment. Before this dream can be made a reality, however, significant advances in fuel cell technology are needed.

The 'Direct methanol fuel cell system for car applications' (Dreamcar) project set out to develop a related set of components required for the assembly of complete fuel cell car demonstrators. The target was the development of a complete 5 kW direct methanol fuel cell stack that can function at over 140°C.

Methanol fuel cells have the advantage of a relatively high power density. The aim of the project was to develop cell components, hybrid membranes and catalysts which can perform at a power density of 300 mW/cm^2. A 1.25 kW module was designed, assembled and tested and the cell components were optimised. Following this, the components were selected and the module design was developed and advanced to a 5 kW stack.

The developed module gives way to a more thorough knowledge of the system in terms of operating conditions such as pressure, flow and temperature. This could help advance the progress for adopting fuel cells in cars sooner than we expect.

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Quieter railways

Partners of the EU-funded project Stairrs(^{1}) has developed a decision-support system to identify the most effective strategies for reducing railway noise and a forum for stakeholders. The objective is to limit noise while increasing the amount of traffic on Europe's rail network.

Over recent years there have been growing calls from residents, green groups and legislators to reduce the level of noise originating from railways. The EU's Environment Commission examined future policy with regard to potential noise legislation. However, it is important that all factors are considered before any new legislation is drawn up as rail has an important role to play in reducing the environmental impacts of road and air traffic.

The Stairrs project has provided information and facilitated the decision-making process to ensure that the best achievable solution is reached. Project partners first developed a cost benefit decision-support system to enable stakeholders to determine the most cost-effective way of introducing noise reduction measures. The system can also help legislators gauge the potential cost of possible noise legislation.

New noise reduction techniques were investigated by the consortium, including the separation of wheel and track and the use of composite brake blocks for rolling stock. The project also acted as a discussion forum for technical experts and decision makers to debate and reach consensus on the best ways of balancing the different economic, technical and environmental needs of stakeholders.

Stairrs also developed a software tool to help researchers determine the effectiveness of various approaches to noise reduction and the economic impact of a range of policies. The effect of different operational measures and noise measures on the viability of rail transport was also determined.

Results showed that insulated windows and barriers were not cost-effective in reducing noise levels. The most effective solution was to control the problem at source such as changes to tracks or rolling stock. The impact of smooth wheels when combined with other measures was found to be cost-effective in reducing noise, while speed restrictions made railways less competitive.

The policy of the European Commission has been to reduce the environmental impact of road traffic by transferring it to rail, which has a number of advantages over other forms of transport. Determining the best way to reduce railway noise can therefore play a crucial role in protecting the environment and improving people's quality of life.

(1) 'Strategies and tools to assess and implement noise reducing measures for railway systems'.

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Innovative valve technology for greener motoring

The days of using mechanical valves in car engines may be numbered thanks to EU-funded research. The ELVAS([1]) project developed and tested an improved electromagnetic valve actuation system that gave better fuel efficiency and reduced carbon dioxide (CO_2) emissions.

The initiative was funded under the EU's Growth programme and developed a high-tech alternative to conventional valves based on an improved electromagnetic actuation system. The new system employed lightweight materials to minimise power loss and maximise fuel economy.

Project partners created a valve actuation system that was 25 % lighter than the conventional valve, used less electricity and was completely recyclable. Carbon dioxide emissions and fuel consumption were reduced by 15 % while engine noise decreased by 10 decibels (dB) at 3 000 rpm. The consortium, which included manufacturers of valve actuation systems and engine intake and exhaust valves, also created guidelines for testing valve components and new manufacturing processes.

The ELVAS project successfully developed lightweight valves and materials that led to reduced valve actuation power losses and helped maximise fuel economy. Lower fuel consumption, less noise and fewer emissions will result in reduced environmental impacts, and more sustainable and cost-effective motoring. This in turn will make the European automobile industry more competitive in the global marketplace.

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Old questions about oil, a few new answers about biofuels

Assessing the effectiveness of measures taken to support the introduction of biofuels in certain European countries can deliver important insights into how their wider adoption can be accelerated. This was the focus of the Premia([1]) project, funded under the Sixth Framework Programme.

Hydrogen and biofuels have been portrayed as a practical, yet problematic option to meeting the increasing needs for transport fuels. And this is reflected in their widely varying uptake across Europe. For example, pure vegetable oil (PVO) is more or less prohibited in France and Italy. In Germany and Austria, on the other hand, it is the fuel of choice for a fleet of more than 10 000 vehicles.

Furthermore, as a result of biofuels' high profile, much discussion has been raised regarding emissions and engine compatibility. Under certain test conditions, vegetable oils generate unacceptably high levels of hazardous air pollutants. Still, emissions from diesel engines fuelled with conventional diesel are probably more toxic. Such controversies need to be discussed across the entire range of alternative vehicle fuels.

The EU-funded project Premia sought to illustrate the various aspects under which biofuels must be analysed and compared, not only against conventional transport fuels, but also against each other. The starting point was a review of past experiences with biofuels and other renewable energy policies and their impact at various stages in the fuel chain.

Issues that may arise if biofuels are widely adopted without protective measures were highlighted. Implementing the ambitious global biofuel targets for 2020 can push crop prices upwards. Furthermore, converting land to produce biofuels, and displacing agricultural activities may decrease and even turn any greenhouse gas emission reductions into a net increase.

However, measures to reduce these risks and negative impacts are at hand. Policy measures that stimulate higher agricultural productivity can increase supply and reduce future land demand for food, feed and fuels. Second generation biofuels produced from residues and crops cultivated on marginal lands will not compete with food crops.

The next step was to assess the effectiveness of measures supporting the adoption of alternative vehicle fuels in the pioneering European countries. The Premia partners analysed the strengths and weaknesses of biofuel support policies and explored possible scenarios for the potential impact in the long-term. They came to the conclusion that important pre-conditions such as fuel standards and compatibility with engines are already in place or are being introduced on an EU-wide basis.

The Premia study is bringing Europe further toward fulfilling targets for replacement of fossil fuels with sustainable alternatives. In-depth data has provided the complete picture for the biofuel option.

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ENERGY AND TRANSPORT

ENVIRONMENT

Protecting the environment as transport develops

Overhauling transport in a rapidly expanding and evolving continent like Europe is a huge undertaking. An EU-funded project has taken on the challenge to assess the environmental considerations of creating a seamless continental transport system.

Strategic environmental assessment (SEA) practice has evolved rapidly over the last few years throughout the world. Massive changes are being witnessed as economies expand or deflate in different directions with corresponding effects on society and the environment. The term SEA refers to any tool that can integrate environmental considerations into policies, plans and laws.

As Europe is undergoing rapid development with regards to its transport system, the EU 'Building Environmental assessment consensus' (Beacon) project tackled the issue of SEA of transport infrastructure. Challenges taken into consideration included the environment, employment and education, working conditions and quality of life in general.

Establishing a platform for discussion involving all stakeholders was a major objective. Linked to this was making sure that the findings of the study reach the right people — the planners and policy-makers — so that opportunities can be made to harness results to action plans.

The Beacon project published papers on the up-to-date situation for SEA in Europe. Also put to press is a new transport manual reporting on the consensus for critical issues facing Europe's rapidly developing transport system.

Most important, there is proof through various selected examples that SEA can support transport planning in the framework of the Trans-Europe network (TEN-T). A planned set of road, rail, water and air transport corridors, these will serve the entire continent of Europe.

When transport projects and plans are carried out, environmental protection must be considered by Member States. The key theme of the Beacon project, environmental aspects of transport policy, stands to provide Europe with a sustainable integrated transport network.

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The threat of an oil spill still looms

A decade after the Prestige oil spill devastated vast stretches of the French and Spanish coastlines, governments and the oil industry may still be unable to manage a large oil spill effectively. According to European researchers, the mistakes of the past are all too often repeated.

Major tanker spills are exceptionally rare events. However, world-wide statistics are no consolation to those whose coastlines and livelihoods were affected by the consequences of accidents such as the Prestige off the coast of Spain in 2002. In such a case the inability to prevent oil spilled from fouling beaches and damaging wildlife is all plainly demonstrated to an increasingly environment-conscious public.

Media has now the ability to relay real-time pictures around the world, sometimes faster than local authorities can get on scene. Such visible events

also have dramatic consequences for the owner of the tanker as well as the oil transportation industry as a whole. The EU-funded project 'Spill response experience' (Spreex) sought to use the experience of European organisations in the fight against the Prestige oil spill. The ultimate aim was to improve our chances for early detection and proper response to future spills.

Whilst society today is better prepared and equipped to deal with major oil spills than in 2002, it still may not be able to overcome some of the fundamental tech-

nical problems. Computer models can be used to calculate the probable movement and spreading of oil spilled. According to the Spreex researchers, experience shows however that it is unwise to place total reliance on such predictions.

Inadequate knowledge of surface currents in the area of the spill and local wind variations are only two of the many factors that can cause the spilled oil to move in surprising directions. This is why aerial surveillance by experienced observers, possibly supplemented by remote sensing equipment, should become an essential element of an effective response.

What is more regrettable is the fact that the most significant oil spills were not dealt with as effectively as current technology should allow. This is frequently because those responsible for managing

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The challenge is to improve this situation in the future. It is essential to evaluate the likely impact of a spill on environmental and economic resources before deciding on the most appropriate strategy and the required scale of any response. Failure to do so prior to mobilising cleanup resources can result in considerable embarrassment at a later stage for those in charge.

This can render the response ineffective and lead to problems in recovering the

the response operations take insufficient account of the extensive technical knowledge and experience that is available. The mistakes of past cleanup operations continue to be regularly repeated.

costs from other parties. Moreover, difficult decisions will be required throughout the response operation. The widely differing requirements of governmental and private organisations, public and political pressures will need to be reconciled. Far more effort needs to be put into ensuring that the lessons of past spills are taken fully into account in future response operations.

The Spreex project highlighted that greater improvements in oil spill response can be achieved. What is already known needs to be applied rather than simply seeking small improvements in techniques, however valuable these may be.

Europe and South America collaborate in climate study

The Claris LPB(¹) project investigated climate change in South America and its effect on regional agriculture and hydrology. An interdisciplinary team of researchers worked together with local stakeholders to develop a series of initiatives to mitigate threats to our climate.

