



European
Commission

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RESULTS MAGAZINE

No 30 March 2014

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'From the forest to the lab, what science can learn from nature'.

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RESULTS MAGAZINE

Published by

Publications Office of the European Union
2, rue Mercier
2985 Luxembourg
LUXEMBOURG
E-mail: cordis-helpdesk@publications.europa.eu

Editorial coordination

Gyn Nilsson

The *research*eu results magazine* is published by the Publications Office of the European Union, as part of the EU-funded research programmes. Content is prepared using several sources, including CORDIS, the Research Information Centre, ERC, as well as original material collected specifically for this publication.

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ISSN 1831-9947 (printed version)
ISSN 1977-4028 (PDF, EPUB)

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Learning from nature

Science and technology have often learned from observing nature. The streamlined forms of ships have been developed thanks to observation of the swift, efficient shapes of fish, while engineers building aeroplanes and other winged craft have been inspired by birds in flight.

Today, scientists are looking even further afield to study natural processes that could help us to build better and more efficient technologies. We can learn from photosynthesising leaves in order to improve solar-power generation. We can study the body's natural defence mechanisms against disease in an effort to boost them or apply them to new ailments.

Furthermore, the more we understand about nature, the better our understanding of basic scientific principles. And this can have applications far beyond the field initially in mind.

In the world of robotics, for example, we have become increasingly used to seeing robots that mimic living examples — not just humanoid robots, but robots that swim like fish or swarm like insects. Dr Barbara Mazzolai of the Center for Micro-BioRobotics at the Istituto Italiano di Tecnologia (IIT) in Pisa, Italy, is taking these ideas even further. She is developing robots that mimic the abilities of plants — plant roots, in particular. In this month's Q&A interview, *research*eu results magazine* asked Dr Mazzolai to explain further her concepts for technologies to mimic plants, and their possible applications. Astonishingly, these extend from medical endoscopes, and environmental monitoring, to space probes.

Our 'biology and medicine' section (starting on page 6) includes many more examples of technology mimicking nature, such as 'Virus-like particles for vaccine development' or 'Elucidating the natural mechanisms of tumour suppression'. Equally, the 'energy and transport' section (which starts on page 16) goes from 'Copying nature's elaborate surface chemistries' to 'Peptide-based electronics for solar technology'. The 'environment' section (on page 21) looks at how studying nature can lead to improvements such as 'Cloud watching improves climate models' and 'Synergising eco-friendly pesticides'.

The feature story in our 'social sciences and humanities' section (page 14) examines a serious issue for our common historical heritage: 'Protecting archaeological sites from wild fire and extreme weather'. A second Q&A interview — with Tom Pearsall, of the European Photonics Industry Consortium (EPIC), in France, and Peter Van Daele, of IMEC at the University of Ghent, Belgium on 'Bridging the "Valley of Death" for photonics SMEs' — closes off our 'IT and telecommunications' section, which starts on page 25.

Finally, the 'industrial technologies' section showcases 3D printing and its role in the factory of the future (page 32), while the 'space' section (page 37) takes a lesson from Hollywood film *Gravity* to see how EU-funded efforts are 'Preventing space overpopulation from man-made debris'.

The usual preview of events and conferences concludes issue 30.

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

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Special topic

Each issue of the *research*eu results magazine* sheds light on a specific science topic. To find out more about the latest results and findings, look out for this icon next to article headlines.



Videos

Want to see EU research projects in motion? Some of the projects presented in this issue have a dedicated video available on the internet. To view a video, just open the digital version of the magazine (available at <http://cordis.europa.eu/research-eu>) and click on this icon.

See you next month!

Coming up in issue 31 of *research*eu results magazine* — a special dossier called 'A world of apps'.

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BIOLOGY AND MEDICINE



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Cell-specific cancer treatment

Modern sequencing technologies create data that link diseases such as cancer to personal genetic information. Can we use this genetic information in the development of new therapeutic approaches?

Conventional cytotoxic cancer therapies, such as radiation or chemotherapy, have little selectivity and trigger a broad spectrum of severe side effects. Individual genetic differences make the situation even more complicated. The *in situ* generation of drugs using nucleic acid template reactions provides a unique strategy for cell-specific treatments. The EU-funded MOLECULARDOCTORS¹ project explored the use of gene-expression-specific chemotherapies for the development of new cancer treatments.

The strategy is based on mRNA template activation by peptidyl transfer reactions of 'peptide nucleic acid' (PNA) 'prodrugs' — medications that are taken in inactive or less-than-fully-active form and are converted to their active form by natural metabolic processes.

PNA is an artificially synthesised polymer similar to DNA or RNA. Synthetic PNA 'oligomers' — short molecular chains of just a few monomers, as opposed to long-chain polymers — have been used in recent years in diagnostic assays and 'antisense' therapies. PNA oligomers show high specificity in binding to complementary nucleic acids. PNAs are not easily recognised by either nucleases or proteases and are stable over a wide pH range. Although an unmodified PNA cannot readily cross cell membranes to enter the cytosol, covalently coupling a cell-penetrating peptide to a PNA can improve cytosolic delivery.

In the project's strategy, two short PNA oligomers were equipped with the fragments of the cytotoxic peptide hybridised adjacently to a complementary RNA, which

must be a biomarker of a malignant cell. One of the PNA probes presents the peptidyl sequence as a donating group, while the other bears an N-terminal cysteine peptidyl sequence as an accepting group. This adjacent alignment triggers a template-dependent ligation, which allows the reconstitution of the full cytotoxic peptide sequence. After the transfer reaction, the PNA with the full cytotoxic peptide can dissociate from the template to be involved in the catalytic production of more peptides.

As a cytotoxic peptide, researchers have chosen the mitochondrial peptide KLAK, which shows cytotoxic properties *in vitro* and *in vivo* by disrupting the mitochondrial membrane and releasing the cytochrome c that triggers apoptosis. After the best peptide pairs had

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been selected, the researchers synthesised the accepting and donating PNA-peptide conjugates.

As a proof-of-concept for this innovative project, they decided to synthesise the accepting probe with a cell-penetrating peptide and run a catalytic template reaction with an extracellular RNA. After the transfer reaction, the full-length peptide-PNA conjugate had to penetrate the cells and trigger the apoptosis. The results of this last

stage of the project are currently under investigation.

Development of new oncologic treatments will undoubtedly have a profound socio-economic impact worldwide. This project is reaching the challenging goal of achieving the specific mRNA-directed release of bioactive species inside the cancer cells. This, in turn, might lead to the discovery of a new class of therapeutics that could be used in the war against cancer as well as for other drug developments.

The project was coordinated by the Humboldt University of Berlin, Germany.

- 1 'RNA-codified release of cytotoxic peptides from PNA prodrugs as a new therapeutic approach to cancer'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12423_en.html



Efficient production of non-natural amino acids

Many of the building blocks of biological systems, such as amino acids, are produced exclusively as one of two mirror images called stereoisomers. In producing drugs where two different mirror-image molecules are possible, a high percentage of the desired version is a crucial factor.

As enantiomers are common in nature, living systems possess a high degree of chemical chirality (a non-superimposable mirror image). The two possible molecules will often react very differently and possess different properties. When applied to pharmaceutical production, this feature is particularly important — especially when one stereoisomer may be toxic.

Initially, the objective of the EU-funded ALKENESTOAMINOACIDS¹ project was to use gold catalysis to selectively convert alkenes to desired amino acids. However, a research team in the United States

discovered the fact that using chiral counter-ions obviates the need for a metal catalyst like gold. A high degree of enantiomer selection is thus possible from electrophilic fluorination of alkenes — 20% of all pharmaceuticals contain fluorine, including Prozac.

The researchers synthesised beta-fluoro amines and expanded the new methodology to produce beta-amino alcohols by developing a source of electrophilic oxygen compatible with the novel protocol. The final step was to isolate alpha-fluoroimines that were then stereo-selectively converted to the desired beta-fluoro amines.

Another focus of the project was to develop highly versatile 3D chiral scaffolds with integrated fluorine. These molecular frameworks are of interest as starting points for building fluorinated pharmaceuticals and in the synthesis of fluoro-analogues of natural products.

As dearomatisation is often an approach taken to derive natural products, a significant achievement included the asymmetric synthesis of a fluoro-analogue of the natural molecule Grandifloracin. Research has suggested that Grandifloracin can reduce the hardness of cancer cells under low nutrition conditions,

a novel approach to cancer therapy in itself.

With the emphasis once again on high enantioselectivity, an exciting discovery was made using two catalysts to achieve catalytic synergy in asymmetric catalysis. The work is expected to be finished soon and the results published in a leading journal, bringing the number of papers published by the ALKENESTOAMINOACIDS team to six in just two years.

The work is a prime example of cutting-edge organic synthesis for drug production. Highly successful collaboration has been fostered between the EU and the United States, and first-class training in research biochemistry has been provided.

The project is coordinated by the University of Cambridge in the United Kingdom.



- 1 'Organic synthesis for chemical biology: enantioselective synthesis of $\pm$ -amino acids from terminal alkenes using gold catalysis and investigation into the selective functionalisation of proteins'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12306_en.html

BIOLOGY AND MEDICINE



Optimised artificial grafts for severe skin defects

A European research initiative is continuing development of the skin substitutes Novomaix, denovoDerm and denovoSkin. Clinical studies will test a one-step surgical procedure.

Large full-thickness skin defects resulting from burns and tumour removal, for example, still present significant clinical problems. Taken from the patient, an autologous graft can result in significant scarring due to possible lack of dermal tissue.

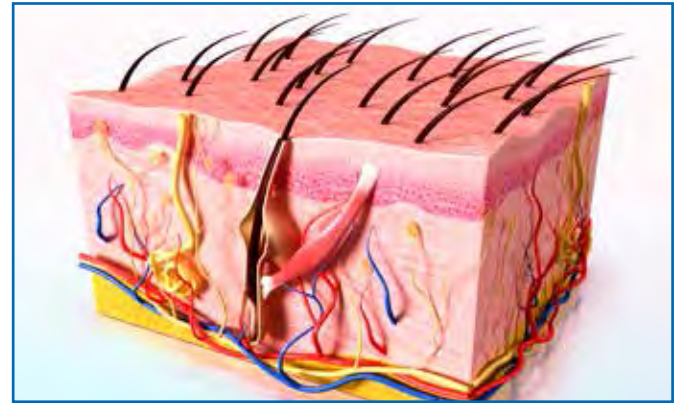
The project EUROSKINGRAFT¹ aims to bring the three novel skin-reconstitution products through clinical trials and then to European and international markets. The dermal substitutes were developed for clinical use with substantial support from the EU's Sixth Framework Programme (FP6) project EUROSTEC².

At the halfway stage, EUROSKINGRAFT researchers have successfully worked on optimising the production of denovoSkin and denovoDerm. MagNA Lyser Green Beads have been successfully used for homogenisation of the skin

substitutes. For the dermis, two marker candidates give a good indication of fibroblast activity that is necessary to maintain skin integrity. Relevant genes have been selected for the epidermis and quantified using 'quantitative polymerase chain reaction' (qPCR).

Approval has been given to two partners for phase I clinical trials, and personnel have received training in good clinical practice. Novomaix has received *Communauté Européenne* (CE) certification and is already in phase I trials. The required toxicology studies for denovoSkin and denovoDerm have been finalised using 'good laboratory practice' (GLP) standards.

All three substitute skins have the advantage that they require one surgical intervention, unlike most current treatment alternatives. In contrast to acellular options on the market, the three EUROSKINGRAFT



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products exhibit the structure and function of skin immediately. The artificial skins are expected to grow at the same rate as those of a child, thus also eliminating the need for additional surgery.

The artificial skins are all highly functional and represent the pinnacle of regenerative medicine as applied in the clinic. Towards the project end in 2016, it is anticipated that devices and matrix templates as well as the skin substitutes will all be marketed commercially.

The project was coordinated by the University of Zurich in Switzerland.

- 1 'A novel generation of skin substitutes to clinically treat a broad spectrum of severe skin defects'.
- 2 'Soft tissue engineering for congenital birth defects in children: new treatment modalities for spina bifida, urogenital and abdominal wall defects'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Health'.
http://cordis.europa.eu/result/brief/rcn/12315_en.html
 Project website:
<http://www.euroskingraft.eu/>



The hippocampus in memory and behaviour

The role of brain structures such as the hippocampus and associated neural circuits in regulating anxiety and memory is still poorly understood. The EU-funded HIPPOPROJECTION project was initiated to elucidate their role in anxiety and memory regulation using mice models.



HIPPOPROJECTION¹ successfully developed a pharmacogenetic tool to selectively inhibit neural projections associated with the hippocampus. This tool comprises 'adeno-associated viruses' (AAVs) expressing a human 'M4 DREADD receptor' along with certain drugs. Results have been validated in mice models and further optimised, enabling testing in wild-type mice models rather than necessitating the development of genetically modified mice.

The 'dentate gyrus' (DG) in the hippocampus is believed to have a role in memory, learning and plasticity. Researchers selectively and reversibly inhibited neural activity in the DG using mice models to study hippocampus-dependent memory

tasks during trace eye-blink conditioning. Scientists were able to identify the structures and neural circuits associated with rapid and persistent memory loss during conditioned responding and learning-associated plasticity.

Recording electrodes were implanted in mice to characterise brain structures associated with the hippocampus. Some important areas investigated include the 'ventral hippocampus' (vHIP), the prelimbic area of the 'medial prefrontal cortex' (mPFC) and the 'rostral lateral septum' (rLS). To test anxiety behaviour, these rats were subjected to open field, elevated plus maze and familiar arena tests, and their local field potentials were analysed.

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These recordings were then compared in terms of familiar environments and anxiety-inducing (unknown territory) environments. Connectivity analysis revealed that the neural projections — vHIP-mPFC and vHIP-rLS — were altered on exposure to the anxiety-inducing elevated plus maze.