European scientists collaborated with colleagues from Argentina, Brazil and Uruguay to determine the effect of climate change on the La Plata Basin (LPB) region of South America. Project partners used data from thousands of meteorological stations to develop new strategies for agriculture and hydrology in order to combat changes resulting from global warming. Researchers investigated climate variability over the time periods 2010-40 and 2070-2100 in order to improve climate change predictions for the region.

Scientists used observations and global models to investigate climate variations over a period of decades and evaluated global models from the UN's Intergovernmental Panel on Climate Change (IPCC). Project partners also conducted computer simulations of the region's present climate and studied extreme events and their effect on the area's agriculture and hydrology.

Stakeholders were closely involved in the design and adoption of strategies for combating climate change.

They also helped in the dissemination of information to interested parties including the general public, the agricultural sector and government policy makers.

The consortium established a group and forum for young scientists in European institutes and strengthened links with their South American partners. A web portal was created to facilitate communication and data access and software for applications that could be easily used by all partners. Researchers also developed a technique that enabled different climate models to be combined.

Activities carried out by the Claris LPB project have helped to further scientific cooperation between the Europe and South America and underline the EU's commitment to combating climate change.

(1) 'A Europe-South America network for climate change assessment and impact studies in La Plata Basin'.

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Clearing the air in Brussels

A case study carried out in Brussels aims to see if car free days (CFDs) are a feasible way of reducing pollution in the city. Results show that CFDs could also potentially be used during weekdays, and not only on Sundays, as is currently the case.

The case study's main objectives were to assess pollution levels, design crisis scenarios, including banning types of vehicles from Brussels and to survey what travellers would do when faced with these scenarios. The project researchers also recorded what effects these situations would have on traffic and pollution levels.

The study considered a range of measures to ensure CFDs run smoothly: crisis car parks in strategic places allowing commuters to carry on with public transport; adapt public transport capabilities to meet higher demand; ways of banning vehicles from entering Brussels; and finally communication campaigns to inform the public.

The research team, as part of the European project 'Integrated software for health, transport efficiency and artistic heritage recovery' (Ishtar), was also keen to explore the impacts of having CFDs on weekdays as well. In the hope that authorities would implement such a plan, they then could examine what measures would be needed to accommodate it.

During CFDs in Brussels, a notable decrease in city noise levels (decibels) was recorded, while decreases in nitrogen oxide and carbon dioxide levels were noticed. However, CFDs were considered ineffective in reducing ozone levels in the short term.

Preliminary results from the scenarios have been positive, with each scenario showing a reduction in emissions. Nitrogen oxides and carbon monoxide and dioxide were all monitored. Notorious for particulate matter, diesel emission were also lower.

As for public opinion, a poll carried out by researchers revealed that 47 % of people would consider a ban on vehicles awkward or very awkward, while around 30 % believed it would not cause too much disruption.

Ishtar results are encouraging for European city policymakers and their bid to reduce air pollution. Car free days can be part of a sustainable programme to make our urban areas cleaner healthier places to live as well as work.

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Scientists warn geo-engineering unlikely to curb dramatic sea rise

Researchers from Europe and China warn that little can be done to stop dangerous increases in the global sea level, as it will rise between 30 and 70 cm by 2100 even if all but the most aggressive geo-engineering schemes are undertaken to mitigate the effects of global warming and stringently control greenhouse gas emissions.

Such changes are likely to cause devastation for the 150 million people living in low-lying coastal areas including inhabitants of some of the world's largest cities. The study's findings were published in the *Proceedings of the National Academy of Sciences (PNAS)* journal.

Some scientists have proposed ways of geo-engineering the Earth to tackle global warming, thereby reducing its impact on both the main contributors of sea level rise: thermal expansion of ocean water and the melting of glaciers and ice sheets.

However, Dr Svetlana Jevrejeva from the UK's National Oceanography Cen-tre, Professor John Moore from Beijing Normal University in China and Dr Aslak Grinsted from Copenhagen University in Denmark believe that only the most ambitious of these schemes would have any effect on sea levels and that they could provoke their own problems.

The researchers modeled sea levels over the course of the 21st century under various geo-engineering schemes and carbon dioxide (CO_2) emission scenarios. 'We used 300 years of tide gauge measurements to reconstruct how sea level responded historically to changes in the amount of heat reaching the Earth from the Sun, the cooling effects of volcanic eruptions, and past human activities,' explained Dr Jevrejeva. 'We then used this information to simulate sea level under geo-engineering schemes over the next 100 years.'

Changes in temperature predicted to result from increased atmospheric CO_2 or geo-engineering are large compared with those caused by volcanism over the last 100 000 years or by changes in the amount of the Sun's energy reaching the Earth over the last 8 000 years.

Dr Jevrejeva's simulations show that extreme geo-engineering projects could have some effect on stabilising sea levels, but she questioned the impact they could have on the planet.

For example, she suggested that injections of sulphur dioxide (SO_2) particles into the upper atmosphere, equivalent to a major volcanic eruption such as that of Mount Pinatubo in the Philippines every 18 months, would reduce temperature and delay sea-level rise by 40 to 80 years.

'Maintaining such an aerosol cloak could keep sea level close to what it was in 1990,' said the researchers.

However, use of SO_2 injection would be costly and risky because its effects on ecosystems and the climate system are poorly understood. Similarly, large mirrors orbiting the Earth could deflect more of the Sun's energy back out to space, reducing temperatures and helping control sea level, but the logistics and engineering challenges of such a scheme are daunting. 'We simply do not know how the Earth system would deal with such large-scale geo-engineering action,' cautioned Dr Jevrejeva.

The researchers argued that perhaps the least risky and most desirable way of limiting sea-level rise was via bioenergy with carbon storage (BECS). Biofuel crops could be grown on a large-scale,

the CO_2 released during their combustion or fermentation could be captured, and the carbon stored as biochar in the soil or in geological storage sites, according to them.

'BECS has some advantages over chemical capture of CO_2 from the atmosphere, which requires an energy source, although both approaches could eventually reduce atmospheric CO_2 levels to pre-industrial level according to the new simulations,' said the scientists.

But Dr Jevrejeva warned that any extreme geo-engineering scheme posed potential serious problems. 'Substituting geo-engineering for greenhouse emission control would be to burden future generations with enormous risk,' she concluded.

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Finding the right tools for the urban sustainability job

Sustainable development is an important ally in the drive to improve the quality of life in Europe's cities. A review carried out by the PETUS([1]) project identified tools for encouraging sustainability and improving the management of urban infrastructure.

Decision makers need access to a wide range of tools if urban areas are to be properly managed. They can provide valuable information and guidance about water, sewerage, waste, transport and energy, which are all crucial to the built environment.

The PETUS project was set up to create a database of tools and case studies that could be used to bring about sustainability in urban areas. Both the public

and private sector benefited from the work, which helped them to manage projects in a better way. The funding was provided in part by the EU through its 'Energy, environmental and sustainable development' programme.

Project partner, the Welsh School of Architecture, Cardiff, carried out a literature review of tools and benchmarking data used for assessing sustainability in cities. The researchers identified different theoretical and practical tools, including those used for assessing environmental, social and economic impacts and those which dealt with specific sectors.

An important issue highlighted through the review was the limited availability of benchmarking data, which is used

to determine an organisation's or government's performance. A further problem was that the available data was found to vary widely between different sectors and was often difficult to calculate and implement.

According to the review, available tools were not being used despite the interest shown by those individuals and organisations that would normally put them into practice. This finding highlighted a gap between what should happen in theory and what actually happens in practice. A positive feature arising from the review was the use of tools to improve links between decision makers and the general public.

The study carried out by the Welsh School of Architecture can be a major benefit to those responsible for developing and maintaining the infrastructure of Europe's cities. The tools and benchmarking data identified can enable these decision makers to make better and more informed choices when managing sustainability in modern urban environments.

(1) 'Practical evaluation tools for urban sustainability'.

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Cleaner vehicles make the grade

A European project has developed a methodology that gives cars a 'green grade'. The rating system allocates clean vehicles high marks through the help of a decision-support tool.

Emissions released from car exhaust have an environmental cost, particularly in large cities with heavy traffic flow. The aim of the EU-funded Cleaner-drive project was to bring down the barriers to the introduction of cleaner vehicles by using the market influence of national programmes and making the most of key player influences in the arena.

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An integral part of the plan was to devise a vehicle environmental rating system which gives a high score to cleaner vehicles and technologies. The use of this system was piloted via a web-based tool.

All of the major sources of emissions were taken into consideration, such as tailpipe emissions and the production of fuel itself. The scores ranged from one to one hundred with the higher numbers indicating the cleaner the car.

The major achievement of the project was the vehicle decision-support tool which is able to cut transport costs and lessen vehicle emissions. A second version of the tool has been implemented and both long and short-term vision for a maintenance plan is foreseeable.

Free travel for marine life

Ballast water carried by ships from port to port is an unwitting vehicle for invading exotic species of marine life. European researchers have looked into the development of a system to stop this often unwelcome microbial immigration.

Ships take in a certain amount of water for stabilisation before a voyage which is discharged at its destination. This so-called ballast water is full of stones, sediment and therefore is home to thousands of marine organisms. It is estimated that over 3 000 species travel around the world on a daily basis in this way.

Invasion of exotic or non-indigenous species can wreak havoc with an ecosystem and cause imbalances that sometimes cannot be reversed, possibly even causing extinctions. To help control the situation, the International Maritime Organisation drew up directives and recommendations for treatment methods and controlling discharge limits for numbers of microbes.

With EU funding the 'Onboard treatment of ballast water and application of low-sulphur marine fuel' (Martob) project aimed to prevent the introduction of living organisms into ballast water. As a second line of defence, the project investigated treatment of the water while on the journey.

For laboratory trials the researchers concocted a 'Martob soup' of microbes to assess the biological impact of all techniques and the environmental effects of the organisms in the concoction. Assessment criteria for the methods included safety for the crew, cost and possible corrosion effects.

Amongst the many options for water treatment, Martob highlighted the importance of design of the tanks so as to minimise the places where the stowaways can hide. Ballast water pumps also play a big role in killing the organisms.

To increase the level of enforceability of regulations, the Martob researchers strongly recommend that there should be an approved procedure for a treatment system. Coast authorities could then ask for proof of active operation of the procedure which could be digitally recorded.

The Martob research has provided the basis for a unified approach for treatment system for ballast water. It is hoped that further research and development will avert any more ecosystems from being destroyed or destabilised worldwide.

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Computers to read your body language?

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Can a computer read your body language? A consortium of European researchers thinks so, and has developed a range of innovative solutions from escalator safety to online marketing.

The keyboard and mouse are no longer the only means of communicating with computers. Modern consumer devices will respond to the touch of a finger and even the spoken word, but can we go further still? Can a computer learn to make sense of how we walk and stand, to understand our gestures and even to read our facial expressions?

The EU-funded Miauce([1]) project set out to do just that. 'The motivation of the project is to put humans in the loop of interaction between the computer and their environment,' explains project coordinator Chabane Djeraba, of CNRS in Lille.

'We would like to have a form of ambient intelligence where computers are completely hidden,' he says. 'This means a multimodal interface so people can interact with their environment. The computer sees their behaviour and then extracts information useful for the user.'

It is hard to imagine a world where hidden computers try to anticipate our needs, so the Miauce project has developed concrete prototypes of three kinds of applications.

Escalator accidents

The first is to monitor the safety of crowds at busy places such as airports and shopping centres. Surveillance cameras are used to detect situations such as accidents on escalators.

'The background technology of this research is based on computer vision,' says Mr Djeraba. 'We extract information from videos. This is the basic technology and technical method we use.'

It's quite a challenge. First the video stream must be analysed in real time to extract a hierarchy of three levels of features. At its lowest, this is a mathematical description of shapes, movements and flows. At the next level this basic description is interpreted in terms of crowd density, speed and direction. At the highest level the computer is able to decide when the activity becomes 'abnormal' perhaps because someone has fallen on an escalator and caused a pile-up that needs urgent intervention.

It is at the second level and the third 'semantic' level of interpretation that Miauce has been most concerned.

One of the Miauce partners is already working with a manufacturer of escalators to augment existing video monitoring systems at international airports where there may be hundreds of escalators. If a collapse can be detected automatically then the seconds saved in responding could save lives as well.

But safety is only one possible kind of application where computers could read our body language.

Face swapping

A second application could be in marketing, specifically to monitor how customers behave in shops. 'We would like to analyse how people walk around in a shop,' Mr Djeraba says, 'and the behaviour of people in the shop, where they look, for example.'

The same partner is developing two products. One will be a 'people counter' to monitor pedestrian flows in the street outside a shop. It is expected to be particularly attractive to fashion stores who wish to attract passers-by. Another is a 'heat map generator' to watch the movements of people inside the store, so that the manager can see which parts of the displays are attracting the most attention.

The third application addressed by Miauce is interactive web television, a technology of increasing interest where viewers can select what they want to see. As part of the project, the viewer's webcam is used to monitor their face to see which part of the screen they are looking at.

It could be used to feed the user further information based on the evidence of what they have shown an interest in. Project partner Tilde, a software company in Latvia, is commercialising this application.

Miauce has also developed a related technology of 'face swapping' in which the viewer's face can replace that of a model. This could be used for trying out hairstyles and clothing.

Ethics and anonymity

These are all ingenious applications but are there not ethical and legal worries about reading people's behaviour in this way?

Mr Djeraba acknowledges that the project team took such issues very seriously and several possible applications of their technology were ruled out on such grounds.

They worked to some basic rules, such as placing cameras only on private premises and always with a warning notice, but the fundamental principle was anonymity. 'We have to anonymise people,' he says. 'What we are doing here is analysing user behaviour without any identification, this is a fundamental requirement for such systems.'

They also took account of whether the applications would be acceptable to society as a whole. No one would reasonably object to the monitoring of escalators, for example, if the aim was to improve public safety. But the technology must not identify individuals or even such characteristics as skin colour.

'Generally speaking, anonymity is the critical point. If we anonymise it's OK, if we don't anonymise it's not OK,' Mr Djeraba says.

Miauce received funding from the Sixth Framework Programme for research.

Robots learning from experience

Software that enables robots to move objects about a room, building up ever-more knowledge about their environment, is an important step forward in artificial intelligence.

Some objects can be moved, while others cannot. Balls can be placed on top of boxes, but boxes cannot be stably stacked on top of balls. A typical one-year-old child can discover this kind of information about its environment very quickly. But it is a massive challenge for a robot — a machine — to learn concepts such as 'movability' and 'stability', according to Björn Kahl, a researcher at the Bonn-Rhein-Sieg University and a member of the XPERO robotics research project team.

The aim of the XPERO project was to develop a cognitive system for a robot that would enable it to explore the world around it and learn through physical experimentation.

Logically testing hypotheses

The first step was to create an algorithm that enabled the robot to discover its environment from data it received from its sensors. The XPERO researchers installed some very basic predefined 'knowledge' into the robot. That knowledge is based on logic. The robot believes that things are either true or false — there are no 'maybes'. The robot uses the data from its sensors as it moves about to test that knowledge. When the robot finds that an expectation is false it starts to experiment to find out why it is false and to correct its hypotheses.

Picking out the important factors in the massive and continuous flow of data from the robot's sensors created one challenge for the EU-funded XPERO project team. Finding a way for a logic-based system to deal with the concept of time was a second challenge.

Initially the robot has no useful vision of the probable future, but with each observation it learns better hypotheses that it can use to predict the effects of its actions. If an experiment showed that one of its hypotheses was false, then there were literally an infinite number of possibilities of what the correct solution might be. The team had to find ways to short-circuit the process to stop the robot spending an infinite amount of time testing each possibility.

Part of the XPERO team's solution was to ignore some of the flow of data coming in every millisecond and instead to get the robot to compare snapshots of the situation after a few seconds. When an expectation proved false they also cut down the possible number of solutions by getting the robot to build a new hypothesis that kept the logic connectors from its old hypothesis, simply changing the variables. That drastically reduced the number of possible solutions.

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An important development from XPERO is the robot's ability to build its knowledge base. 'It makes no distinction between previous knowledge and learnt knowledge,' explains Mr Kahl. 'That it can re-use knowledge is very important. Without that there would be no incremental learning.'

Award-winning demo

In award-winning demonstrations, robots with the XPERO cognitive system on board have moved about, pushed and placed objects, learning all the time about their environment. In an exciting recent development the robot has started to use objects as tools. It has used one object to move or manipulate another object that it cannot reach directly.

While exploring robots makes great theatre, the most exciting developments to come out of XPERO are what the team learnt about the process of learning itself, says Mr Kahl. 'We gained a lot of insight into what the challenges in learning are and how machine-learning really works. Just getting the robot to figure out that something is not right required major insights from a research point of view.'

They are planning a new project that will run one or two robots for a much longer time — perhaps months — to see how they advance.

The XPERO project lays the first cornerstones for a technology that has the potential to become a key technology for the next generation of so-called service robots, which clean our houses and mow our lawns — replacing the rather dumb, pre-programmed devices on the market today. A robotics manufacturer is already planning to use parts of the XPERO platform in the edutainment market.

'But while XPERO advances machine learning, it is still far short of the capabilities of a baby,' says Mr Kahl. 'Of course, the robot can now learn the concept of movability. But it does not understand in the human sense what movability means.'

The XPERO project received funding from the FET-Open strand of the EU's Sixth Framework Programme for research.

Adaptive software — a late bloomer

Adaptive software is the largely unfulfilled promise of mobile technology, but now a new platform developed by European researchers promises to finally deliver software that reconfigures itself depending on the context.

Adaptive software — software that can configure itself automatically to deliver the maximum functionality for a given context — is finally coming. One of the long-promised fruits of the mobile technology tree, adaptation has proven a late bloomer, in large part due to the number of extremely tough problems that dog the idea.

For starters, there are thousands of different potential devices, from mobile phones to media players to computers. Added to that are the even vaster number of applications.

'The MUSIC([1]) project wanted to create a platform for adaptive applications that could work on any device and with any software,' explains Geir Horn, researcher with Sintef in Norway and coordinator of the project. '[It's] because people often want software to work differently in different contexts.'

Faulty defaults

For example, most emailing software downloads each email with all attachments in the order they were received. On a slow internet connection, it can mean waiting an hour or more to retrieve all the emails a user has received, and the connection could even drop out before the important last mail has been downloaded.

But email clients have a 'slow connection' setting that lets users download just the basic information: the subject, the sender and the size of the file, and it can be very useful when roaming data feeds or when the bandwidth is limited.

And it is not just download options that can be optimised for particular contexts. Encryption, too, can be usefully adjusted for office use or when on the move, with simple or even no encryption for the office, but extremely strong encryption outside the office.

'Of course, the email software developers could write their software so that it adapts when the internet connection is slow, or when the user is moving, or when the user is in a particular location, but there are possibly hundreds of different situations that they would need to

think of, and it quickly gets prohibitively expensive,' stresses Mr Horn. 'And that is just for one application.'

MUSIC handles all these issues. It takes account of a user's location, whether it is at home, the office, in a car or on public transport. It notes the device in use, whether a mobile phone, netbook or desktop, and it is aware of dozens of other variables, from the strength of the internet connection to the time of day, from light levels to the condition of the battery.

By combining all this information, the MUSIC middleware can make a very good guess of the users' context, what the user will want to do at a particular time, in a specific location with a given device.

The MUSIC platform does not need to be configured by the user, it derives its possible settings from the high-level behaviour descriptions that are part of most software developed today. High-level behaviours describe functions such as displaying SMS messages via text or using audio.

These descriptions tell the software what settings can be altered, and MUSIC then simply uses the most appropriate settings for a given context. In the SMS example, it would render the message in text when the user is in a restaurant, but render it in audio when he or she is in a car.

'The biggest challenge that the MUSIC consortium faced was trying to create software that would install on any device, whether it is a mobile phone, PDA, netbook or server,' Mr Horn relates. 'In the end, we decided to use Java, which we thought was the most appropriate cross-platform development language.'

The developers also used a plugin paradigm so the software can be extended in useful ways. For example, any software can take advantage of MUSIC functionality simply by developing a plugin for the platform. Similarly, the platform can expand its functionality via plugins too.

So while the base MUSIC configuration may take account of location via GPS

and time via the device clock, plugins could expand the base configuration to take advantage of other sensors, such as a compass, accelerometer or light meter.

Mission accomplished

The MUSIC project achieved all its design goals and has created a robust prototype platform. The software is designated open source and is freely available. There is a fledgling development community coalescing around the platform and, while there is no formal commercialisation plan as such, it is very likely that MUSIC will slowly, almost surreptitiously, become part of the mobile landscape.

That is because the platform is tiny, just a few hundred kilobytes in its base configuration. 'So if a company wants to offer services that depend on MUSIC, they can just bundle the software with the service,' Mr Horn remarks.