This groundbreaking research will pave the way for future work on associating brain structures with behavioural and memory disorders such as epilepsy and Alzheimer's disease. This could prove useful in the development of effective interventions to correct such disorders.

The project was coordinated by the European Molecular Biology Laboratory (EMBL) in Germany.

- 1 'Role of descending hippocampal outputs in anxiety studied using a novel pharmacogenetic efferent inhibition tool'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12349_en.html



Better fruit trees thanks to genetic research

An EU-funded initiative has bridged the gap between genetic research and its application to fruit breeding. The resulting cutting-edge breeding tools are providing both growers and consumers with high-quality cultivars.

The FRUIT BREEDOMICS¹ project was established to improve the efficiency of apple and peach tree breeding. Project partners developed molecular and bioinformatic tools to exploit the diversity found in European germplasm collections and breeding populations.

Researchers conducted apple and peach surveys to identify the most important traits and develop a better understanding of current breeding strategies. Donors for resistance traits to common diseases in peach and apple were characterised and used to introduce and/or combine these traits in breeding materials through crossing.

A fast-breeding approach was developed and used to introduce 'quantitative trait loci' (QTL) resistance to fire blight, a contagious disease in apples and other members of the *Rosaceae* family. The QTL comprised stretches of DNA containing or linked to the genes that underlie a trait.

The FRUIT BREEDOMICS project created five apple and four peach European 'core collections' (CCs) plus one Chinese CC. Scales and measures were standardised to enable comparison between collections. Researchers also designed a low-density array of 384 'single-nucleotide polymorphisms'

(SNPs) to facilitate the rapid genotyping of apple germplasm.

A pilot study was conducted in a mapping population to determine the quality of genotyping by sequencing data and to evaluate the problems of missing data in apple 'genome-wide association' (GWA) studies. The GWA study examined common genetic variants in different individuals to determine if any variant was associated with a particular trait.

A relational database was developed for the collection of phenotypes and a user-database interface created for the

management and exploration of the database content. For genotyping data, the team developed tools for semi-automated data input.

Project partners also created a public website for FRUIT BREEDOMICS, and a leaflet and newsletter about the project was produced and distributed. Furthermore, a stakeholder network was initiated with more than 240 stakeholders.

The success of FRUIT BREEDOMICS will enable favourable genes to be selected and used to improve the main horticultural traits and the collected genetic data to be used in future breeding programmes. Although the project focused on apple and peach, the tools created and the knowledge gained will also benefit other species of the *Rosaceae* family.

The project is coordinated by the Institut national de la recherche agronomique (INRA) in France.



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- 1 'Integrated approach for increasing breeding efficiency in fruit tree crops'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Food, agriculture and fisheries, and biotechnology' (KBBE).
http://cordis.europa.eu/result/brief/rcn/12343_en.html
 Project website:
<http://www.fruitbreedomics.com/>

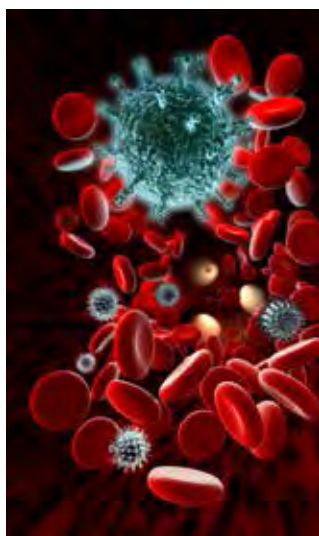
BIOLOGY AND MEDICINE



Virus-like particles for vaccine development

'Virus-like particles' (VLPs) resemble viruses in their organisation and structure but are non-infectious as they do not contain viral genetic material. The importance of these particles as tools has been realised in vaccine development with several commercially available prophylactic vaccines now using this technology.

The EU-funded VLPSIRNA¹ project investigated the use of VLPs for delivering carbohydrate antigens as immunogens. Carbohydrates — also known as glycans — are present on the



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surface of a variety of pathogens and malignant cells in a highly repetitive manner. Their use as vaccine candidates is hampered by their poor immunogenicity and the low affinity of anti-carbohydrate antibodies.

To overcome this, VLPSIRNA researchers proposed to increase the immunogenicity of glycans by delivering them through the inherently immunogenic VLPs. Given the potential to chemically and genetically manipulate the surface of VLPs, they provide a unique and robust platform for optimising antigen delivery.

The platform of bacteriophage Q beta was exploited for the generation of an effective vaccine against the pathogen *Streptococcus pneumoniae*

(pneumococcus). More specifically, the surface of the virus was functionalised with sugar serotypes of pneumococcus and their immunogenicity was evaluated in mice. The generated immune response was significantly higher than any other method tested previously, indicating the efficacy of VLPs as polysaccharide vaccines.

Using tumour-associated antigens such as Tn antigen, the VLP approach was extended to the design of anti-cancer vaccines. Scientists attached this antigen to the 'cowpea mosaic virus' (CPMV), a plant virus, and tested the immunogenicity of these vaccine formulations in mice.

Collectively, VLPSIRNA findings support the use of VLPs as immunogen carriers in vaccine

formulations, mainly for reinforcing the effectiveness of poorly immunogenic antigens, including polysaccharides. The potential of the generated platform for the development of anti-cancer vaccines is expected to find immediate clinical applications, such as cancer and disease prevention.

The project was coordinated by the Eindhoven University of Technology, the Netherlands.

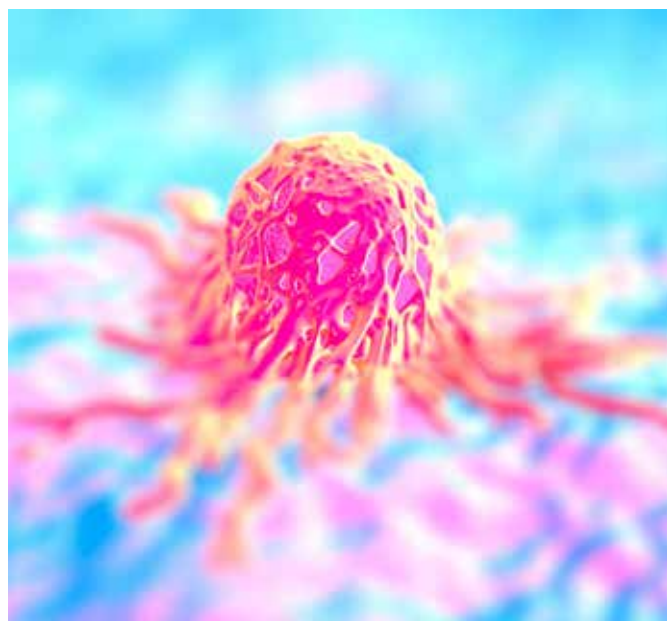
1 'Virus-like particles: The next step in gene therapy'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12433_en.html



Elucidating the natural mechanisms of tumour suppression

Cells can naturally enter a state of arrested replication and division under certain conditions. Scientists are studying the mechanisms promoting or inhibiting such a state with implications for tumour suppression.



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The normal cell cycle of growth, duplication and division is controlled by a multitude of factors and genes. Thus, it takes place at the required rate to either maintain the status quo (homeostasis) in adults or to facilitate growth during development.

The exhaustion of replicating potential in the presence of continued metabolic activity, a kind of cell-cycle arrest, in cultured primary cells is known as senescence. There is now overwhelming evidence of similar phenomena *in vivo*. Senescence appears to be a natural anti-tumour mechanism. In fact, malignancy occurs when 'onco-gene-induced senescence' (OIS)

is bypassed through mutations in oncogenes or tumour suppressors. It also plays a role in age-related disorders by inhibiting the self-renewal of stem cells.

Scientists investigated genetic pathways and molecules regulating cellular senescence with support from the EU-funded EPITHELIALSENESCENCE¹ project. The small INK4/ARF locus in humans contains senescence-associated tumour-suppressor genes. One of these encodes the protein p16INK4a. Enzymes known as 'polycomb repressive complexes' (PRC1 and PRC2) are involved in silencing the INK4/ARF genes without changing the DNA sequence (epigenetic silencing).

Investigators have now shed new light on the ways in which

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two homeobox, or Hox, proteins mediate INK4a silencing. H2O-like homeobox 1 (HLX1) and homeobox A9 (HOXA9) directly associate with the INK4a promoter and repress INK4a expression by recruiting PRC2 and a molecule with which it interacts (HDAC1). Furthermore, six other homeobox proteins were shown to repress

p16INK4a. Also, HLX1 and HOXA9 were found to regulate other senescence-associated PRC targets in addition to INK4a.

Taken together, project results support the interplay of homeobox proteins and PRCs as a key contributor to the repression of senescence, potentially leading to tumour growth. More detailed

understanding of the cellular mechanisms of oncogenesis will pave the way to targeted therapies for arguably the 21st century's most aggressive disease.

The project was coordinated by Imperial College London in the United Kingdom.

- 1 'Identification of genes controlling senescence in human epithelial cells: Role in cancer'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12431_en.html

Protein tool kits to spur innovative drug discovery

Proteins play a critical role in most bodily functions and their dysfunction causes numerous pathological processes. Scientists are developing high-throughput tool kits for enhanced protein accessibility and rapid drug discovery.

Together with environmental and other factors, proteins are responsible for characteristics as varied as eye or hair colour and disposition. Their recipe for production is encoded by the genome, and they are integral components of enzymes, receptors and more. The dysfunction of proteins and protein complexes is also behind a significant number of diseases. As such, the development of high-throughput production systems for selected high-value target proteins could have inestimable impact on drug discovery and biotherapeutics.

The innovative EU-funded COMPLEXINC¹ project is combining academic and industrial expertise to develop such

advanced tool kits. Challenging areas in protein biologics are being addressed, including high-throughput production of difficult target proteins, multi-protein co-expression, synthetic gene regulatory nanosystems, and the engineering of metabolic pathways. Application areas of prime importance are basic research, vaccine development and enzyme replacement therapy (ERT) for certain rare diseases.

To date, the consortium has delivered eight tool kits, including the MultiBac platform for eukaryotic multi-protein complex production, MultiYeast and MultiPichia for the same in yeast, and a eukaryotic genome engineering tool kit (recombinase-mediated cassette



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exchange (RMCE)) for long-term stability of expression in mammalian and insect cell lines. The drug-discovery platform generates a large number of expression constructs for parallel expression tests in prokaryotic and eukaryotic expression systems.

COMPLEXINC is developing powerful tools to increase accessibility to proteins, protein complexes and medicinal products. Application of the tools is already fostering intense basic research as well as exciting innovation and

discovery. This is expected to boost EU health care and the economy.

The project was coordinated by the European Molecular Biology Laboratory (EMBL) in Germany.

- 1 'New technologies and production tools for complex protein biologics'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Health'.
http://cordis.europa.eu/result/brief/rcn/12316_en.html
 Project website: <http://www.complexinc.eu/>

Making mathematical sense out of chaotic situations

An EU-funded project has carried out theoretical research on the mathematical viewpoint of chaos. Theoretical insights from mathematics can help research in the physical and biological sciences.

Chaos is mathematically defined as a situation that presents extremely great sensibility to the initial conditions. A well-known example is the so-called 'butterfly effect', whereby any parameter, regardless of size, can bring about change, so

the butterfly flapping its wings in Australia can generate a hurricane in Europe.

Dynamical systems represent the mathematical approach to studying chaos. The EU-funded DYNEURBRAZ¹ >



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BIOLOGY AND MEDICINE

project set out to investigate systems of low complexity or disorder, and of higher complexity — i.e. systems with positive entropy.

In addition, the project looked at systems where a perturbation can alter the dynamics radically. For example, some of DYNEURBRAZ's results involved the notion of phase transitions, such as when water boils to form steam.

However, the main outcome from the research was related

to the classification of numbers and writing them in bases other than the normal base 10. In its study of more complex systems, the project quantified the frequency with which a hyperbolic system is chosen as the random choice among all the possible systems available.

Bifurcation theory is the mathematical study of changes, such as those in the solutions of a family of differential equations. The project has laid the foundations of a bifurcation theory for random

dynamical systems, which are highly relevant to many applications.

In the now completed DYNEURBRAZ project, another mathematical theory was developed for the emergence of synchronisation in networks of dynamical systems in order to describe, for example, neuron interactions. This result could help explain some of the paradoxical phenomena that are observed in brain recordings.

The project was coordinated by the University of Western Brittany, France.

1 'Dynamical complex systems'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12327_en.html

Microbiota determine gut vessel formation

The mammalian gut has co-evolved with trillions of colonising bacteria. A European study focused on understanding the impact of these bacteria on gut vascularisation and unravelling the implicated mechanisms.



Studies on mice raised in germ-free conditions suggest the involvement of gut microbes in gut vascularisation. When these animals are returned to a normal environment, extensive capillary formation is observed. This indicates that microbial infection switches on the expression of a pro-angiogenic gene repertoire in the intestinal mucosa.

Based on this observation, the EU-funded MICAG¹ project set out to elucidate how gut microbes affect intestinal morphology and trigger vessel formation. Conventional mice (CONV-R) and germ-free-born mice raised under conventional conditions (CONV-D) were used to investigate the expression of various angiogenic factors in the intestinal mucosa.

Upon microbial colonisation, an altered expression of the 'protease-activated receptor 1' (PAR-1) coagulation pathway was observed in the enterocytes. These changes were linked to alterations in the signalling pathway of Angiopoietin-1/Tie-2. Analysis of the small intestine in mice deficient in PAR-1 and PAR-2

receptors confirmed changes in new blood-vessel formation. Results clearly indicate that the extrinsic coagulation pathway contributes to vascular remodelling in the small intestinal mucosa. No changes in the VEGF pathway could be observed, suggesting that it is of less importance in mucosal vascular remodelling.

Since increased angiogenesis is described as a hallmark of Crohn's disease, these mechanisms have important clinical ramifications. A detailed understanding of how microbes affect intestinal morphogenesis could help delineate disease pathogenesis and identify avenues of therapeutic exploitation.