A tourism office, for example, can develop a package that will show users specific information at a precise location — say the history of a famous church — when the user is standing there. When the user subscribes to the service, the software can be downloaded to their phone directly. That makes the MUSIC functionality available to any other MUSIC-enabled software on the user's phone.

By degrees and utility, then, MUSIC has a very strong chance of becoming a very common platform and then, finally, mobile technology will evolve to become truly 'adaptive'.

Combining existing technologies for more efficient air travel

A leading aircraft manufacturer has designed and tested plans for an aircraft that has improved autonomous operation. The plane is not only safer and more efficient than previous models, it can be manufactured at an economic price.

As demand for air travel continues to rise and safety regulations become more stringent, technology will have to advance so aircraft can measure up to these heavy demands. Headed by a leading aircraft manufacturer, Airbus Industries, and with EU funding, the 'Aircraft in the future air traffic management system' (AFAS) project aimed to develop a more autonomous aircraft and refine and improve air traffic control systems simultaneously.

The AFAS project successfully provided the plans for an autonomous aircraft that can be produced maintaining safety standards and over an economically viable time frame.

AFAS researchers also defined an operational package to increase passenger capacity and the required air traffic management (ATM) network. Using real-life scenarios, they demonstrated the plan's viability.

The new system used a digital exchange of information between pilot and traffic control to create a seamless operation. Existing flight management systems and flight trajectory are key elements. An advantage is that existing computer architecture, wiring and data is used to keep down costs.

The new AFAS systems maintain the required level of safety while increasing the capacity of both airport and routes. In terms of efficiency, service is improved reducing delays at the airport, a boon for the holidaymaker and business interests alike.

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Getting aeronautics simulation software to cooperate

When software fails, factories grind to a halt, vehicles break down, computers crash... In aeronautics the consequences can be devastating. Widespread use of simulators and simulation software helps prevent the worst from happening. A European project has worked on interoperability tools to get all the different simulators and systems talking together.

Simulation has been successfully used in aeronautics for more than 30 years, strongly contributing to technological progress in the sector. Simulation software provides support to aircraft designers and engineers and simulators to help train air traffic controllers, pilots and crew.

Well-known applications in the aeronautics sector can test aircraft structural dynamics and behaviour in flight, engine combustion chambers, and flight control systems. Realistic flight and air traffic control simulators can familiarise crews and controllers with different potential flying conditions.

There is a catch, though. These applications were not usually built at the same time or by the same people. They don't always coordinate well together, which can be frustrating, costly and even dangerous. In particular, differences appear in connection with real-time and numerical simulations.

The EU-funded project 'Interoperable management of aeronautical generic executive software' (IMAGE) set out a few years ago to change this. The eight partners in four countries worked on several challenges: better simulations to reduce aircraft development cost and time to market; more efficient and cost-effective flight simulators and computer-based training; and simulations and 'virtual' platforms supporting customer care and information exchange efforts.

The team reached its goal of developing what it describes as a 'generic prototyped environment for numerical and interactive simulations optimising aeronautical industry computing investment'. In other words, underlying connection and management technology to boost the effectiveness of current and potentially future simulators and software simulations.

Since ending, the IMAGE consortium has conducted demonstrations for multi-disciplinary collocated and distributed simulators and for distributed simulators coupling training and education functions.

The project has expressed interest in outside support to further validate its prototypes or possible product development. IMAGE's behind-the-scenes work on simulators and simulation software is an important contribution to a sometimes undervalued part of the aeronautics business.

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Turning remote control into intimate support

All the remote controls lying around our houses or fixed to our walls can be combined via new standardised middleware. Combined control enables new levels of home support to the elderly and disabled.

Any networked home appliance or software service can be integrated with any user interface, via an open standardised middleware developed by researchers as part of the project 'Intuitive interaction for everyone with home appliances based on industry standards' (I2HOME).

The I2HOME solution can replace the plethora of remote controls we use to operate our TVs, stereos, DVD players, and laptops, as well as those fixed to the walls to control heating, air conditioning and ventilation, cookers, washing machines, dishwashers and lights.

Proprietary smart home solutions that can link appliances to a control hub have been available for a number of years. But complete proprietary home networks are costly. The I2HOME middleware decouples the home networking code from the user interface. That enables any user interface to be 'plugged' into I2HOME's universal control hub.

This shaves costs for the developers of home appliances and services. They need no longer be concerned with the networking capabilities of their equipment, provided they work to the ISO standards that I2HOME's 'Universal control hub for universal remote consoles' (URC-UCH) is based on.

For householders, I2HOME is a step towards a future where they could quickly and easily integrate new appliances, devices or services into their home network without employing professionals to configure everything.

The I2HOME solution even allows several devices to be controlled at the same time. That is important in the digital home where devices often need to operate and be controlled together. For example, the TV and DVD player must be able to run together to view a DVD.

Remote support
The I2HOME solution is particularly useful for the elderly and people with a range of disabilities. For instance, someone with poor sight could replace visual interfaces with a single speech interface. Or the householder could use technology that they are already familiar with, such as a mobile phone, to control a range of devices around the home.

There has been constant development in so-called ambient technologies that sense and respond to the presence of people. There are user interfaces that can read gestures, facial expressions, or that can be controlled by eye movements. The flexibility in the architecture means that all of them can be integrated with the universal control hub.

To boost uptake of the solution, researchers on the EU-funded project have created a resource server from which user interfaces and other software can be downloaded that integrate particular devices with the Hub — in just the same way that drivers can be downloaded to enable a PC to use a particular printer, or apps can be downloaded to the iPhone. The resource server creates an open market for adaptable user interfaces for the digital home.

Integrating the control of a range of home appliances enables a higher level of support for people with disabilities via 'activity management'. The householder can specify an 'activity' such as making coffee and toast for breakfast. A support worker can arrange the tasks that need to be taken in chronological order in the I2HOME system — water boiled, coffee filter filled and loaded, toaster loaded… The I2HOME activity man-

ager will monitor whether each step in the process has been completed before prompting the next step.

Activity management enables people with cognitive disabilities to be more independent by providing simple ways to do tasks — from changing the TV channel to picking the song they want on a CD. And a calendar that integrates with the universal remote console can remind the householder to take their medicine, to pay a bill, or to put out the rubbish bins.

One of the biggest challenges, according to Jan Alexandersson of German Research Centre for Artificial Intelligence — DFKI GmbH and I2HOME project coordinator, was getting the balance right. They wanted to create a system that simplified and supported people but not a system that left people feeling that it controlled them!

Support outside the home
Mr Alexandersson sees I2HOME as a step towards a smart environment, rather than just smart homes. 'This infrastructure should be built into the future ICT so that it is available everywhere. It is a technology that could tell you how to reach a meeting room in a strange building or that you could use to buy a rail ticket via your desired user interface.'

The I2HOME project received funding from the ICT strand of the Sixth Framework Programme for research.

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IT AND TELECOMMUNICATIONS

Future phones just got smarter

The next generation of mobile phones will be able to do more than ever before — both safely and efficiently. An EU-funded team has created a software platform that enables the use of multi-core technology on mobile embedded computing devices by way of virtualisation techniques.

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The dual multi-core and virtualisation solution developed by the 'Embedded multi-core processing for mobile communication systems' (EMUCO) team allows for both higher processing capacity and low power consumption, with the added value of security and flexibility. The project received almost EUR 3 million in support under the information and communication technologies (ICT) theme of the EU's Seventh Framework Programme (FP7).

The EMUCO project began as an idea developed several years ago by European academics and industrial partners in the mobile embedded market. Their aim was to explore the principles, suitability and commercial feasibility of multi-core technology and virtualisation as a way to juggle the needs of high computational performance and flexibility with low power consumption.

The two-year project, coordinated by Ruhr-Universität Bochum in Germany, has achieved just that through a software platform based on a small operating system kernel. The kernel, which is accompanied by a range of operating system components, makes a variety of uses possible.

Multi-core technology refers to processors that have two or more working processor chips. The technology, adopted in personal computer design several years ago, ensures enhanced performance with less power through parallelisation.

Virtualisation, meanwhile, isolates the software from the underlying hardware so that there is no direct access and control. This makes it possible to protect your device and download applications safely without the fear of contracting a virus.

Dr Attila Bilgic from Ruhr-Universität Bochum said: 'Today's smart phone users want to download applications and individually customise their phones according to their needs and preferences.'

The platform developed under EMUCO ensures that applications for mobile phones will be broader (a result of the higher processing capacity brought about by the multi-core technology) and more flexible (a result of visualisation).

Mr Adam Lackorzynski of Technische Universität Dresden in Germany explained that the system creates access to the lat-

est embedded multi-core architectures which offer efficient programming and processing of a broad range of different applications. These applications can range from 'special purpose applications, such as protocol implementation, to whole virtualised commodity operating systems'.

'It is expected that the emerging multi-core and virtualisation technology [will] revolutionise how a mobile phone will be perceived and opens new business models in the telecommunication market,' concluded Dr Maria Elizabeth Gonzalez from Ruhr-Universität Bochum.

In addition to Ruhr-Universität Bochum, the EMUCO consortium comprised Infineon (Germany), Technische Universität Dresden (Germany), *Politehnica* University of Timisoara (Romania), IBM Rational (Sweden), Architecture for the Digital World (UK), and the University of York (UK).

Future computing in the ether

As computer networks become more complex and pervasive, and their development is in a state of constant flux, leaving their design and management to human intervention is becoming increasingly unfeasible. An EU-funded project has come up with an innovative, self-adaptive architecture to enable future ubiquitous networks to deal automatically with changing circumstances.

The ancient Greeks believed that, above the terrestrial sphere, the universe was filled with a mysterious element called ether or aether (also known as the 'fifth element'). In early modern physics, ether was believed to be the substance that filled all of space.

Although we now know better, the word lives on in the language and is used to refer to things that are ubiquitous. It is thus no accident that a European project focusing on ubiquitous or pervasive computing should call itself Aether[1].

And as Web 2.0 technology is already demonstrating to us, the future internet will not just be confined to our desktop and laptop computers but will quite likely fill the ether, as computer processors not only find their way into most everyday objects in our physical environment — at home, at work, on the road, or at play — but all these objects will communicate with one another. This is a far cry from how computing was once perceived.

'Only a matter of a few decades ago, a computer was a very big, expensive and

intriguing machine for most people,' explains Christian Gamrat, the coordinator of Aether. 'Nowadays, of course, the picture has completely changed and we find people surrounded by dozens of computers, many of them sitting hidden in the most unlikely places.'

He goes on to say that: 'We have witnessed a silent change in the way most computing resources are being used, gradually shifting from a few big mainframe computers to millions of small embedded micro-processors that run most of our everyday applications.'

But this growth in embedded computers and their interconnectedness raises major challenges. The pervasive computing networks of tomorrow will be rapidly evolving meshes of different processors and other hardware, not to mention soft-

ware and operating platforms, which will make it costly and perhaps impossible to rely on human programmers to build and manage these diverse systems.

'In this context, the problem of programming and managing applications running on such complex, highly heterogeneous and potentially volatile computing resources is a key issue,' notes Mr Gamrat.

Computer adapt thyself

With 14 partners from 9 countries, the Aether project has come up with an innovative solution to the challenge of building and managing complex, organic, ever-evolving ubiquitous networks. Known as 'self-adaptive computing', the framework is designed around the idea that the platform or system must be able to react by itself to changes in the environment, such as the optimal execution of a wide range of applications on a variety of different platforms using a wide spectrum of dispersed computing resources.

'The Aether project ranges from the topmost layer of programming and setting the goals and objectives of the application, down to the design of computing resources with adequate properties,' points out Mr Gamrat.

At Aether's core is a descriptive language known as S-NET which enables several levels of static and dynamic adaptivity. S-NET maximises the use of computing resources by minimising the amount of computing power required for execution. There is also a clear separation between the world of the application designer and that of the computing environment.

The system uses two protocols to support the self-adaptive virtual processor (SVP) and the system environment place (SEP) in delegating tasks to vastly different resources in the pervasive network.

The SANE choice

For the S-NET model of self-adaptive computing to work requires it to be integrated into the system architecture at the processor level. This is what the Aether project calls SANE, or self-adaptive networking elements. 'By designing each computing element along the SANE design pattern, we guarantee its seamless integration within the Aether framework,' says Mr Gamrat.

He adds that SANE ensures that 'each and every bit of computing resources has a level of autonomy that makes it suitable to accept jobs delegated by the run-time systems and returns reports indicating the actual cost of execution'.

As Aether is about the principles and the protocols needed to implement 'self-adaptivity' in heterogeneous networks, it is a very versatile technology. It can be applied both to standard or reconfigurable processors and future bio- or nano-based architectures, as well as contemporary mobile technology and futuristic pervasive computing. It can also be used to develop complex systems that are not only self-adapting but self-healing and self-repairing.

Spin-off projects seeking to harness Aether's full potential have started or are already in the pipeline. One example is the EU-funded Apple-CORE project which seeks to mainstream multi-core processors and to integrate many-core chips into the PCs of the future.

Aether was funded by the FET-Proactive initiative (advanced computing architecture) of the EU's Sixth Framework Programme for research.

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Using electronics for the most intelligent way to drive

A European project has developed the know-how so drivers will have an intelligent car that avoids accidents and maximises fuel usage. The basis for this leap in research lies with an electronically controlled powertrain and a human-machine interface in a vehicle running on intelligent tyres.

Car accidents are 97 % due to driver error. To reduce the number of accidents on Europe's increasingly busy roads, the most logical path is to develop an accident avoidance system that can override driver input if danger threatens.

The EU-funded project 'Powertrain equipped with intelligent technologies' (PEIT), designed and developed an electronically controlled powertrain with input from a human machine set of displays and controls, the interface. The powertrain is the engine and other components that transfer the power to the drive function of the vehicle.

PEIT engineers developed an intelligent powertrain that would be virtually accident-free. A key feature is that the powertrain interface makes possible the integration of completely drive by wire applications into the system for steering and braking, gear-changing, as well as energy management.

Drive by wire replaces the mechanical with electronic control systems. Hence steering wheel, pumps, driveshafts and other traditional components are missing.

In conjunction with this electronic control system, an intelligent tyre was developed that can record the level of friction between it and the road. Information from the tyre is used to determine how well the car can handle corners and brake in any conditions. Friction is obviously the main criterion when roads become slippery.

PEIT research established a firm platform on which to further developments of intelligent systems for reducing accidents and improve energy efficiency. Research planned in the follow-on project, SPARC, included advanced drive by wire systems and a co-pilot for heavy goods and passenger vehicles.

Waste powers autonomous robots

As the saying goes, one person's garbage is another person's treasure. In this instance, the garbage in question is used by a robot to harness energy for its own operation. EU-funded researchers have developed a series of autonomous robots that feed off food waste and raw materials.

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For the last few years, the team of EU-funded scientists behind the EcoBot series (I, II, III) of robots has generated energy by feeding the machine food waste and raw materials. They have now set their sights on converting energy from urine for the same outcome. The EcoBot-III project received EUR 320 000 in funding under the EU's Sixth Framework Programme (FP6).

Dr Ioannis Ieropoulos, Professor John Greenman, Professor Chris Melhuish, and other researchers from the Bristol Robotics Laboratory (BRL) in the UK are responsible for a succession of experiments undertaken with EcoBots I, II and III.

Their unique approach has been to create an artificial digestion system for the robot. This 'gut' is designed around novel microbial fuel cell (MFC) technology, which draws on bacterial cultures to break down 'food' in order to generate power.

'Over the years we have fed our MFCs with rotten fruit, grass clippings, prawn shells and dead flies in an attempt to investigate different waste materials to use as a food source for the MFCs,' said Dr Ieropoulos. 'We have focused on finding the best waste materials that create the most energy.'

Access to energy is one of the greatest obstacles to widespread use of autonomous robots, particularly in remote areas. The scientists believe that for a robot to be truly autonomous it must not only use its energy wisely but also generate this energy from its own surroundings. This means being able to search, collect and digest waste materials to replenish its energy reserves. This, in turn, has the potential to contribute significantly to the waste management issue.

The latest challenge that underlies the team's current undertaking is to use urine for MFCs. Dr Ieropoulos explained that urine is rich in nitrogen and possesses chloride, potassium, bilirubin and other compounds — all of which make it ideal for MFCs. Preliminary tests have already shown it to be a very effective waste material.

The first step for the researchers is to enable MFCs to work together in a series of cells that are linked under a continuous flow system known as a 'stack'. A stack of linked MFCs are both more efficient and produce more energy than the same quantity of individual MFCs.

The team is working towards producing a prototype portable urinal that would use urine to create power from fuel cells. Although the project is in its initial stages, the scientists believe that a machine of this type could be used at outdoor events such as musical festivals.

In fact, the researchers have already secured interest from the UK-based waterless urinal company Ecoprod Technique. Ecoprod's Marcus Rose said the collaboration is both interesting and valuable for the company: 'We have talked to the researchers who say this product is the only type totally suited to complement this research. We are looking forward to helping with this unique project.'

As part of the EcoBot project, the researchers are concurrently looking into the possibility of using MFC power generation technology underwater. The apparatus would act as an artificial gill, where organic matter would be used as the biomass fuel for the bacteria and oxygen.

'Advances in this area could provide a significant contribution to the challenges we currently face in terms of energy production and waste clean-up,' concluded Dr Ieropoulos. 'We hope this research will help change the way we think about energy and human waste.'

EcoBot-I and EcoBot-II were developed in 2002 and 2004 respectively.

Innovation, reinvented

A carmaker reports that design time on a new model dropped from six months to just one, thanks to new tools for innovation and collaboration developed by European researchers. The way companies get and develop good ideas has undergone its own profound reinvention.

It usually takes up to six months to design a new car model; researchers at Fiat and Alfa Romeo can accomplish that feat in just one. It is a graphic illustration of the dramatic impact that new tools, developed by EU-funded European research, can have.

The 'Collaboration environment for strategic innovation' (Laboranova) project developed 18 tools or tool concepts and highly refined 8 core tools. These eight were then tested in various combinations among some of Europe's biggest corporations. Fiat and Alfa Romeo both independently tested InnoTube, developed primarily by Insead's Centre for Advanced Learning Technologies (CALT) of France. InnoTube is a bit like YouTube with massively enhanced collaboration and a host of additional functionality.

'InnoTube is a collaboration tool that implements the most important elements of Web 2.0, notably tagging, rating and recommendations, and it takes advantage of three drivers in Web 2.0 design,' explains Marco Luccini, research associate at business school Insead, France, and one of the tool's designers.

The first of those drivers is rich media video communication (users can also attach any kind of document or comment). Second, InnoTube provides a new way of accessing information by focusing on people and their knowledge. A third driver is instant gratification. Users are more motivated to use the tools, and to use them well, to establish their authority and share what they know.

Participation

'It is like Wikipedia, people get a real kick out of participating, and now it has millions of articles, and all because Web 2.0 lets people do what they would like to do anyway. But with Web 2.0 they are connecting with people immediately,' Mr Luccini stresses.

InnoTube also boasts a host of enhancements to all these relatively common Web 2.0 elements. For example, users can look at a type of 'mind-map' showing the links between different users who like the same content, and Mr Luccini emphasises that there is an inherent value to such 'connected knowledge'; it helps highlight information that will probably be useful even if you have no idea the information is there.

'If you like somebody's choices for one item, chances are that you will like it for another. If you are interested in a subject that one user covers very well, you will probably find lots of information you were not aware of in the files she or he recommends,' he says.

There is almost no end to the enhancements Insead's CALT has added to their package. People can communicate asynchronously, by starting forums around particular content or topics, or synchronously by using instant messaging, chat and video chat, public or private.

Special agents

The InnoTube platform also uses 'agent technology' to enhance its functionality. A concierge agent can alert you to what is

new, a similarity agent can help compare and contrast different users. All this information can quickly get overwhelming, so Insead also developed a recommendation agent to advise you about what information you need to follow or what people to get in touch with.

There is a game element, too, where players use words to describe a video. This serves two purposes. First, it connects players together; if the words match, they each get a point. Second, it annotates the video with useful keywords, keywords that reflect the interest of a particular user.

For example, a motor advertisement might inspire an engineer on the aerodynamics of the car, while the same video inspires a marketer for its message. In this way the relevance of videos is made plain.

Finally, a connection agent watches exchanges, key words and relationships as they develop, seeking to discern connections between people, between ideas. This is the vital element and the reason InnoTube was developed. To help users make connections.