The project was coordinated by the Johannes Gutenberg University of Mainz, Germany.

1 'Microbial-induced angiogenesis in the gut'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12436_en.html

Nanoantennae to detect disease biomarkers

EU-funded scientists are developing novel optical nanoantennae exploiting the vibrational spectra of disease biomarkers for a sensitivity of two or three molecules.

Scientists are continually identifying new proteins present in bodily fluids, such as blood, plasma and saliva, which are biomarkers of specific diseases and pathologies. Exploiting their full potential in early detection, diagnosis and treatment requires highly sensitive and specific sensors.

EU-funded scientists working on the NANOANTENNA¹ project are developing a novel optical biosensor that could even detect just two or three biomarker molecules.

The system is based on the unique optical properties of functionalised metallic nanoparticles (NPs). The NPs have a bioreceptor molecule attached to them that binds the target biomarker with high specificity and affinity. The NPs then act as optical nanoantennae, enhancing light-matter

interactions such that the spectroscopic vibrational signal of the proteins is detected through resonant excitation of the NANOANTENNA device. In other words, the metallic NPs are chosen to match their resonant frequencies to the vibrational frequencies of the molecules of interest, enabling them to increase the signal rather than dampen it.

The first step is thus determining the spectral signal of the four biomarker proteins of interest. Scientists are currently finishing experiments to acquire a complete record of the proteins' vibrational spectra. In the end, the two biomarkers with the most reliable signals will be chosen for validation.

Researchers are exploiting extensive modelling to optimise the transduction properties of

the metallic NANOANTENNA devices. As a result, they expect to arrive at the best geometry and size for maximum signal amplification. The team is currently experimenting with various bioreceptor candidates to determine the most effective NP functionalisation.

Finally, several tests have been completed on the way to defining prototype characteristics. The team is disseminating the results via the project website, a promotional leaflet, a Wikipedia page and several workshops. The first articles have already been published in peer-reviewed scientific journals.

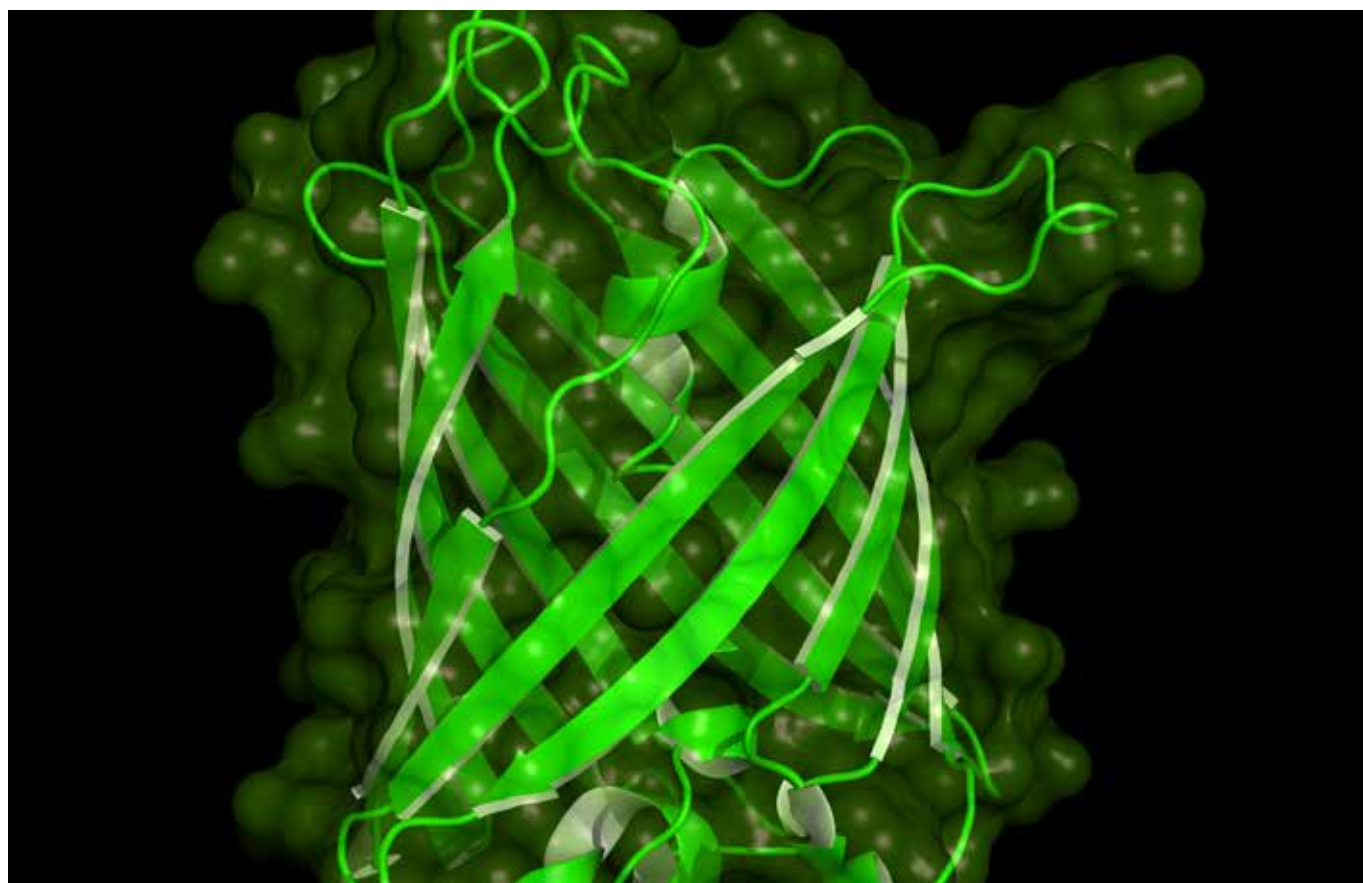
NANOANTENNA optical biosensor technology is poised to revolutionise early diagnosis of diseases leading to rapid intervention and improved patient outcomes. Although it will be

validated with two selected biomarkers, the concept paves the way for development of tailor-made sensors for any pathology for which biomarkers have been identified.

The project was coordinated by the French National Centre for Scientific Research (CNRS) in France.

1 'Development of a high sensitive and specific nanobiosensor based on surface enhanced vibrational spectroscopy dedicated to the *in vitro* proteins detection and disease diagnosis'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Health'.
http://cordis.europa.eu/result/brief/rcn/12406_en.html
 Project website:
<http://www.nanoantenna.eu/>



SOCIAL SCIENCES AND HUMANITIES



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Protecting archaeological sites from wild fire and extreme weather

Fire and extreme weather are major threats to archaeological sites. However, a European collaboration has developed a warning system to protect our cultural heritage. In fact, last year it helped to save the ancient city of Rhodiapolis, in the Antalya region of Turkey, which subsequently escaped a wild fire.

FIRESENSE¹ is an automatic early-warning system which takes advantage of recent advances in multi-sensor surveillance technologies. It uses a wireless sensor network capable of monitoring different conditions, such as temperature, as well as optical and infra-red cameras, and local weather stations. The system's network of cameras coupled to smoke-detection equipment raised the alarm about a potential disaster approaching Rhodiapolis.

It is now being tested in other countries, according to Nikos Grammalidis, scientific director of the FIRESENSE project, based at the Centre for Research and Technology Hellas in Thessaloniki. The system has already been tested at the archaeological site of Kabeirion in Thebes, Greece and is currently being installed in the Temple of Water, in Zaghouan, Tunisia.

'Further tests are taking place in Galceti Park, in Italy and in Dodge Hall, located in Boğaziçi University, Istanbul,' he adds.

Of course, none of this would have been possible without the support of a European consortium of 10 companies and research institutes from Greece, Turkey, Italy, the Netherlands, Belgium and Tunisia, and with funding of nearly EUR 3 million from the European Commission.

The system works by sensors transmitting data to a monitoring centre which employs intelligent computer vision and pattern-recognition algorithms. This system uses data-fusion techniques to automatically analyse sensor information. It works by generating an automatic warning signal for local authorities whenever a dangerous situation arises, such as fire, storm or other environmental threats.

However, detecting wildfire is only the first step in fire-fighting. The next stage is to estimate the direction and speed of the fire in order to assess the risk to any sites potentially in its path. Panayiotis Vlamos, associate professor

of informatics at Ionian University, Greece says FIRESENSE uses a Geographic Information System and 3D representations to approximate the evolution of fire and other phenomena. 'A concrete model will enhance the efficiency of the system,' he concludes.

The project is coordinated by the Centre for Research and Technology Hellas, Greece.

1. 'Fire detection and management through a multi-sensor network for the protection of cultural heritage areas from the risk of fire and extreme weather conditions'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Environment'.
http://cordis.europa.eu/news/rcn/36302_en.html
 Project website: <http://www.firesense.eu/>

Towards social inclusion for increased health-care access

Certain health-care needs of vulnerable populations are not being met in developing countries. Poor and informal-sector workers comprise one such group that is suffering. Researchers are investigating whether different kinds of financing arrangements can change the status quo.

While reforms in health financing in 'low- and middle-income countries' (LMICs) have improved the utilisation of care, social exclusion continues to limit their success. Bureaucracy, complex eligibility rules and differential access to information are just some of the barriers, besides finance, hindering access to health care. Such barriers also prevent socially excluded groups from enrolling in financing schemes, even when they are eligible. However, efforts to empower such groups may increase social inclusion, and may also enable them to benefit from publicly funded health care.

Funded by the EU, the HEALTH INC.¹ project is using a mix of research methods to examine these issues in Ghana, India (Karnataka and Maharashtra states) and Senegal. The schemes being researched are Ghana's National Health Insurance Scheme (NHIS), India's Rashtriya Swasthya Bima Yojana (RSBY) national health insurance scheme for families below the poverty line, and Senegal's exemption scheme, Plan Sesame, for people over 60 years old.

The project has set the foundation for establishing a research network and building capacity, through

meetings and training sessions. A comprehensive literature review on social health protection was completed, and a conceptual 'SPEC-framework' and methodological 'SPEC-by-step' tool was developed, based on the 'social, political, economic and cultural' (SPEC) dimensions of social exclusion. The two SPEC instruments and research protocols have been submitted to the European Commission.

HEALTH INC. researchers reviewed government documents and scientific publications, and held stakeholder interviews on health-financing mechanisms and social exclusion for each study site. Data collection, stakeholder interviews, household surveys, focus group discussions and in-depth interviews have been completed in Senegal and Ghana, and are being finalised in India. Going forward, work will concentrate on case study findings and recommendations.

Having set five specific research questions pertaining to the main points of interest, project members are comparing results in each context, in order to make policy recommendations. Thereafter, a feasibility analysis will be carried out with

local policy-makers and population groups to identify and test recommendations. These will then be shared with researchers, local, national and international public health authorities, and health and development stakeholders.

Project outcomes will contribute to the international debate and knowledge base on health financing in LMICs, and to health systems research by LMIC partners. Overall, the HEALTH INC. study will support research on social exclusion in health systems in LMICs as well as help develop policy tools to increase social inclusion, for improved health-care access in LMICs.

The project was coordinated by the London School of Economics and Political Science (LSE) in the United Kingdom.

- 1 'Socially inclusive health-care financing in West Africa and India'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Health'.
http://cordis.europa.eu/result/brief/rcn/12385_en.html
 Project website: <http://www.healthinc.eu/>



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Medieval shipbuilding and repair practices uncovered

Scientists investigated tar from a well-preserved 15th century vessel known as the Newport Ship. Their study examined shipbuilding and repair, as well as tar degradation.



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Tar and pitch, sticky substances manufactured from trees, were widely used in medieval times to preserve wood and to provide waterproofing. The EU-funded AMPT¹ project set out to understand the impact of the burial environment on tar and pitch degradation. AMPT researchers also hoped to shed light on medieval shipbuilding and maintenance practices.

'Gas chromatography-mass spectrometry' (GC-MS) and isotopic analysis were used to identify the range and sequence of tars used on

the *Newport Ship* and to study how the tar degraded in comparison with tar from other excavated ships.

Researchers were able to distinguish tars used for building and later repair work. These tars differed in both chemical composition and geographical source. The effects of degradation were found to be highly variable but the researchers were able to link some specific degradation products to particular burial environments.

The AMPT project showed that tar and pitch analysis can prove useful for broad observations of construction and repair in ancient ships. The research also demonstrated the significant impact that degradation

of tar and pitch has on interpretations that can be drawn from the chemical composition. The findings add to the body of knowledge on the preservation of maritime museum collections.

The project was coordinated by the British Museum in the United Kingdom.

- 1 'Ancient maritime pitch and tar: a multidisciplinary study of sources, technology and preservation'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12427_en.html

ENERGY AND TRANSPORT



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A vision turns into reality in the development of electricity networks

Europe's vision for the development of electricity networks, which can significantly reduce the environmental impact and allow consumers to play a part in adjusting the system, has turned a vision into a reality.

The ADDRESS¹ project focused on the electricity networks of the future with the aim of making them flexible, accessible, reliable and economical, as per the vision of the SmartGrids² European Technology Platform (ETP). To do this they have developed technical solutions at the consumer's premises, and on the power system level, allowing domestic and small commercial consumers to take part in 'active demand' (AD) programmes. This approach enables consumers to change their own electricity demands upon the request of an aggregator providing economic incentives.

The ADDRESS project team believed active demand was one way to solve

constraints and support the development of 'Renewable-energy resources' (RES) through the flexibility that it could offer and thus provided economic benefits for consumers.

A comprehensive commercial and technical framework was developed for active demand and a pilot study was completed in Italy, with other studies being carried out in France and Spain. These were conducted by installing the ADDRESS system in households, in medium-voltage control centres and on the network. Smart appliances, smart plugs to control traditional appliances and an energy management box that received aggregator's signals and

managed home appliances accordingly, were all installed in households.

The ADDRESS consortium of 25 partners from 11 European countries selected their test sites based on the different climates: for example, the difference in temperature between Spain and France necessitated using different equipment and usage patterns. Using different network topologies and acceptance conditions this approach validated the entire concept.

Marina Lombardi, who assisted the project coordinator at Enel Distribuzione, says: 'Having completed tests in Italy, we are currently testing the system in around

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300 homes in Spain and about 30 in France. Homeowners agree to test the system with us, encouraged by the incentive to save 20 % on their energy bill in Spain, plus EUR 50 when joining the scheme and an additional EUR 0.50 for every AD request (in gift vouchers) in France.'

The equipment installed in homes allows owners to receive aggregator's signals and have their demand adjusted accordingly by the energy-management box.

Ms Lombardi explained how the pilot study was evaluated: 'We relied on questionnaires, personal interviews and diaries in order to gauge the experience of our consumers, and how their lives are adapting to this new system.'

The project was coordinated by Enel Distribuzione S.p.A. in Italy

- 1 'Active distribution network with full integration of demand and distributed energy resources'.
- 2 'European Technology Platform for Electricity Networks of the Future'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Energy'.
http://ec.europa.eu/research/infocentre/article_en.cfm?artid=31556
 Project website: <http://www.addressfp7.org/>



Copying nature's elaborate surface chemistries

EU researchers have prepared artificial photosystems, which are multi-coloured and organised, for use in photovoltaic devices. The use of bio-inspired architectures improves the efficiencies of organic solar cells.

In nature, photosystems are highly efficient in converting sunlight into the chemical energy of life, thanks to their multi-chromophoric structures. Similarly, highly organised 'reduction-oxidation' (redox) pathways allow the electrons and holes generated by the photosynthetic process to travel through separate pathways and thus suppress charge recombination.

Phthalocyanine (PC) is an intensely blue-green-coloured aromatic

macrocyclic compound. However, while pure PC-based dyes have been widely used in organic electronics, the synthesis of structurally modified PCs has proved a challenge.

Preparing these molecular assemblies was the aim of the SUPRAL_SAS¹ project, funded by the EU. During the project, these assemblies were prepared by the self-organising and surface-initiated polymerisation of PC to form

separate pathways for hole and electron transport.

To obtain the desired structures, the PCs were arranged into two types of assemblies. One type, the conductive, was used to introduce the positive or p-type transport channels. The other, which showed poor photoactivity, produced the negative or n-type charge-transport channels.

Two approaches were engineered and investigated to minimise the recombination between the charges in the conductive pathways: an antiparallel redox gradient and a lateral multiple channel.

Now complete, the project's outcomes will increase the prospects of using structurally modified PCs in more practical applications.

These results will not only benefit the scientific community, but also companies and industries that design and fabricate optoelectronic materials. Moreover, the molecular assemblies on a surface produced and studied in this project will also be of interest for making advanced organic-based transistors. These have a multitude of applications, including displays, sensors and electronic bar codes.

The project was coordinated by the University of Geneva, Switzerland.

- 1 'Supramolecular active layer, self-assembly on surface'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12309_en.html



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Biowaste converts to biofuel

Scientists are using algae to convert biowaste to biogas and solid combustible pellets. The same technology is removing hazardous nitrogen and phosphates from the waste and carbon dioxide (CO₂) from industrial emissions.

Global energy demand is rising and the EU has set ambitious goals for increasing the share of renewable energies and reducing 'greenhouse gas' (GHG) emissions. Biowaste in landfills is a major source of methane

emissions and is also a source of contaminants such as nitrogen and phosphate that turn up in surrounding water and soil.

Using biowaste to produce renewable biofuels while

reducing emissions and contamination is now on the horizon thanks to the EU-funded project BIOWALK4BIOFUELS¹.

Scientists are exploiting the use of macroalgae to treat biowaste

and industry emissions and, in the process, to produce biofuels. Macroalgae need nitrogen and phosphate to grow, so biowaste is a great source of nutrition. Green algae store energy in the form of starch just as grains do, and can be used directly to catalyse fermentation and biogas production without the need for cereal crops. This bodes



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well for reducing costs and land-use issues.

Organic residues from the biogas digester can be dried and formed into pellets either to produce combustible biomass or to be used as organic fertiliser. A boiler will provide its CO₂ to the

open-pond culture system and the biogas can then be used for 'combined heat and power' (CHP) production, cutting GHG emissions by half compared to a fossil-fuel plant.

Investigators have selected the best macroalgal species in

terms of growth rate and energy as well as the appropriate biowaste to maximise their yield. Researchers optimised the prolonged dry-ground culture conditions to maximise regeneration rate and have built the open-pond system, including pipelines connecting it to the pretreatment plant and anaerobic digestion plant. The biogas treatment plant has been designed and a life-cycle impact analysis of the biogas production has been carried out.

BIOWALK4BIOFUELS is using macroalgae as an efficient and effective interface between biowaste and biofuels. The complete cycle from biowaste to fuels requires no external inputs and produces biogas and solid combustible bio-pellets while eliminating emissions and

contaminants. Proof-of-concept is expected to have an important impact on the planning of future power plants and the achievement of EU goals for renewable energy and emissions.

The project was coordinated by the Sapienza University of Rome, Italy.

- 1 'Biowaste and algae knowledge for the production of 2nd generation biofuels'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Energy'.
http://cordis.europa.eu/result/brief/rcn/12335_en.html
 Project website:
<http://www.biowalk4biofuels.eu/>



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Bountiful energy supply from the sea

Scientists are jump-starting the exploitation of renewable energy from wind, waves and tides by developing project assessment tools and standardisation recommendations.

The EU is actively developing programmes to support renewable alternatives to the combustion of fossil fuels. The harsh ocean and deep-sea environments are a treasure trove of powerful wind, waves and tides whose energy could be harnessed to relieve dependence on conventional forms of energy.

Although multi-purpose platforms for 'marine renewable energy'

(MRE) are still in their infancy, they hold great promise for the future. In order to kick-start their growth, EU-funded scientists are developing design and optimisation tools focused on system integration and cost reduction. The project MARINA PLATFORM¹ combines over 40 years of experience in deep-water engineering gained from European oil and gas developments with state-of-the-art concepts for offshore wind and wave exploitation.

The first project period identified more than 90 novel concepts for multi-purpose platforms exploiting wind, wave and tidal resources. During the second reporting period, 10 generic concepts were selected from the original proposals and developments relating to assessment tools were employed to whittle these down to four or five for the final project period.

Specifically, the team put the final data from 10 years of wind, wave and tidal data collected over the whole of Europe into a site-selection tool that will be made public. Scientists developed numerical models of each of the 10 concepts individually for a set of representative locations. Structural models focused on survivability, power production and responses to forces and stresses in the extreme environments in which the platforms will operate.

Researchers also developed a tool with which they evaluated critical components and conducted statistical cost analyses. Finally,

they made important progress in assessing grid availability for selected locations and defining cost-effective solutions for connection and distribution.

Ultimately, MARINA PLATFORM will deliver a variety of tools to assess the engineering, economic and environmental suitability of multi-purpose MRE platforms as well as a spatial planning decision-support tool. In addition, recommendations are being developed for standardisation and certification groups that should facilitate safe, effective and efficient exploitation of MRE.

The project was coordinated by Acciona Energia S.A., Spain.

- 1 'Marine renewable integrated application platform'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Energy'.
http://cordis.europa.eu/result/brief/rcn/11385_en.html
 Project website:
<http://www.marina-platform.info>



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Peptide-based electronics for solar technology

EU-funded scientists are developing an almost entirely organic modular solar cell. Replacing semiconductor materials with peptides and photosynthetic components promises cost-effective and highly efficient solar technology.

Solar cells convert the Sun's energy to electricity by exploiting the photovoltaic effect, the generation of a voltage difference in a material in response to electromagnetic radiation. The material is typically a semiconductor photodiode that absorbs photons, generating charge carriers (electron-hole pairs) and separating them by preferentially allowing the unidirectional flow of either electrons or holes. Current solar cells do not separate light absorption, exciton routing and charge-separation functions so optimisation of one often occurs at the expense of another.

Scientists initiated the EU-funded project PEPDIODE¹ to develop a modular biomimetic system of molecules acting as light harvesters and electron guides. Peptide-based diodes will allow the unidirectional flow of electrons. They will be coupled with tailor-made building blocks that tunnel electrons to

photosynthetic modules to produce a photocurrent-generating device. Concurrently, scientists are developing the 'complementary metal-oxide semiconductor' (CMOS)-based chip to accurately measure the 'current-voltage' (I-V) characteristics of the peptide diode array.

The team has successfully developed the technology to synthesise dense peptide arrays with a peptide laser printer. They are currently able to manufacture 10 000 peptides per square centimetre (cm²) and transfer them to a recipient solid support.

In addition, partners have made the first step towards enabling the coupling of the peptide arrays to a measuring chip. Specifically, scientists have produced a nano-structured surface of 10 000 spots/cm² of a synthetic amino acid fluorophore that can absorb light at specific wavelengths. Importantly,

investigators have created a process to make gold surfaces on individual pixel electrodes with excellent electrical contact to the CMOS component — a major achievement given that gold is not compatible with CMOS processing. In addition, they will soon be able to measure I-V characteristics of all peptides in the array simultaneously. Work is under way to develop protein scaffolds to fix and organise the modular components.

PEPDIODE is well on its way to demonstrating the principles of a photosystem-inspired solar cell. In the long term, the technology will open the door to low-cost, high-efficiency organic solar cells to produce electricity much more economically than conventional power plants and with major benefits for the environment.

The project was coordinated by the Karlsruhe Institute of Technology (KIT), Germany.



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1 'Peptide-based diodes for solar cells'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Energy'.
http://cordis.europa.eu/result/brief/rcn/12361_en.html
 Project website:
<http://www.imt.kit.edu/projects/pepdiod>

Sweet dreams for sleepers living near freight trains

An EU-initiative has developed and assessed measures to ensure acceptable levels of vibration for residents living in the vicinity of freight railway lines in order to facilitate the extension of freight traffic on rail.

European rail operators want to double the volume of goods being transported on the railways. However, vibration caused by freight trains passing through residential areas at night disrupts residents' sleep and could halt the process.

The CARGOVIBES¹ initiative is developing measures to ensure acceptable levels of vibration for residents living in the vicinity of freight railway lines. This will enable an increase in the volume of freight traffic.

Uniform assessment methods of adverse effects were not available so the project partners developed relevant criteria. Existing knowledge of mitigation measures was not directly applicable because soil-vibration patterns created by conventional railways cannot be directly applied to freight. Therefore, new mitigation measures for freight rail traffic are being designed and validated.

CARGOVIBES first assessed the reported health impacts of freight train vibration among



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residents. A questionnaire was developed to measure the perception, annoyance and sleep disturbance caused by vibration. Guidelines which focus on night-time freight traffic and are acceptable to both rail operators

and residents will also be drawn up.

The questionnaire was used in three field surveys whereby indoor measurements of vibrations were carried out



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in homes close to freight railway tracks. In addition, researchers conducted experiments to evaluate sleep disturbance as a result of whole body vibration from freight transportation.

Technical mitigation measures available for freight-train operation are limited so three will be added by CARGOVIBES. The first measure uses on-board and track-based monitoring equipment to pick up excessive vibration from wagons, locomotives and track sections.

The second approach will reduce ground-borne vibrations by replacing wooden or concrete sleepers with ladder track or similar track structures. Alternatively, larger sleepers can be used, the spacing between sleepers reduced or elastic rail fixation employed to reduce vibration and the amount of maintenance needed.

Soil barriers will provide the final measure, which can be applied when track-based solutions are not feasible. The soil-barrier approach is suitable for

improving an existing situation with minimum disturbance to the railway. In addition, project partners will develop computer models that will design the most suitable soil barriers.

By establishing the right criteria and using them to determine the effect of new and existing mitigation measures, CARGOVIBES will address the problem of vibrations from rail freight. This will enable a larger volume of goods to be transported by rail and residents living nearby to get a good night's sleep.

The project is coordinated by the Dutch Organization for Applied Scientific Research (TNO) in the Netherlands.

- 1 'Attenuation of ground-borne vibration affecting residents near freight railway lines'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Energy'.
http://cordis.europa.eu/result/brief/rcn/12408_en.html
 Project website: <http://www.cargovibes.eu>



Combining renewable energy technologies

EU-funded scientists have developed a novel technology to remotely monitor the integrity of wind-turbine blades. In line with the renewable energy focus, the system converts blade vibrations into electricity for autonomous power.

Harnessing the wind to produce electricity is making an increasingly important contribution to the EU's alternative renewable energy policies to alleviate dependence on fossil fuels. A rise in the number of wind-turbine blade defects resulting in turbine failure has highlighted the need for continuous 'structural health monitoring' (SHM) as an improvement to current routine inspections.

Scientists developed the required technology within the context of the EU-funded project WINTUR¹. It exploits sensors embedded in the composite blades that transmit their signals via Bluetooth to the nacelle, the housing for the main generator components. The nacelle unit then transfers the data via wireless technology to the wind farm control centre. To top it off, the system uses energy harvesting to convert the mechanical energy in the vibrations being measured to the electricity required to operate the system.

The WINTUR system exploits integrated 'acoustic emission' (AE) and 'long-range ultrasonic testing' (LRUT). AE is the release of energy in the form of stress waves resulting from the sudden redistribution of stress in a

material. In composites, AEs are often indicative of matrix cracking, fibre breakage and debonding. LRUT employs transducers that direct low-frequency ultrasonic waves into the material to be tested, and detects changes in properties associated with defects.

Final trials demonstrated that WINTUR SHM technology for monitoring composite wind-turbine blades effectively, and reliably detected growing defects, blade-intrusive damage and impact damage.

Signal-processing tools then located the area of the defect and wireless communications systems transferred the data with 100 % signal integrity. A graphical user interface provided a visual status indicator, a tabulated display of critical information and a reporting function.