Useful strategy

The strategy worked. By using InnoTube, two teams working separately at Alfa Romeo and Fiat were able to dramatically reduce the amount of time it took to develop a new car design, from six months down to one month in one case. Insead's CALT has a long-standing relationship with Fiat and the company agreed to test InnoTube in two of its carmakers, Fiat itself and Alfa Romeo. In each case, there were up to 100 people using the tool.

'The people were from different departments, different companies, and even different countries and continents,' explains Mr Luccini. 'InnoTube offered them a unified way to exchange ideas, get to know each other, cooperate and move the project forward, in this case, designing a car.'

Early on, InnoTube revealed profound cultural differences between different departments. 'It was really funny to see how the different teams would use Inno-Tube. With engineers, they would often just use their

camera phone, and then provide some black and white schematics as an attachment. It was very, very functional, all about getting the job done well as simply as possible,' explains Mr Luccini.

'By contrast, the contributions from the sales and marketing teams were like Hollywood productions, with logos and graphics and all sorts of animations. Their presentations, too, were very beautiful compared to the black and white functionality of the engineers. It was a really sharp illustration of how differently people from different departments communicate.'

Great accolade

Fiat took on the tools to do Insead's CALT just to test them for the project, but perhaps the greatest compliment for InnoTube is that, even though the assessment phase is over, Fiat and Alfa Romeo, and other companies who tested the tool, are still using it.

'We cannot reveal all the companies using these tools, but those that helped us assess InnoTube really like it, so much so that they continue to make use of it even though the assessment is over.'

InnoTube represents just one of the applications developed by Laboranova, and many of the other tools report similarly positive feedback from the companies using them.

Insead's CALT will further develop the InnoTube tool and start offering commercial versions in the near future.

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INDUSTRIAL TECHNOLOGIES

Roadmap for robot helpers

The humble robot cleaning your floor heralds a wave of robot helpers, from miners to surgeons, that could be joining us in the coming decades. How should European industry prepare for these new markets?

Since the 1980s industrial robots have become commonplace and in recent years cleaning robots have started tidying up in our homes. In 2007 there were an estimated 6.5 million robots around the world and that figure is projected to rise to 18 million by 2011. Europe has a quarter of the world market for industrial robots but how can it ensure that it maintains its position in the future?

The EU-funded project 'Coordination action for robotics in Europe (CARE), coordinated by Rainer Bischoff and Tim Guhl of KUKA Roboter in Augsburg, Germany, was set up in 2006 to create a Strategic Research Agenda (SRA) to guide the development of robotics. 'We wanted to make sure that a lot of different stakeholders were involved,' said Mr Guhl. 'And we wanted to have an industrially driven agenda — that was very important.'

The project was run in association with EUROP, the European Robotics Technology Platform, set up to enable European robotics companies to build and maintain world leading positions in all robotics markets to the benefit of European society. More than 130 organisations helped to develop the agenda over a period of three years.

Product visions
CARE assembled teams of experts in each sector of robotics — industrial, professional service, domestic service, security and space — to think about the kinds of 'product visions' that might one day lead to marketable products. A total of 39 were identified, ranging from mining robots to surgical robots and robot teachers.

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But when the experts looked closely at the product visions they discovered an alternative way to classify robots, by six cross-sector 'application scenarios'. These are robotic workers, robotic co-workers, logistics robots, robots for surveillance and intervention, robots for exploration and inspection and 'edutainment' robots.

'If you look at each of the application scenarios, their product visions have similar requirements,' says Mr Guhl. 'But as the product visions come from various sectors it follows that cross-fertilisation may be greatly beneficial. The SRA highlights where there are similarities and where the sectors can support each other, where technology developed within space robotics, for example, might become useful for domestic service robotics or the other way round.'

Eighteen technologies
One thing that sets robotics apart from other industries is that there is no one technology called 'robotics'. In fact, 18 different groups of technologies are identified in the report and many of the product visions make use of all of them. That can make it difficult to know where to focus development efforts. The basic question to ask, says Mr Guhl, is whether a technology is driven by robotics or not.

'Batteries, for example, are very important for mobile robotics,' he says. 'But a lot of money is already going into developing batteries for the automotive industry and for mobile devices. On the other hand, you have technologies like autonomous navigation. This technology is mostly driven by roboticists, but is also integrated in automobiles which you would normally not classify as robots. So some technologies need to be driven by robotics and some don't.'

The agenda lists eight conclusions, or 'commandments', that the robotics community needs to adopt if it is to make the most of the available opportunities.

A major challenge in robotics is the integration of the many different technologies into coherent systems, which has implications in many areas such as education. The SRA advises that a European supply chain is needed to reduce dependence on overseas suppliers. Research should concentrate on the key, robotics-driven technologies. Also, it will require more effective working between academia and industry and greater cooperation between the traditional sectors to create new markets.

Multitalented specialists
The multiplicity of technologies also leads to unusual education and training needs. 'You don't need specialists in one or two areas to sit around a table and come up with a good product,' says Mr Guhl, 'You need a number of different specialists, sometimes having knowledge of a numerous disciplines — such as mechatronics engineers — speaking the same language.'

Social, legal and ethical issues also need to be anticipated if robots are to play a greater part in our lives and carry out some of the functions normally done by human beings.

The Strategic Research Agenda was published in July 2009 and the CARE project finished last October. A successor project, euRobotics, is set to make the agenda 'come alive', as Mr Guhl puts it, and 'get the whole community working together more closely'.

Whatever happens, he expects to see many more robots appearing in our day-to-day lives over the next decade or so. 'They can help us with caring for people, with making our public spaces safer, with being productive enough to keep manufacturing in Europe, and so on. There is close to no area where robotics can't help in one way or another.'

CARE received funding from the ICT strand of the EU's Sixth Framework Programme for research.
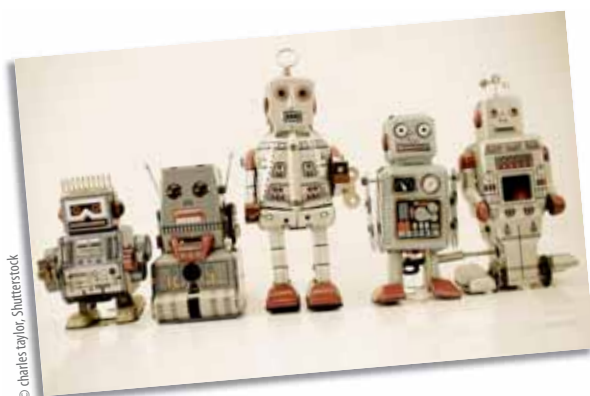
Quantum microchips emerge

State-of-the-art chip fabrication techniques developed by European researchers in the Microtrap project will help quantum computing emerge from the lab into a host of potential applications, from more powerful computers to quantum engineering.

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Quantum information processing is the next big paradigm shift in both computing technology and applied quantum mechanics, promising to propel both fields in a great leap forward. Quantum information processing, or QIP as it is often called, is considered an even greater advance than that achieved by the transistor, which led to personal computing, the internet and the information age.

'Quantum information is a radical departure in information technology, more fundamentally different from current technology than the digital computer is from the abacus,' noted W. D. Phillips, 1997 Nobel Prize winner in Physics.

Quantum information is more than a simple progression from digital to quantum. It is a new scientific field, a convergence of two great scientific endeavours of the 20th century: quantum mechanics and information science. Scientists in the field casually refer to QIP as the second quantum revolution.

While the first quantum revolution was about discovering and describing the weird world of subatomic physics, the second revolution will be about exploiting that weirdness for computation.

Spooky quantum mechanics?

Quantum state transfer can be achieved by the 'spooky action at a distance' of quantum mechanics, and is often described as teleportation but more readily called entanglement by specialists. Also, scientists have now shown that information processing can be achieved by collective interactions between quantum states of particles and electromagnetic radiation.

Exploiting these phenomena promises an enormous boost in processing power. In classical computing there are two binary states, on or off. Quantum information processing in its simplest form makes use of two quantum states. However, these states can be combined in superposition states to form qubits. The multitude of possible qubit or superposition states can represent myriad possible values at the same time.

For example, three classical binary digits, or bits, express one number between zero and seven; but three quantum bits (or qubits) can express all possible numbers between zero and seven at the same time. It is almost unimaginably more powerful. The consequence of quantum scaling, then, is that a quantum computer could calculate all values of three bits at once and in parallel.

Once the technical obstacles are overcome, quantum computing can provide massive parallelism. A 300-bit quantum computer could store more combinations of data than there are particles in the universe.

All this just by exploiting a basic difference between the two approaches. It is impossible to imagine what will be achieved when scientists begin to master the technology and get more creative.

Enormous challenges

Quantum computing is a hugely desirable technological goal, and like all such goals it presents enormous challenges.

Today, trapped ion technology is one of the most accessible technologies for demonstrating the quantum information science phenomena, on account of its ability to withstand quantum state decoherence brought on by environmental disturbances. A trapped ion quantum processor uses ions charged atomic particles which can be confined with electromagnetic fields. The qubits are stored in the electronic states of each ion.

'Most of the major experimental advances in quantum information science over the last decade have been demonstrated first on trapped ion systems,' explains Professor Patrick Gill of the UK's National Physical Laboratory, coordinator of the EU-funded Microtrap project.

'These advances include qubit operation, deterministic entanglement, basic quantum algorithm demonstration, quantum gate operation and deterministic quantum state teleportation,' he adds.

Trapped ion technology has proven to be capable of meeting almost all of the DiVincenzo criteria named after IBM's David DiVincenzo which define the essential technical achievements required to create a viable quantum computer. The Microtrap project gathered most of Europe's leading trapped ion experts into a single group to address these criteria in a concerted way. A big challenged they faced was how to scale up the technological breakthroughs already achieved in this field, according to Prof. Gill.

So, the team approached scalability through the miniaturisation of trapped ion architectures. Miniaturisation allows researchers to undertake quantum logic operations within arrays of trapped ions. It also helps to minimise interference due to environmental noise, more commonly known as decoherence.

Design and fabrication

Microtrap not only sought to design a range of viable architectures, it also aimed to fabricate them using current industry standard wafer machining and chip-fabrication technology and processes. In this, the team took advantage of European micro-machining and micro-fabrication facilities.

The project's goals included materials and fabrication, preparation, trap and array design, multiplexing for scalability, and detection and read-out of quantum bits.

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'All of these needed to be addressed within a comprehensive framework in order to achieve viable steps towards integration with micro-electronics materials, fabrication processes and platforms,' Prof. Gill notes. This is state-of-the-art capability and the theoretical and practical work undertaken by Microtrap represents a significant advance for European expertise in the field.