Wind energy is becoming an important player in the renewable alternatives field. WINTUR technology will help keep turbines running to keep the energy coming while, at the same time, encouraging new investment

whilst reducing maintenance costs.

The project was coordinated by TWI Ltd in the United Kingdom.

- 1 'In situ wireless monitoring of on- and offshore wind turbine blades using energy harvesting technology'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/result/brief/rcn/12373_en.html
 Project website: <http://www.wintur-project.com/>





Boosting jobs and growth through sustainable and intelligent forestry

The creation of a pan-European information system will help unlock substantial forest resources in a more sustainable manner. This is the aim of the EU-funded SIMWOOD project, which is developing MOBILISER, a new online knowledge base that will spread integrated, transferable solutions and viable policies across Europe.

Europe has more than 117 million hectares of forest. However, sustainable utilisation — especially in privately owned woods — falls some way short of its potential. In addition, the ever-increasing demand for wood for material and energy applications is becoming more and more difficult to meet.

The four-year SIMWOOD¹ project was launched in November 2013 to address this issue, and to promote more efficient use of the available supply of wood. Initially, the project will record existing socio-economic, technical and ecological barriers to sustainable forestry. Through a series of pilot projects,

SIMWOOD will then test promising initiatives in close cooperation with local stakeholders. The MOBILISER online information system will help to evaluate the effect of these new approaches, and improve them as required.

Through MOBILISER, good practices and technologies, existing stakeholder initiatives and effective support programmes will be promoted and disseminated. An expert system will evaluate the impact of up-scaling solutions to the EU level. The system will also link to regional learning labs in order to foster greater participation in the scheme and enhanced forest governance.

The system will feature an intuitive, multi-lingual interface to maximise the uptake of integrated solutions by forest owners and other stakeholders across Europe and beyond. This will give the owners, foresters and SMEs access to information and recommendations that, until now, have been difficult to acquire.

Making better use of Europe's sustainable forestry resources could help boost jobs and growth. It is estimated that 853 million cubic metres (m³) of timber and 585 million m³ of wood for energy will be needed in 2030 — the provision of such



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quantities represents both a challenge and an opportunity.

The timber industry in Europe alone currently totals around 600 000 companies, including sawmills and furniture manufacturers, employing 4 to 5 million workers and generating annual sales of EUR 550 billion. For the industry as a whole, a reliable local source of raw materials can guarantee stable growth.

The project, which will receive a total of EUR 5 990 311 in EU funding, involves 28 partners from Germany, Belgium, Finland, France,

the United Kingdom, Ireland, the Netherlands, Portugal, Sweden, Slovenia and Spain. The consortium also includes two European research institutes — the Joint Research Centre (JRC) and the European Forest Institute (EFI). Their involvement will enable the project results to be widely disseminated, and will ensure that the cross-regional monitoring system will continue beyond the project's lifetime.

Overall, the project is expected to play a significant role in increasing supplies of wood, enhancing sustainable forest use and strengthening the forest-based sector as a key contributor

to Europe's growing bioeconomy. SIMWOOD is scheduled for completion in October 2017.

The project is coordinated by the Bavarian State Institute of Forestry in Germany.

1 'Sustainable innovative mobilisation of wood'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Food, agriculture and fisheries, and biotechnology' (KBBE).
http://cordis.europa.eu/news/rcn/36347_en.html



Cloud watching improves climate models

Clouds and cloud cover create a lot of uncertainty in climate models as their effects are difficult to quantify or predict. A new project is developing novel ways to measure clouds and their impact in an effort to overcome this uncertainty.

Recent studies of climate models have shown that clouds are introducing a large amount of uncertainty into Earth System Models (ESMs), the most common climate-change model. Without dependable cloud data, these models are vague and have low predictive power.

To address this problem, the EU is funding the project EUCLIPSE¹. This study brings together meteorologists and climate-modelling experts.

The researchers aim to improve modelled cloud behaviour, to develop a way to measure the

accuracy of cloud effects, and to better define the parameters of cloud processes in ESMs. Another part of the project will focus on how clouds react to climate change in the physical world.

EUCLIPSE has implemented the use of a new cloud simulator for ESMs that provides improved data for the modelling, as well as new evaluation tools to check the output of these models. The physical study of cloud formation and interaction has begun, and data from this study has reduced bias in the models used.

Future work will focus on creating standard diagnostics to

evaluate the effect of clouds on climate models. The work done during EUCLIPSE will help to predict climate change more accurately as well as improve our understanding of the phenomenon.

The project is coordinated by the Royal Netherlands Meteorological Institute (KNMI) in the Netherlands.

1 'EU cloud intercomparison, process study and evaluation project'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Environment'.
http://cordis.europa.eu/result/brief/rcn/12318_en.html
Project website:
<http://www.euclipse.eu/>



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Synergising eco-friendly pesticides

Biocides are chemicals commonly used in pesticides and wood protectors to protect against flies, cockroaches, termites, wood-rotting fungi and other pests. Globally, there are increasing concerns about the toxicity of the conventional biocides used and their effect on both the environment and human health.

The EU-backed BIMOSYN¹ project, involving academia and five small and medium-sized enterprises (SMEs), was initiated to address these concerns. Scientists investigated the use of promising plant extracts from antioxidant-type and medicinal-type plants in certain

insecticides and fungicides. Their aim was to reduce the toxic chemical concentration while increasing their efficacy against pests.

Scientists were highly successful in their endeavours and several breakthroughs were achieved.

After screening a number of extracts, two compounds were shortlisted for use in wood protection and urban pesticide products. Tests were carried out to enhance synergy with selected chemicals and optimise the extract-to-biocide ratios.

Project partners successfully increased wood resistance against fungal degradation and xylophagous insects, such as termites and bark beetles, by using these extracts with wood protectors. Several insecticides combined with extracts showed better housefly control than insecticides alone.

After optimising the extraction process, project partners developed water-based biocide prototype formulations for urban pests

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and wood protection that demonstrated good chemical stability and biological efficacy. In accordance with European standards, their effectiveness and ecotoxicity against certain fungi, termites and

Hylotrufes larvae were tested with promising results.

BIMOSYN members then worked on the industrial validation of their prototypes through real-case

scenarios such as testing timber impregnation with formulations in an autoclave. Fungicides showed wood penetration of up to 20 mm and met criteria for use in fences and doors not permanently exposed to fresh or saltwater. Insecticides demonstrated effectiveness against cockroaches but were not commercially viable due to the plant extract extraction and addition process.

SMEs are working on commercialising the wood protector and sprayable insecticide products after further optimisation and patenting. Besides a positive impact on wood protection and urban pest sectors, these eco-friendly

products will reduce air, ground and underground water pollution.

The project was coordinated by the Fundación Tecnalia Research and Innovation in Spain.

- 1 'Development of new ecological pesticides by incorporation of synergic bio molecules'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.

http://cordis.europa.eu/result/brief/rcn/12341_en.html

Project website:
<http://www.bimosyn.eu/>

Ecological competition affects animal signalling

Classical ecological and evolutionary theory subscribes to the concept that related species display character divergence, such as varying beak size, to facilitate coexistence in a habitat. The findings from the EU-funded AVIAN COMPETITION project demonstrate just the opposite in the Hypocnemis antbirds from the Amazon rainforest.

The project AVIAN COMPETITION¹ investigated the interactions and differences between the two related bird species *Hypocnemis peruviana* and *Hypocnemis subflava* that live in the same habitat in Peru. Vegetation surveys and remotely sensed 'light detection and ranging data' (LIDAR) were collected to determine variations in species ecology. Differences in bird morphology were assessed using measurements from ringed individuals, foraging strata, field observations and 'geographical information system' (GIS) analyses.

Scientists also accounted for diet overlap using stable isotope analysis of blood samples. The songs of *Hypocnemis* antbirds were recorded and mapped into a GIS from both within and outside the species overlap area. This helped assess the influence of environmental factors and species interaction on song acoustic characteristics.

Surprisingly, the two *Hypocnemis* species living in the same habitat demonstrated greater similarity in song characteristics than with their own species living away

from the contact zone. This provided compelling evidence for song convergence.

As these birds are inter-specifically territorial, differences in diet could be explained by variation in the type of arthropods (e.g. insects) occupying their territory. Character convergence was confirmed through similar morphological measurements in the overlap area. Lack of hybridisation between species together with these findings demonstrate that these strong ecological competitors maintain territories and

compete for resources within them.

Project outcomes have opened up novel avenues for the investigation of evolutionary dynamics and species distribution. Understanding the effects of phenotypic similarity, ecological competition and territorial overlap on species distributions will have important implications for environment management and systems modelling.

The project was coordinated by the University of Oxford in the United Kingdom.

- 1 'The role of ecological competition in the evolution of animal signals'.

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

http://cordis.europa.eu/result/brief/rcn/12324_en.html



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Enhancing operations in small EU wineries

European winegrowers, typically small and medium-sized, family-owned companies and cooperatives, manage some 65% of the world's wine production. An EU-funded initiative has advanced a system to reduce the impact of vineyard operations on the environment while, at the same time, strengthening capacity for quality production.

Wine production activities result in solid and liquid residues that need to be treated appropriately, to lessen their impact on the environment. The discharge of large volumes of waste water with extremely high organic loads burdens municipal waste-water treatment plants or impacts rivers and lakes (when the vineyards are not connected to a sewer system). In many cases, solid residues are deposited in the vineyards for use as fertilisers, and waste degradation during storage contaminates groundwater and leads to odour formation.

The SUSTAVINO¹ project was set up to help European wine producers resolve such issues, and also to meet related environmental regulations. The project aimed to do this by

developing an 'Environmental-quality strategy for wine production' (EQSW) and an EQSW label.

Project members employed a case-study approach, involving wine cellars in four countries, to examine the technologies and techniques applied to the different waste and waste-water streams resulting from wine production. Development of the EQSW focused on integrating approaches for minimising waste and waste water, as well as for treating and valorising such residues in an ecological and cost-effective manner.

Three main EQSW modules were developed, covering waste minimisation, waste-water treatment, and solid waste and valorisation alternatives. A preliminary EQSW was

implemented in participating cellars to check and assess compatibility with actual operations. Changes resulting from the implemented EQSW were then evaluated, following the application of a monitoring protocol over a specific time period. Results were recorded for each cellar, the details of which are available on the SUSTAVINO website, along with other project information.

Throughout the project, special emphasis was placed on finding ways to implement simple, economic and efficient solutions that will help European wineries, small ones in particular, compete in emerging markets. Thus, the SUSTAVINO project has contributed to helping European wine producers meet environmental regulations, enhance the commercial appeal

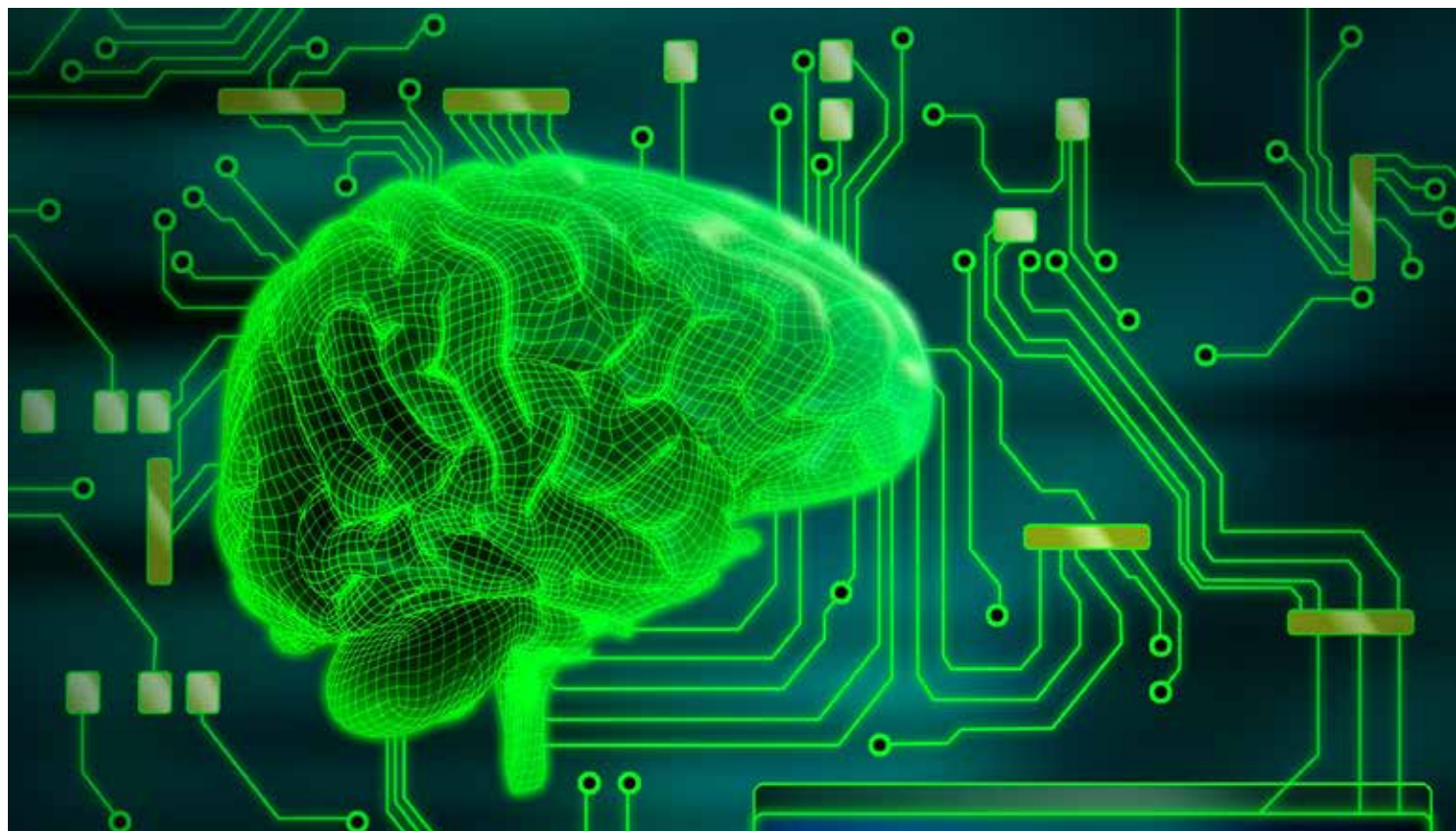
of their products, and safeguard the rural economic sector at regional level.