'The technology development focused on a number of novel approaches. The outputs to date represent a major step forward in integrating QIP into micro-electronics platforms, bridging the gap between large, complex laboratory demonstrations and viable microtrap chips,' Prof. Gill states.

In design and fabrication, Microtrap looked at three technologies: ceramic wafer 3D layered traps, two-dimensional (2D) planar surface traps and 3D silica-on-silicon traps.

The ceramic wafer microtrap, in particular, demonstrated several QIP techniques, such as sideband cooling, ion transport and Ramsey spectroscopy. In the latter half of the project, gold-on-quartz 2D (surface) traps were designed, fabricated and operated.

'We have also achieved a range of techniques for microtrap mounting on industry standard chip carriers, allowing 'easy access' chip connectivity and interfacing directly with standard micro-electronics design. This is a 'lab-on-a-chip' approach, but with control and manipulation of the quantum state,' Prof. Gill emphasises.

Microtraps developed within this project have undergone the initial stages in the evaluation of their suitability for quantum information applications. The team also measured the parameters of heating and associated decoherence rates.

From quantum science to engineering

They also demonstrated some of the elementary operations required for entanglement and gates, including coherent spectroscopy and precisely controlled ion transport. Such achievements are essential prerequisites in addressing the scalability challenge of ion trap-based quantum information processing.

In all, Microtrap achieved impressive technical and theoretical breakthroughs and boosted European expertise in trapped ion quantum computing systems. It also established a robust network of leading European players in the field.

The potential impacts of quantum information technology are difficult to overstate, whether it is based on trapped ion technology or some other process. Not only will QIP give rise to immensely powerful computers, but it will also usher in the era of quantum engineering, where quantum mechanics is regularly applied to technology. Here, Microtrap has clearly demonstrated that the new era will dawn sooner than we expect.

Microtrap project received funding under the FET-Open instrument of the Sixth Framework Programme for research's information society technologies (IST) programme. The consortium wishes to extend microtrap capability to arrays of microtraps under a proposed Seventh Framework Programme (FP7) research project.

Working together on particle paths

Flow field analysis is a vital technology with applications in aerospace, the motor industry and medicine. A European project has collected research from key players in the arena to push the boundaries of research progress by encouraging information exchange and dissemination.

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Particle image velocimetry (PIV) is one of the cornerstones in state-of-the-art avionics research. As the name suggests, it measures the velocity over time of small tracer particles introduced into a flow field. Software then translates the data into an image where the flow can be analysed.

In the field of aerodynamics, PIV has been applied to a wide range of flow problems including the air flow over an aircraft wing in a wind tunnel. In this context it is responsible for improving the design of aeroplanes by modifying the structure of industrial wind tunnels.

The EU-funded project Pivnet2[1] aimed to extend the scope of PIV technology by promoting information exchange between research laboratories and encouraging synergy between the network partners. The objective was to solve more complex, highly important research problems including icing and decay of wake vortex structures behind aircraft.

Trailing vortices, for example, are a by-product of differing airflows on the upper and lower surfaces of aircraft wings that can persist for many kilometres. These can be very hazardous for smaller aircraft following larger ones.

Research areas that still present many technological challenges include two-phase flows involving particles of different size, background illumination in flames and reflections from walls.

All these involve complex research that cannot be handled by all laboratories. Due to financial and time constraints, it is crucial that researchers can compare their work with other labs to avoid duplication and provide that edge to their investigations.

Project researchers have published a book of papers giving details of PIV techniques in a variety of application areas on the basis of Pivnet2 workshops. A set of interviews on particular applications has also been produced by the more expert scientists.

Advancements in PIV research are not only applicable to aeronautics but to the car industry, turbomachinery, combustion and even for analysis of vortices in prosthetic heart valves. Many fields in European technological research could therefore benefit from this valuable reference book.

Sounds nice: making better urban noise

The bulk of the noise that we experience when a vehicle drives past us is from the contact between the tyre and the road surface. However, according to the partners of the EU-funded project Silvia([1]), it is now possible to reduce traffic noise considerably.

The world of today is facing a number of changes. The population in European cities like London, Rome and Paris is increasing dramatically. The concentration of people in large cities in turn increases the impact of traffic on the environment and in particular, traffic noise.

There is however large potential for reducing the noise nuisance problem, if providers of road infrastructure, as well as city councils give the necessary support. By combining their efforts, substantial achievements in noise reduction can be gained based on existing technology and advancements from current research.

To contribute to the reduction of traffic noise burden in large cities, the European Commission decided to fund the Silvia project. Initiated by the Forum of European National Highway Research Laboratories (Fehrl), this project aimed to derive the full benefit from the use of low-noise road surfaces.

Over the past 20 years various types of low-noise road surfaces have been introduced, including thin asphalt concrete and stone mastic asphalt. Despite advances in the construction of these road surfaces, they are still not widely used even though they represent a relatively inexpensive means of reducing traffic noise.

Building substantially quieter road surfaces does not necessarily incur additional costs, unlike, for example, the construction of roadside noise barriers. However, their porosity can deteriorate over time, leading to a reduction in their noise-reducing properties. Methods are therefore required for monitoring their performance.

Within the framework of the Silvia project, the use of maximum length sequence-based measurement techniques has been shown to be effective in determining the acoustic absorption spectra of surfaces. Researchers have optimised these techniques for use under static as well as dynamic conditions.

Trial measurements have demonstrated the stability of this approach at towing speeds of up to 30 km/h for good quality road surfaces, such as those that have recently been laid. With further development, it may also be feasible to use such techniques to routinely assess the performance of older or more heavily trafficked roads.

The 'European guidance manual on the utilisation of low-noise road surfacings', the final output of the project, is the compilation of all the key research findings. It takes into account the fact that it should ideally be possible to make use of the content without any particular expertise in road building.

The project partners' hope is that this manual will help decision-makers to rationally plan noise mitigation measures by combining low noise surfaces with other noise control measures.

Developing engines for greener flight

The expected rapid increase in air transport means that new technologies are needed to reduce the air pollution caused by the sector. A team of researchers from across Europe looked into a new modelling system to test soot emissions for different aviation fuels.

The development of new aero-engine concepts relies heavily on computational fluid dynamics (CFD) modelling to evaluate the effect of different design features on combustion process and emissions.

Such modelling reduces the need for expensive rig tests, enabling more efficient development. However, accurate modelling depends on the quality of data input.

The 'Soot in aeronautics — towards enhanced aeroengine combustor modelling' (Sia-Team) project is the first step in turning research into industrial application. Researchers started with a detailed investigation into the influence of different kerosene fuel compounds and blends on soot formation.

The team developed an 'enhanced and validated mechanistic soot model' for these fuels. This was then translated into

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usable codes for CFD modelling to simulate the combustion conditions found in aero-engines.

The project, which was partly funded by the European Union, drew together partners in industry and academia from Germany, France, Italy and the United Kingdom.

The results of the project should make an important contribution to the development of the next generation of cleaner airplane engines — bringing the age of greener flying one step closer.

3D cameras enter the mainstream

A very clever breakthrough technology developed by European researchers makes 3D cameras cheaper, smaller and more accurate. It will open a new era in human-computer interfaces.

Thomas, a quadriplegic adolescent, can laboriously move his head just millimetres from side to side. It is the only movement that remains.

But with new 3D time-of-flight (TOF) hardware and software developed by European researchers, that tiny movement is enough to control a low-cost input device for a computer, suddenly unlocking the world of communication for Thomas.

This fictional scenario neatly illustrates the power and significance of new breakthrough technology recently created by an EU-funded research project. The 'Action recognition and tracking based on time-of-flight sensors' (ARTTS) project sought to improve the underlying technology and develop new algorithms, the codes that control the sensors, for action recognition and object tracking.

TOF cameras are a hot, emerging technology. 'Microsoft recently bought the Israeli TOF company 3DV Systems because they want to use the technology in their next-generation console,' explains Professor Erhardt Barth, deputy director of the Institute for Neuro- and Bioinformatics at the University of Lübeck, Germany, and coordinator of the ARTTS project. 'The main thrust of our research was human-computer interaction using TOF.'

The principle behind TOF is simple: The sensor measures the time it takes light to travel from the camera to an object and back — the time-of-flight — and uses this data to calculate the distance to the object. It is a 3D camera such as stereovision and laser scanners. But it is cheaper and more adaptable than either of those technologies.

Faster, leaner, cheaper

However to achieve that aim, the researchers had to embark on a highly ambitious programme of work. They had to dramatically improve TOF cameras over the state of the art, by increasing the depth resolution and the quality of the signal while reducing size, power consumption and cost.

'We had to show that you could develop sensors… small enough that you can imagine people putting them into webcams, computers and even mobile devices,' stresses Prof. Barth. 'What makes this new camera different is that it really is a lot smaller and more power efficient than what existed before. It only requires a USB port for power and it still retains the properties of the other machines that are much bigger and heavier and energy consuming.'

But smaller, cheaper and efficient was not enough, the camera had to be accurate too. 'Accuracy is another important point,' notes Prof. Barth. 'This camera uses active illumination, so there are some infrared diodes in the camera, but what makes this illumination special is that it is modulated: The brightness changes very quickly over time, and so the accuracy depends on the frequency — how fast this illumination is changing. We managed to build a 60-megahertz light source. It

changes 60 million times a second, which makes the camera much more accurate in the near range.'

Other cameras are optimised for the far range, 1-7 metres and beyond, but the ARTTS camera is more accurate within a metre, which is the relevant distance for using gestures with smart phones. 'The iPhone made people familiar with using gestures, and so the next step would be to have interaction without touch, and that's where we come in.'

'So, actually I think the ARTTS camera developed by partner CSEM is the main competition to what Microsoft now has. I think ours is better, in fact, but it needs more work to become a mass market product,' Prof. Barth emphasises.

Dual camera

The team also developed a second camera that combines both a low-resolution TOF sensor and a HDTV-quality image sensor. 'Partner SMI thinks this sensor will provide better functionality for security and health care, providing video links to elderly people, and alerting healthcare workers if there is a problem with a patient, for example,' reveals Prof. Barth. For example, it could track people as they move through a room and recognise their actions.