The project was coordinated by the Verein zur Förderung des Technologietransfers an der Hochschule Bremerhaven (TTZ) in Germany.

- 1 'Integrated approaches for sustainable European wine production'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs':
http://cordis.europa.eu/result/brief/rcn/12397_en.html
 Project website:
<http://www.sustavino.eu/>





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From electronic brains to artificial vision

The EU budget has provided more than EUR 1.9 billion for brain research since the start of the current EU Framework Programme for Research, FP7, in 2007. This has funded over 1200 projects with more than 1500 participants from the EU and beyond.

Information technologies have long had an association with the human brain: the old simple explanation of a computer was that 'it's like a sort of electronic brain'. But computers have rapidly become so ubiquitous that nowadays the beginner's explanation of the brain is often that 'it's like a kind of biological computer'.

Commenting on last year's announcement of EUR 150 million of funding for brain-related ICT research projects, Neelie Kroes, Vice-President of the European Commission responsible for the Digital Agenda for Europe, said: 'Despite great progress over recent decades, there is much more still to be discovered: from computers that think like our brains do — like computer networks that replicate brain structure to better cope with "big data" — to detecting and curing the brain disorders that affect up to one-third of Europeans each year, from Alzheimer's and autism to schizophrenia.'

Brain boxes: computers model humans

Understanding the human brain is therefore one of the greatest challenges facing 21st century

science. Ambitious new projects in the EU, the 'Future and emerging technology' scheme (FET) Flagship 'Human Brain Project' (HBP), and in the US, the BRAIN project, are now starting to try to meet this challenge, with the hope of gaining profound insights into what makes us human, developing new treatments for brain diseases and building revolutionary new computing technologies.

The HBP's first goal is to build an integrated system of ICT-based research platforms, providing neuroscientists, medical researchers and technology developers with access to the innovative tools and services that could radically accelerate the pace of their research. The project will receive around EUR 1 billion in funding over 10 years, and will work closely with US President Obama's new initiative on 'Brain Activity Mapping' (BAM), worth US\$ 100 million (EUR 75 million) in its first year alone.

The HBP's second goal is therefore to trigger and drive a global, collaborative effort that uses these platforms to address fundamental issues in

neuroscience, medicine and computing. The end result should not only be a better understanding of the brain but also transformational new ICT. For example, the brain manages billions of processing units connected via kilometres of fibres and trillions of synapses, while consuming no more power than a light bulb. Understanding this could transform our computer power and help build a new ICT infrastructure.

The BRAINSCALES¹ project is helping computers to 'think' more like humans. Our brains work at different scales simultaneously: from individual neurons to large areas devoted to functions like sight or smell, and from milliseconds (physical reactions) to hours or days (learning). The project team is using simulations on ultra-fast supercomputers to build 'an artificial synthesis of cortical-like cognitive skills', and is developing a 'non-von Neumann hardware architecture'.

Traditional computers are based on the 'von Neumann' architecture familiar to us from dealing with our PCs, using separated memory/ storage and processing units. But by using



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structures that mimic the multi-scale functioning of the human brain, the team has designed a non-von Neumann computing device. As well as having applications outside the realm of brain science, this work by the BRAINSCALES project helped in the preparation of the FET Human Brain Project.

Similarly, the REALNET² project aims to develop the first realistic real-time model of the 'cerebellum' — a part of the brain with an important role in motor control and involved in cognitive functions such as attention and language. The team is developing specific chips and imaging techniques to take neurophysiological recordings from neurons in the cerebellum.

The end result will be a realistic neuronal network based on anatomical and physiological data, connected to both simulated and real robots to evaluate its functioning. REALNET aims to provide a radically new view on the computation carried out in central brain circuits — laying the basis for new technological applications in sensing, motor control and cognitive systems.

Mind control: computers mimic limbs

As well as learning how the brain works — and copying it — ICT brain research is working towards realising a dream as old as fairy tales and daydreams: control of the physical world by the mind alone — moving objects just by thinking.

One of the biggest contributions brain research could make is to help the wheelchair-bound victims of car accidents or people suffering full-body paralysis or locked-in syndrome. Millions of Europeans have some form of motor disability that restricts their ability to move, interact or communicate with others.

The BRAINABLE³ project is a three-year initiative supported by EUR 2.3 million in funding to develop and integrate advanced 'brain-computer interface' (BCI) systems, 'ambient intelligence' (Aml), 'virtual reality' (VR) and other technologies that, when used in combination, promise unprecedented autonomy for those with such disabilities.

'Our aim is to give people with motor disabilities as much autonomy as technology currently allows and in turn greatly improve their quality of life,' says Felip Miralles who is coordinating the project at the Barcelona Digital Technology Centre, a Spanish ICT research centre.

By combining BCI and other assistive technologies, the researchers have enabled users to remotely control a robot and manoeuvre it around the house, thereby improving such patients' ability to communicate with people. The BRAINABLE researchers are overcoming the slow reaction speeds of previous systems by embedding intelligence into their platform, so that the system understands the user's context and habits

and can act proactively. The platform even enables simplified access to social networking platforms such as Twitter and Facebook, which are becoming increasingly important tools in helping disabled people overcome social isolation.

In another, dramatic application of BCI technology, the EU-funded MINDWALKER⁴ project could help the thousands of people in Europe paralysed by a spinal-cord injury. The project's mind-controlled robotic exoskeleton should help such patients walk again — and could also assist in the rehabilitation of stroke victims or astronauts who need to rebuild their muscles after long periods in space.

Most BCI systems are either invasive, with electrodes placed directly into brain tissue, or require users to wear a 'wet' cap on their head, using special gels to reduce electrical resistance. MINDWALKER uses a 'dry' technology with electronics to amplify and optimise the brain's signals.

'The dry EEG cap can be placed by the subject on their head by themselves in less than a minute, just like a swimming cap,' explains Michel Ilzkovitz, the project coordinator at Space Applications Services in Belgium.

In addition, the project team have developed a new walking strategy which differs from most previous exoskeletons, which are designed to be balanced when stationary and to move slowly by taking very small steps. MINDWALKER uses a controlled loss of balance in the walking direction which replicates the way humans actually walk.

'This approach is called "limit-cycle walking" and has been implemented using "model-predictive control" to predict the behaviour of the user and exoskeleton, and control the exoskeleton during the walk,' Mr Ilzkovitz explains. Greater efficiency means that the exoskeleton has a longer range and lighter battery packs.

Artificial eyes: ICT that sees

The SEEBETTER⁵ project is also looking to develop artificial vision prosthetics for the blind. Conventional image sensors have severe limitations, but 'silicon retina' vision sensors aim to mimic the biological retina's information processing — computing both spatial and temporal aspects of the visual input. To date, these silicon retinas suffer from low quantum efficiency — meaning low light sensitivity — and an inability to combine both spatial and temporal processing on the same chip.

SEEBETTER's team of experts — from biology and biophysics, as well as biomedical, electrical and semiconductor engineering — are aiming to use genetic and physiological techniques to understand better the function of the retina and model its vision processing. They will then design and build the first high-performance silicon retina, implemented on a single silicon wafer,

specialised for both spatial and temporal visual processing.

Understanding the neurobiological principles of seeing — beyond the functioning of the retina alone — may help us to replicate the success of human vision for computers and robots. The RENVISION⁶ project aims to achieve a comprehensive understanding of how the retina encodes visual information through the different cellular layers, and to use such insights to develop a retina-inspired computational approach to computer vision.

Using high-resolution 3D microscopy will allow the researchers to make images of the inner retinal layers at near-cellular resolution. This new knowledge on retinal processing will help develop advanced pattern recognition and machine-learning technologies. The project could therefore solve some of the most difficult tasks in computer vision — such as automated scene categorisation and human action recognition — so that robots and computers can see and perceive what is happening in the images they receive.

These are just some of the EU-funded ICT projects using electronics and computing technologies to understand, augment and improve the human brain and its functioning. The results have the potential to reduce the impact of disability and disease, and improve our computing power, IT infrastructure and economy.

The projects featured in this article have been supported by the Seventh Framework Programme (FP7) for research.

- 1 'Brain-inspired multiscale computation in neuromorphic hybrid systems'.
- 2 'Realistic real-time networks: computation dynamics in the cerebellum'.
- 3 'Autonomy and social inclusion through mixed reality "brain-computer interfaces": Connecting the disabled to their physical and social world'.
- 4 'Mind controlled orthosis and VR training environment for walk empowering'.
- 5 'Seeing better with hybrid BSI spatio-temporal silicon retina'.
- 6 'Retina-inspired encoding for advanced vision tasks'.

Links to project websites:

- Human Brain Project website: <https://www.humanbrainproject.eu/>
- BRAINSCALES project website: <http://brainscales.kip.uni-heidelberg.de/>
- REALNET project website: <http://www.realnet-fp7.eu/>
- BRAINABLE project website: <http://www.brainable.org/>
- MINDWALKER project website: <http://www.mindwalker-project.eu/>
- SEEBETTER project website: <http://www.seebetter.eu/>
- RENVISION project website: <http://www.renvision-fp7.eu/>

The projects featured in this article have been funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).

This article is an edited version of:
http://cordis.europa.eu/result/story/rcn/11274_en.html
 and
http://cordis.europa.eu/result/brief/rcn/11275_en.html



Building a robot to mimic plants

Many of us probably picture robots as roughly human-shaped — as seen in countless science fiction films — or perhaps as little more than mobile computers. But one EU-funded project is taking inspiration from the smart, efficient strategies of plants in order to develop a new generation of robots and ICT technologies, such as sensing or distributed adaptive intelligence.

In particular, plant roots are excellent natural diggers, points out Dr Barbara Mazzolai of the Center for Micro-BioRobotics at the Istituto Italiano di Tecnologia (IIT), the coordinator of the project. The characteristics of roots — such as adaptive growth, energy-efficient movements, and their ability to penetrate soil at any angle — are interesting from an engineering perspective, she says.

In fact, owing to their sessile lifestyle, plants have evolved the ability to respond to a wide range of signals and efficiently adapt to changing environmental conditions. Plant materials are optimised to reduce energy consumption during motion and these capabilities offer a plethora of solutions for the world of robotics, using approaches that are muscle-free and thus not necessarily animal-like.

*Research*eu results magazine* asked Dr Mazzolai to tell us more about her work in the PLANTOID¹ project.

What are the main themes and objectives of the PLANTOID project?

The goal of the project is to design, prototype, and validate a new generation of robotic systems, as well as ICT hardware and software technologies, inspired by plant roots. Just like their natural counterparts, these robotic systems have distributed sensing, actuation and intelligence to perform soil exploration and monitoring tasks.

There are many features of plants or plant roots that we are investigating in this project, including: capacity of growth and movement in response to external stimuli; growth from the tip of the root by adding cells and production of lateral hairs, to reduce the friction and pressure needed to penetrate the soil;

sensory capabilities to detect a range of different physical and chemical quantities in the environment; osmotic actuation, used for triggering fast movements or driving slow movements in plants; and emergent behaviour by coordination of the roots of the whole organism towards optimal targets.

What is new or innovative about the project?

Plants have rarely been considered as a model of inspiration for designing and developing new technology — especially in robotics. This is probably due to their radically different operational principles compared to animals and difficulties in studying their movements and features. As a consequence, plants are often considered as passive organisms, which are not able to move, to communicate, and to escape from a hostile environment.

The first innovative aspect of this project is to observe plants from another perspective, and to consider their structural, functional and physiological properties as a revolutionary source of inspiration in robotics and ICT technologies. Plants are based on evolutionary strategies aimed at reducing energy consumption and optimising the use of local resources. PLANTOID is the first robot designed to actually grow in a way inspired by plant roots — using similar strategies to penetrate and explore soil in an energy-efficient way.

What first drew you to research to learn from nature in designing technology?

My personal aim in working in the biorobotics area is to better understand the nature and workings of living creatures in order to conceptualise, design and fabricate new artificial devices and bio-inspired robots.



© PLANTOID project

The approach I follow is first to select the biological systems — plants, in this case — which have the relevant characteristics we wish to implement in robots. We then identify and extract the key principles underlying these biological functions and translate them into a technological solution.

At the same time, my goal is to increase the knowledge of the biological system that we use as models. To this end, one cannot simply copy nature, but rather one must carefully select biological models from which the underlying principles can be extracted and translated to an artificial device.

What are some of the difficulties you have encountered, and how did you solve them?

Moving in an unstructured environment such as soil requires new approaches. The proposed new concept of a root-like growing robot penetrates soil while extending its own structure using an additive layering technique.

Layers of new material are deposited adjacent to the tip of the device to produce a motive force at the tip and a hollow tubular structure extending to the surface of the soil. The

addition of material at the tip reduces friction to almost zero, as the sides of the tube do not move, cutting down the energy consumption needed for penetration of the soil.

What are the concrete results from the research so far?

The first PLANTOID prototype includes two functional roots, one embodying artificial growth and penetrating the soil by an additive process of material; the other root implementing bending capabilities in three directions: the sensory systems for temperature, humidity, gravity and touch, and the electronics required for sensor conditioning and actuation control.

The two roots are integrated in a trunk containing a microcontroller main board with communication capability. The branches of the trunk integrate artificial leaves made with materials that “respond” to environmental changing conditions (e.g. humidity and temperature). This result is a prelude to more complex studies on the hierarchical structure of the plant cell walls.