He is very upbeat about this camera because even a low-resolution TOF sensor provides very usable distance data, whereas a low-resolution image sensor is less useful. 'I think this type of dual camera will be ideal for most environments and devices,' he notes. 'Essentially, it just uses a beam splitter that sends the infrared light to the TOF sensor and the visible light to the image sensor. Beam splitters are a mature, low-cost technology already widely used in camcorders.'

So the hardware is state of the art, but software is essential for functionality, and in this area university teams from Denmark, Germany and Romania worked on three problems. The first was generic, simply seeking to dramatically improve the quality of the signal from the TOF sensors, and the team used some very ingenious solutions.

For example, Prof. Barth's group realised that light intensity and distance are not independent values but are related to each other by the shading constraint. If the reflectance properties of the observed object are known, the quality of the range maps can be dramatically improved, objectively and subjectively, by imposing the shading constraint. Other solutions improved the signal further.

The second software objective was to develop an algorithm for object tracking. 'I spent a lot of time before trying to track human features like the eyes and the nose and it is pretty hard,' reveals Prof. Barth, 'especially if you need to work in places like a car, where the light changes all the time.'

Subtle sensing
However, with the TOF sensors you get two measures: a high-resolution distance map and a low-resolution light intensity map. Combined with the distance map, the intensity map is good enough to do useful applications. For example, by using this combination of information, ARTTS was able to develop various object-tracking algorithms which can track people, because the distance provides one measure that is corroborated by another from the light-intensity signal.

This is an important basis for the team's other work. Once the system can track an object reliably, it is ready to learn gesture recognition, which was the main goal of the ARTTS project from the beginning.

And it turns out that the ARTTS system is capable of recognising quite subtle gestures. Sure, there are measurement errors for each pixel that give you a distance value, but there are a lot of pixels and so a lot of values that average out in the aggregate, which dramatically increases sensitivity. In its current version, the system can even control a slideshow presentation using hand gestures to point, change slides, go back and more.

The applications of these technologies are potentially endless. After an intensely competitive application process, the project received EUR 400 000 of funding from the German government to create a start-up which will provide both technology and services. Customers can buy a hardware and software platform to develop their own applications, or they can hire the new firm TOF-GT to develop the application for them.

The team is developing an advertising application for the Vienna train station. It consists of a 12-metre-wide high-definition screen and a number of TOF cameras. The cameras will enable commuters to interact with the screen as it plays advertisements. It could also be used to conduct surveys, or handle customer information. The team is also considering a smaller version for use in stores or shopping centres.

It 'is' brain surgery
The team is also collaborating with neurosurgeons and a medical instrument company to develop gestures for the operating room. Neurosurgeons use a vast amount of information in a variety of formats — images, vital signs, read-outs from a large number of instruments. 'Right now, a surgeon has to put down his tool, change the data view and then proceed, but we will develop a system that will make changes in response to specific gestures. It is not a research project, it will become a new application.'

It is a taste of things to come for the technology. Currently, the widest application of TOF sensors is the dairy industry. They are used in automatic milking machines to connect to the cow's udder. But the potential TOF sensor applications are literally limitless and now, thanks to the ARTTS project, they are small, affordable, efficient and optimised for object tracking and gesture recognition.

ARTTS was funded under the IST strand of the EU's Sixth Framework Programme for research.

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INDUSTRIAL TECHNOLOGIES

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

Strategic energy technology plan conference 2010

The strategic energy technology plan (SET-Plan) conference will take place in Brussels, Belgium on 15 and 16 November 2010.

The SET-Plan conference 2010 will report on the progress of all action lines of the European Commission's SET-Plan, officially launch the European Industrial Initiatives for bio-energy and nuclear energy and kick-off the international dimension of the SET-Plan. The SET-Plan 2010 conference gathers a broad range of stakeholders including the research community, the industry, the financial community, policy makers and international partners.

For further information, please visit:
http://www.setplan2010.be/

International conference of education, research and innovation (ICERI2010)

The ICERI2010 will take place in Madrid, Spain from 15 to17 November 2010.

This annual event brings together professionals in the field of education, research, innovation and new learning technologies. It is an excellent opportunity to share your experiences and projects with educators and professionals from all parts of the world.

For further information, please visit:
http://www.iated.org/iceri2010/

Urban mobility brokerage event

The Mobilis brokerage event will be held on 16 and 17 November 2010 in Strasbourg, France .

This two-day event will hold a series of conferences dedicated to urban mobility. Companies and research laboratories will be given the opportunity to meet and discuss potential future collaboration. Participants will also get the latest information on the current technological trends and research activity.

Topics on the agenda include: urban clean technologies; driving smart systems; mobility management; innovative materials, processes, and systems.

For further information, please visit:
http://www.b2match.com/mobilis/

'Positive visions for biodiversity' EPBRS workshop under the Belgian EU Presidency

The workshop entitled 'Positive visions for biodiversity' by the European Platform for Biodiversity Research Strategy (EPBRS) under the Belgian EU Presidency will take place in Brussels, Belgium from 16 to 19 November, 2010.

In the context of the international year for biodiversity and under the Belgian EU Presidency, the EPBRS, the Belgian Biodiversity Platform, and the Belgian Science Policy Office are initiating a participatory workshop on 'Positive visions for biodiversity'. Scientific research can only provide the information on the impacts and likely effects of our activities in regard to biodiversity, and can help draw the roadmap to a potentially better destination. But society has to choose which road to follow.

In a Europe-wide contest held alongside the workshop, cartoonists are invited to draw their positive visions for biodiversity. The comic strip must feature the idea that people understand and treasure their place in a complex ecosystem, where humans no longer feel separated from their natural surroundings.

For further information, please visit:
http://www.biodiversity.be/epbrsbe2010/page/index

First world congress on targeting mitochondria

The first world congress on targeting mitochondria will be held on 18 and 19 November 2010 in Berlin, Germany.

Mitochondria are ubiquitous organelles found in eukaryotic cells. Their primary function is to generate energy supplies in the form of Adenosine-5'-triphosphate (ATP). They play a critical role in aging and development, making them an attractive target for drug and antioxidant-delivery strategies. Mitochondrial dysfunctions are associated with a range of pathologies such as cancer, diabetes, neurodegenerative diseases, migraine and infertility.

Research has increasingly focused on how to target mitochondria with bioactive molecules, drugs or nutrients in order to treat and prevent pathologies and chronic diseases.

The event will highlight the issues surrounding mitochondrial use as a target of contemporary medical research. It also aims to highlight potential mitochondrial applications and strategies in the prevention and treatment of many chronic diseases and pathologies.

The conference will be organised in four sessions. These sessions are mitochondrial dysfunctions in chronic diseases: recent advances and conclusions; mitochondria in practice: methods and instruments; strategies to target mitochondria, and targeting mitochondria: recent clinical and therapeutics studies.

For further information, please visit:
http://www.targeting-mitochondria.com/

Conference on microbes and industrial biotechnology

The ESF-BU-CeBiTec conference on microbes and industrial biotechnology 2010 will take place from 21 November to 24 November 2010 in Bielefeld, Germany.

The conference will feature lectures by invited high-level speakers, short talks by young researchers and round table discussions about future developments. The goal of the conference is to promote scientific excellence in microbial biotechnology by providing leading scientists and young researchers with a platform to present their work, to discuss current scientific understanding along with recent developments in key areas of industrial biotechnology, and to identify the priorities for further research.

Biotechnological processes are of increasing significance for industrial production. This trend is likely to take up more momentum in the light of decreasing oil availability. Production processes in industrial biotechnology make use of recent advances in microbial research, and microbial biotechnology is likely to play an important role towards the sustainable use and production of renewable bio-resources.

The conference will be the first in a series of annual conferences on advances in industrial biotechnology.

For further information, please visit:
http://www.esf.org/index.php?id=7123

Renexpo Austria

The 'International trade fair and conference for renewable energy and energy efficient building and renovation' (Renexpo) will take place from 25 November to 27 November 2010 in Salzburg, Austria.

Part of a series of high-level trade fairs focusing on the important topic of renewable energy and energy efficient building and renovation, Renexpo Austria 2010

builds on the previous edition with some 130 exhibitors, 500 conference attendees and 4 000 visitors expected from more than 20 countries.

Themes at this year's trade fair include district heating, heat pumps/geothermal energy, solar technology, hydropower, wood energy, energy consultation, green jobs, mobility and alternative fuel vehicles, biogas, wind energy, cogeneration, vegetable oils, and more.

Renexpo Austria also hosts a brokerage event which offers bilateral meetings with potential partners from all over Europe in fields such as bioenergy and energy efficiency (building, processes and mobility), as well as wood, hydro and solar powered sources.

For further information, please visit:
http://www.renexpo-austria.at

First international workshop on the security of the internet of things

An international workshop on the security of the internet of things will be held on 29 November in Tokyo, Japan.

The aim of the workshop will be to find ways of securing the internet of things, linking people, devices, telecoms and data networks into one, vast network of networks.

Participants will discuss emerging risks and vulnerabilities, privacy and data ownership and intrusion detection among other things. The conference aims to bring together researchers and professionals from universities, private companies and public administrations interested or involved in all security-related heterogeneous aspects of this topic.

The term internet of things refers to the networked interconnection of everyday objects. If these objects were to be equipped with minuscule identifying devices, interconnected via a wireless net-

work of sensors, then solutions to issues such as running out of stock, finding lost parcels in the post or even theft could be revolutionised.

The workshop will be part of the Internet of Things 2010 conference.

For further information, please visit:
http://www.isac.uma.es/seciot10/index.html

'Fluid machinery — meeting the environmental challenge'

An event on 'Fluid machinery — meeting the environmental challenge' will take place in London, UK on 30 November and 1 December 2010.

Fluid machines are, collectively, the largest consumers of energy in most industrial plants. For the manufacturing sector, they can be considered as having a high impact vis-a-vis the environment.

There is a significant amount of environmental legislation and fiscal controls (e.g. directives concerning energy using products, noise regulation laws, carbon dioxide emissions tariffs) which impact the design and operation of fluid machinery. More stringent requirements are inevitable as stricter global, European and national targets are imposed.

Fortunately, reducing environmental impact need not always mean increased cost. There is significant scope for financial savings, such as through reduced energy usages, improved design for remanufacturing and reuse of components.

This event aims to raise awareness of legislative requirements and showcase best practices being adopted by manufacturers and users, highlighting where opportunities exist to reduce the wider impact of fluid machinery and work in harmony with environmental requirements.

For further information, please visit:
http://events.imeche.org/EventView.aspx?code=s1527

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