In terms of components, new osmotic actuators have been developed which can be used as components per se



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© PLANTOID project

Dr Barbara Mazzolai

(e.g. for a passive drug release) or applied to achieve the bending of the robotic root. Several sensors will be integrated in the robotic root to detect the following parameters: gravity, temperature, touch, humidity, sodium

(Na⁺), potassium (K⁺), pH, nitrate (NO₃) and phosphate.

What are the advantages of participating in such an EU project?

European projects, like PLANTOID, offer the opportunity to integrate different competences and skills, increase multidisciplinary, solve complex problems, as well as establish new scientific and technological collaborations. Moreover, these projects represent a training opportunity for young researchers who are open and exposed to a European context.

What are the next steps in the project, or next topics for your research?

The next steps will be focused on the integration of the identified functions into a single robotic root that embeds sensors, actuators, control units, an elongation/growing zone, and a bending area. The robot roots will be able

to penetrate and steer in the soil, guided by gravity or the proximity of water or other chemicals.

On the engineering side, our goal is to develop new flexible plant-inspired robots able to grow by adding new materials. This will require the development or use of new flexible sensors based on soft materials, as well as distributed control and robotic architectures. One interesting topic for study is plant structures that exploit external environmental energy to move or implement efficient motion strategies.

Another important question we intend to address is whether plants exhibit intelligent behaviour. A simple definition of plant intelligence could be adaptively variable growth and development during the lifetime of the individual. Exploiting adaptive abilities in plants could lead to the development of smart devices — not only with the ability to

sense, but with the capability to follow stimuli and take decisions to accomplish the required tasks.

Applications for such technologies inspired by plants include soil monitoring and exploration for contamination or mineral deposits — whether on earth or other planets — but could also include medical and surgical applications, like new flexible endoscopes, able to steer and grow in delicate human organs.

The project is coordinated by the Istituto Italiano di Tecnologia (IIT) in Italy.

- 1 'Innovative robotic artefacts inspired by plant roots for soil monitoring'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
Project website:
<http://www.plantoidproject.eu/>

Microprocessors need liquids to beat the heat

Efficient heat removal is one of the most important challenges in sectors from electronics to power generation. EU-funded scientists demonstrated that nanofluid coolants applied to microprocessors could more than double computing capacity.

As current coolant technologies are approaching their technical limits, nanofluids have been reported to have superior thermal properties compared to conventional ones. Published reports of performance at the lab scale have suggested a more than 40 % improvement. However, the mechanisms are not clear.

Scientists initiated the world's largest collaborative project, NANOHEX¹, for the research and development of nanofluid coolants to methodically explore this potential. Researchers focused on formulations for use in data centre cooling and traction power electronic cooling.

Thermal tests of a variety of nanofluids enabled the population of a comprehensive database, the largest in existence,

and the selection of two nanoparticle (NP) species for further development. Scientists prepared and optimised dispersions of silicon carbide (SiC) and aluminium oxide (Al₂O₃) in two different carrier fluids, water and water/ethylene glycol (EG). They demonstrated enhanced thermal conductivity between 10 and 20 % for the NPs dispersed in water/EG.

Although lower than that expected, based on published laboratory results, the enhancement is certainly promising. Investigators also found that the addition of NPs has important effects on viscosity, a consideration for future research. The team developed an assessment model to predict thermal performance of novel nanofluids using experimental data on viscosity and conductivity.

Two demonstrator units were produced for each application and a life-cycle analysis and economic viability study were

conducted. Results showed that a nanofluid-cooled data centre has important environmental benefits compared to



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conventional cooling. In addition, a simulation showed that water cooling could more than double the computing capacity of a data centre while nanofluids increased that by another 10 %, opening up important new markets for liquid-coolant technology. Although nanofluid coolants do not affect the environmental impact of traction-power electronics, they

could significantly increase the operating lifetime of inverters.

NANOHEX modelling and experimental results demonstrated a definite market for nanofluid coolants with particularly promising results in data centre cooling. In addition, the world's largest comprehensive database of nanofluid thermal properties,

together with simulation tools, will be of tremendous importance in the continued development of high-performance and eco-friendly nanofluids for cooling applications.

The project was coordinated by Thermacore Europe Ltd in the United Kingdom.

1 'Enhanced nanofluid heat exchange'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Nanosciences, nanotechnologies, materials and new production technologies' (NMP).
http://cordis.europa.eu/result/brief/rcn/11456_en.html
 Project website: <http://www.nanohex.org/>

Battling fraud in communications technology

The communications sector has its share of fraud attempts and scams. A new EU-funded solution has been designed to help overcome these high-tech threats.

The scale of fraud in traditional telecommunications networks is depriving telecom operators of billions of euros each year, according to the Communication Fraud Control Association (CFCA). The problem is expected to increase with the continued migration to 'voice over Internet Protocol' (VoIP) — technology allowing audio communication over computer networks — particularly since such systems offer increased openness and vulnerabilities.

The EU-funded SCAMSTOP¹ project worked on tackling these weaknesses of the relatively young technology.

To protect VoIP providers from fraud and users from theft, the project envisioned a sophisticated fraud-detection system based on advanced monitoring, detection and alerting mechanisms in VoIP environments. Representing the core SCAMSTOP effort, innovative algorithms for misuse and fraud detection were formulated. The

algorithms have been designed to achieve a high detection rate while using low processing power and memory resources.

Work revolved around investigating the scope of fraud, classifying it, identifying specific problems in VoIP networks, and designing anti-fraud architecture. Types of fraud include subscription fraud (obtaining service with false identity and without paying) and superimposed fraud (obtaining resources from legitimate users by gaining

access to their phone accounts). Fraudsters can also break into a PBX system and conduct what is known as mobile-phone cloning.

The solution created by the project team features many different components to identify fraud, representing a complete 'fraud management solution' (FMS) for VoIP networks. The system features a rich management interface complete with alarms and the visualisation of results, and also enabling the drawing up of rules and the configuration of algorithms.

SCAMSTOP is contributing significantly to knowledge in VoIP security and helping service providers earn their due revenue. It is enabling small and medium-sized enterprises (SMEs) to secure their infrastructure and protect themselves against fraudulent activities, helping to create more sustained development of Europe's VoIP sector. Numerous technologies, such as telephony, messaging and video conferencing, are set to benefit from this endeavour.

The project was coordinated by the Fraunhofer Society for the advancement of applied research, Germany.

1 'Scams and fraud detection in Voice over IP networks'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/result/brief/rcn/12400_en.html
 Project website: www.sme-scamstop.eu



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Novel device enhancing care for older generation

Fall detectors, used mostly by the elderly, are restricted by bad ergonomics and unreliability. Researchers have proposed a new-generation device encompassing an entire fall-detection system that enables early intervention and minimises the consequences of falls for this vulnerable population.

Funded by the EU, the objective of the FALLWATCH¹ project was to develop a wearable and radio-communicating fall-detection device. The first of its kind, the Vigi'Fall solution comprises a miniaturised embedded electronic device patched to the skin.



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Seeking to overcome deficiencies of existing fall-detection products, FALLWATCH project partners advanced the concept of a comprehensive system able to manage a fall event from the moment it happens. From detecting the event to assessing its cause to initiating medical intervention, Vigi'Fall is a 'context-aware' rather than stand-alone system.

Embedded in the holder, the device continuously measures kinematics and classifies the situation according to low, medium or high activity. Another system component, an in-home control box, monitors ambient activity from movement detectors, classifying the situation on its own three-degree scale (inactivity, average or exceptional).

Miniaturisation of the device involved complex technological

routes for electronics, a 'miniaturised multi-chip module' (MCM) and battery miniaturisation. Other technical work included development of a fall-detection algorithm, the construction and testing of an electrochromic display, the development and manufacture of a functional mechanical biocompatible package, and the selection of silicon material for the housing.

The prototype has been delivered and integrates the whole system, covering a MCM, battery, electrochromic device, package and patch. Vigi'Fall has been validated on the first version of a prototype; following the industrialisation phase, it will be refined to produce a commercial first version of the device.

FALLWATCH achievements not only have the potential to better respond to the needs of the

elderly in the event of a fall, but a range of sectors will also benefit significantly. Small and medium-sized enterprise (SME) partners will boost their competitiveness and help develop MCM and battery design, biocompatible materials and packaging, electrochromic pigments and high-tech electronics in general. Moreover, SMEs will have extended opportunities in the human health market.

The project was coordinated by Vigilio S.A., France.

- 1 'A wearable miniaturised fall-detection system for the elderly'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/result/brief/rcn/12394_en.html
 Project website:
<http://www.fallwatch-project.eu/>

Bridging the 'Valley of Death' for photonics SMEs

While research projects often develop new devices — sensors, components, lasers, etc. — it can be difficult to turn these into products ready for market. An EU-funded project has been working on bridging the gap between laboratories and businesses.

Sometimes, when research produces a new device, a spin-out company is formed for exploitation, but it takes a lot of work to turn the invention into a product: testing, optimising the components for specific applications, putting it in a package and complying with standards, etc. No grants cover this activity and investors typically only get involved once there is a market. This gap is called the 'Valley of Death', because many start-ups fail during this phase.

NEXPRESSO¹, a continuation of ACCORD², set out to put pre-competitive photonic components and

systems in the hands of researchers and students — at no net cost to the university or to the company that furnishes the prototypes. The team then facilitated transfer of the evaluation results to potential end-users, assisting companies to access new markets and new applications.

Research*eu results magazine asked project partners Tom Pearsall, of the European Photonics Industry Consortium (EPIC), based in France, and Peter Van Daele, of IMEC at the University of Ghent, Belgium, to tell us more about their work in the NEXPRESSO project.



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What are the main themes and objectives of the project?

First, we set out to demonstrate an efficient pathway for SMEs to transform innovative prototypes into commercial products, shortening time to market and thus increasing competitiveness. In addition, we identify or solicit prototype components and systems involving photonic technologies — lasers, LEDs, detectors, modulators, sensors, materials, etc. — and evaluate

proposals for short-term development of prototypes.

The project also provided supervision and quality control of the funded proposals and helped provide direct access for researchers and students to pre-commercial photonic components. Finally, the project team has tried to develop and implement long-term sustainable funding to ensure continued operation after FP7 funding ends.



Peter Van Daele



Tom Pearsall

What is new or innovative about the project?

NEXPRESSO is the first EU project to identify and address the so-called 'Valley of Death'. This refers to the absence of funding support (either private or public) in the gap between the public support for pre-competitive research — where EU funding usually takes place — and private investment for development and exploitation of existing products.

The project benefits the company by providing cash flow to fund further development, providing focused evaluation and feedback from the R&D project at the pre-market stage, and creating a link between students who perform the research and the employment needs of the company seeking to launch the prototype as a product.

As far as we know, the NEXPRESSO project is the first anywhere to focus on creating a bridge between advanced prototype development and product launch. The project has been successful in recommending design changes, creating employment opportunities, and stimulating the first commercial sales.

In a nutshell, NEXPRESSO sends out a call for prototypes, and SMEs respond with a description of a prototype they would be willing to furnish, along with some of their needs concerning testing,

evaluation or adaptation to a specific application. NEXPRESSO publishes this list, and sends out a call to R&D organisations (typically universities) to respond with a four-page proposal for a six-month project on a specific prototype.

These proposals are ranked by an independent panel of reviewers and the NEXPRESSO team then awards the project according to ranking and financial limits. In so doing, the project brings the SME and the research organisation together as a team — including agreements on intellectual property and other aspects.

NEXPRESSO then negotiates a transfer price with the SME, purchases the prototype, and lends the prototype to the research organisation for the duration of the project (three to nine months). If the R&D organisation completes its task successfully, it can keep the prototype, and NEXPRESSO will transfer ownership.

What first drew you to work on this topic?

We were interested in the innovation process, especially in the photonics area. We had heard about a project, supported by the National Science Foundation (NSF) in the United States, where university researchers would send in requests for prototype components based on modifications of existing products. The NSF project would then contact the appropriate company and negotiate the limited manufacture of some prototype components based on the design by the research organisation.

NEXPRESSO developed this idea of prototype exchange by focusing on the real obstacle that SMEs face in turning a prototype into a product that generates cash flow. In our project, the SME plays the deciding role by identifying the prototype component it wants to turn into a product.

What difficulties did you encounter, and how did you solve them?

One of the main obstacles was 'transfer pricing': how to establish a price for a prototype component when the market does not exist yet? When prototype components are purchased from the SME,

ownership is transferred to one of the NEXPRESSO project partners. The purchase is paid using public funds so this process must be transparent and justifiable.

In fact, an important part of the solution came from the Commission. The European Commissioner for Competition at that time, Neelie Kroes, developed and published helpful rules for state aid — specifying that state aid to private companies for product development is allowed in cases where there is no working market for the product. We designed the NEXPRESSO project to conform to these rules.

In addition, transfer pricing was determined by a negotiation process with the SME. Our aim was to pay only for the manufacturing cost of the product and not, for example, overheads or engineering investment.

What are the concrete results from the research so far?

During the lifespan of the project, NEXPRESSO brought several prototypes to maturity as products. In addition, several of the exchanges we supported resulted in a continued collaboration between the research group and the company — a collaboration which did not exist before. And overall, NEXPRESSO and its predecessor ACCORD funded over 25 exchanges that resulted in development-assessment projects.

Also, we discovered that there is an optimum size or value for an exchange. We experimented with three kinds of offers: multiple units of an inexpensive component (for example, five units of a EUR 5000 laser), a single component with more functionality (for example, a smart camera with spectral recognition) at around EUR 25, or a more complete system with high functionality, at EUR 50000 or more.

We found that the best projects resulted from single prototypes costing about EUR 25000 as they are usually more innovative. SMEs are much more cautious about negotiating an IP agreement for a more expensive un-marketed system, while multiple units of inexpensive components appear to

result in development projects that have less overall impact.

What are the advantages of participating in such an EU project?

The EU project enabled us to offer the NEXPRESSO exchange on a European scale. We have managed projects involving a company in France with a research organisation in Finland, and a research organisation in Scotland with a company in Spain, as examples. NEXPRESSO can contribute directly to greater mobility of European scientists and technologies. This is an important result because SMEs in the photonics business typically have no local market. Export is necessary and contacts at international locations are critical.

What are the next steps in the project, or next topics for your research?

The two high-priority topics for the NEXPRESSO consortium are to establish sustainable operations by transferring the concept to an industry development authority, or creating a Europractice action funded by end-users, and to expand the context of NEXPRESSO from photonics to a range of advanced technologies, such as bio-medical, environmental, manufacturing, security, etc.

To encourage others in the EU research community to take up this concept and adapt it to their own areas of interest, the project has written a 'keys in hand' manual for creating and operating a prototypes exchange programme like NEXPRESSO. We call it a 'Copy Kit'. It is available at no cost to anyone who would like the information.

The project was coordinated by the IMEC Interuniversity Microelectronics Center in Belgium.

- 1 'Network for exchange and prototype evaluation of photonics components and optical systems'.
- 2 'Advanced components cooperation for optoelectronics research and development'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
Project website:
<http://www.nexpresso.eu/>

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A 3D-printed key to the factory of the future

The promise of 3D printing has many of us spellbound, and indeed the ability to conjure up objects on demand could completely change our lives. In homes, offices and workshops around the world, this revolution is only just beginning — mainly with equipment designed for small-scale production at a leisurely pace. Just think what could be achieved with fast, high-precision printers built for large-scale manufacturing, such as those developed by the EU-funded PHOCAM project.

PHOCAM¹ focused on two core techniques — 3D printing for high-performance ceramics and 3D printing with ultra-high resolution — and achieved remarkable results. It has improved processes so significantly that its printed ceramic parts now measure up to the most stringent criteria for high-precision engineering. It has also set a new speed record for printing in nanoscale resolution.

It has managed to bridge the gap between a promising theory and a convincing product, too. 3D printers based on the project's ceramic printing technology are already available on the market and in industrial

use. A spin-off company — Lithoz — is handling the commercialisation.

Manufacturing in a new light

Innovations such as these could ring in a new era for the manufacturing industry. Basically, a 3D-enabled factory would be freed from long lead times and high set-up costs, and so could turn out a wide variety of products as and when required. Any manufacturable object, once its form has been designed, could be produced at short notice.

It would also be possible to switch flexibly between completely different products, generating them in large or small batches — no

need to adapt tooling or adjust assembly lines. 'You just change the job file for your 3D printer,' says Professor Stampfl of the Vienna University of Technology, who coordinated the project.

This is the theory. In practice, he explains, 3D printing today is mainly used for prototyping or very specific small-scale applications. A number of limitations have to be addressed before 3D printing could viably be used for large-scale manufacturing. PHOCAM, an EU-funded project initiated in the context of the public-private partnership 'Factories of the Future', set out in June 2010 to do just that. The partners' work focused on photopolymer-based techniques

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— where light-sensitive materials are sculpted by lasers.

More specifically, thin coats of liquid polymers are made to harden along the required outlines by exposure to light, with successive layers building up to form objects. Ceramic objects can be produced by mixing particles into the polymer, which is later eliminated. While there are other powerful 3D technologies, the partners were convinced that this approach offered a particularly high potential for the development of industrial applications.

Heavy-duty ceramics

Producing ceramic parts with suitable mechanical properties was one of the key challenges: while 3D printing techniques existed, they could not turn out objects to the required standard. PHOCAM managed to overcome this limitation. By the time the project ended in May 2013, it had developed technology that could reliably produce high-performance ceramic parts for demanding engineering applications.

How were these improvements achieved? In short, process-chain integration: 'We had a consortium where we had the capability to cover the whole process chain,' says Prof. Stampfl, emphasising that work on individual steps or aspects of the process would not have yielded the same results.

The need for speed

Another key consideration was speed — or lack of it. PHOCAM was determined to take high-resolution 3D printing to new heights by achieving outstanding precision at the nano-scale. However, the ability to produce objects would be of limited practical value, says the professor, if printing them takes forever.

The partners were therefore equally determined to accelerate production, and their process-chain approach proved successful again. In fact, the speeds they achieved for this particular type of technology are unprecedented, measured in metres rather than the usual millimetres per second.

Advances such as these are widening the scope for industrial applications, and they are only the beginning. Professor Stampfl is convinced that 3D technologies can play a key role in shaping the future. 'If the European R&D community and industrial community get it right, 3D printing could be a cornerstone of the reindustrialisation of Europe,' he concludes.

The project was coordinated by the Vienna University of Technology, Austria.

- 1 'Photopolymer-based customized additive-manufacturing technologies'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Nanosciences, nanotechnologies, materials and new production technologies' (NMP).
<http://ec.europa.eu/research/infocentre/> > search > 31460
 Project website: <http://www.phocam.eu/doku.php>

With an eye on invisibility

Cloaking devices and perfect lenses are the subject of intense research. Scientists have demonstrated manufacture of the necessary building blocks using established manufacturing technology and paving the way to realisation.

Development of cloaking devices requires the prior development of metamaterials, synthetic composites demonstrating properties not normally seen in nature. Among these are 'negative-index materials' (NIMs) which have a negative index of refraction that bends light in the opposite

direction to that expected when passing from one material to another.

The first demonstration of such metamaterials in the visible range came in 2007 and the race is on for large-scale manufacture of large-area materials,

particularly 3D ones. The ambitious EU-funded NIM_NIL¹ project went beyond the state of the art to maintain Europe's position in optical devices.

Scientists exploited silver and graphene to achieve NIMs in the visible range. They chose 'nano-imprint lithography' (NIL) to enable upscaling of manufacturing processes for mass production. NIL is a method for high-throughput patterning of nano-structured materials through mechanical deformation, offering great precision and low cost.

Gaining insight from simulations, investigators designed a variety of NIMs and micro-optical devices. They manufactured the NIL stamps with feature sizes down to 50 nanometres (nm) as well as 3D micro-optical structures for realising NIM prisms. To achieve NIMs in the visible range, researchers selected silver processed to enhance stability and optical response. Applying

graphene on the silver structures further increased stability. Optimised single-layer NIMs were stacked, again using a NIL-based process, to achieve 3D NIMs. In the end, NIM_NIL scientists delivered a 3D micro-optical NIM prism formed by layers of NIM materials produced with scalable NIL and demonstrating negative refraction in the visible-light regime.

NIM_NIL results open the door to large-scale production of large-area 3D NIMs. With this development comes the promising reality of cloaking devices, perfect lenses and magnification of devices below the diffraction limit.

The project was coordinated by PROFACTOR GmbH, Austria.

- 1 'Large-area fabrication of 3D negative-index metamaterials by nanoimprint lithography'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Nanosciences, nanotechnologies, materials and new production technologies' (NMP).
http://cordis.europa.eu/result/brief/rcn/12430_en.html
 Project website: <http://www.nimnil.org/>



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Innovative running footwear for safer exercise

Running increases fitness, but repeated stresses and strains on joints can lead to injuries. European researchers set out to develop a new running-shoe concept that prevents joint injury and muscle strain by alleviating the force of foot-floor impact.



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The HEELLESS¹ project developed and optimised a novel lightweight running shoe — with no heel. The heelless design decreases — by at least 50% — the force experienced when the foot strikes the floor.

Partners also sought to improve shoe rigidity and strength with the use of natural-fibre-reinforced plastics, and to double the running life of conventional running shoes. More specifically, the project's two main objectives were to refine the materials needed for the novel components of a heelless running shoe, and to validate the heelless concept.

Project work included an innovation strategy for research and development activities, shoe specifications based on market

and user requirements, materials and production research, shoe prototyping, development of the manufacturing process, and a clear market analysis.

Product appearance, durability, environmental impact, performance and price were included in the marketing parameters established for the finalised shoe. These were then converted into technical requirements and shoe properties.

Concept validation, through laboratory and field tests, showed a 40% cost reduction in materials and a high production quality, among other positives. Other areas investigated covered the degree to which wearing the shoe alters postural control, gait pattern and running style, as well as comfort, performance and durability for end-users.

The enormous athletic footwear market continues to grow and embrace novel concepts. With

consumers increasingly aware of safety factors and injury risks, the HEELLESS shoe has strong market potential as a high-quality sports product. Following project completion, partner businesses (small and medium-sized enterprises) plan to commercialise the heelless shoe concept and prepare market roll-out.

The project was coordinated by PRO Support BV in the Netherlands.

- 1 'Development of a heelless shoe to reduce injury during running'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/result/brief/rcn/12399_en.html
 Project website: www.heelless.org

A comb to untangle the molecular structure of materials

Scientists have demonstrated for the first time a novel type of spectroscopy in the frequency region relevant to the resolution of molecules. The compact device will make it easily adaptable by research and hospital labs worldwide.



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A graphical representation of an optical frequency comb can be described as having very fine teeth in a beautiful continuum of all possible colours and different lengths. Its spectrum is produced from millions of ultra-short, closely spaced pulses of laser light of different colours, corresponding to the millions of different frequencies (or wavelengths) in the electromagnetic spectrum.

Frequency combs, introduced in the 1990s, have revolutionised measurements of frequency and time. They are widely used in optical metrology, have paved the way to atomic clocks and have enabled the

highest resolution yet in laser spectroscopy.

Entering the realm of molecular spectroscopy, their enormous spectral coverage together with the very high spectral resolution of each 'tooth' of the comb enables the identification of individual atoms and molecules. However, until now, spectroscopy in the mid-infra-red (IR) range corresponding to wavelengths of 2 to 20 micrometres, the so-called 'molecular fingerprint', was little used by medical and scientific specialists. This was due to the bulky nature of the systems imposed by an indirect method of producing the mid-IR spectrum.

Scientists working on the EU-funded project IRCOMB¹ have demonstrated for the

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first time the direct production of mid-IR frequency combs based on novel techniques and choice of materials that enable compact packaging. The miniaturised source consists of a crystalline micro-resonator pumped with a continuous-wave laser. Using a non-linear process called four-wave mixing, scientists have produced

a broad comb spectrum near 2.5 micrometres that is poised to revolutionise science and medicine.

IRCOMB has extended frequency comb spectroscopy into the molecular fingerprint region in a small, compact device suitable for use by medical and scientific experts.

The extremely high-resolution technology promises to open new windows of understanding of the molecules that make up engineered materials, living organisms and the Universe.

The project was coordinated by the Swiss Federal Institute of Technology (EPFL) in Switzerland.

- 1 'Monolithic frequency comb generators in the mid-infrared'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12415_en.html

An enlightened take on light-emitting diode production

The global market for discrete 'light-emitting diodes' (LEDs) is growing rapidly, yet small EU enterprises have trouble competing due to high manufacturing costs. EU-funded scientists developed technology to put them in the game.

White and blue LEDs are typically produced on wafers made of silicon carbide (SiC) or sapphire — aluminium oxide (Al₂O₃). The most expensive and time-consuming steps involve lapping and polishing. Lapping to remove surface scratches and saw marks takes place immediately after cutting the ingots into wafers. Polishing comes next, usually with two or three recursions, on very high-precision machines.

Replacing lapping with conventional grinding would reduce processing time and enable better surface quality, consequently reducing the time required for polishing. To date, this has been difficult to accomplish because the grinding of sapphire wafers is subject to significant variability and there is no direct way to monitor process parameters

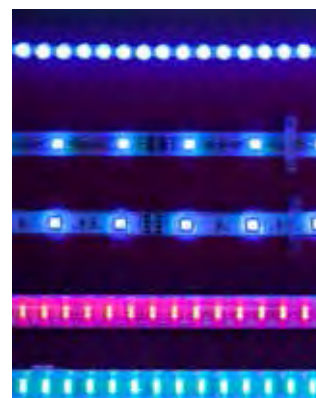
at the contact zone between the grinding wheel and the wafer. Partners working on the EU-funded project TCRG¹ solved this issue with innovative technology to measure and control grinding temperature, one of the key variables for process control.

Researchers exploited sapphire's optical transparency to infra-red (IR) radiation by using sapphire to form the core element of an IR-transparent hollow-spindle wafer-clamping system — a 'vacuum chuck'. A sensor detects IR radiation from the sapphire wafer that is transmitted through the chuck, enabling optical access to any preferred position on the wafer. Having analysed in detail the dependency of the temperature signals on various parameters and operating conditions, scientists determined

thermal-control criteria for the grinding process. From the correlations, they developed the machine-tool integrated-loop control system.

TCRG scientists have developed an innovative solution to the problems of the costs and time required for the production of blue and white LEDs on sapphire wafers. EU small and medium-sized enterprises (SMEs) will now be in a strong position to compete with foreign manufacturers in this huge global market. In addition, the modular technology should boost sales of individual components for other applications for the partner SMEs manufacturing them.

The project was coordinated by the Fraunhofer Society for



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the advancement of applied research, in Germany.

- 1 'Thermally controlled rotational grinding of sapphire wafers for highly efficient manufacturing of modern white LED light sources'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/result/brief/rcn/12403_en.html

Fire-resistant cables for emergency circuits

EU-funded scientists have developed promising new silicone compounds for currently lacking fire-resistant network cables. Secure power and data transmission for alarm systems and emergency lighting will save lives and money.

Fires cause thousands of deaths and hundreds of thousands of injuries each year in the EU alone, with a financial cost estimated at close to EUR 100 billion. Fire alarms and emergency lighting are very effective in reducing such damage. However,

their effectiveness is dependent on fire-resistant cables to transmit data and power, which are currently subject to failure at the joint in a metallic shield layer.

EU-funded scientists initiated the project FIRE SHIELD¹ to produce

improved fire-resistant cables, and specifically a currently non-existent fire-retardant network data cable.

Current soft-skinned fire-resistant cables are vulnerable to failure at the joint running the

length of the cable where metalised polymer films (generally copper-based) are wrapped around the elastomeric cable compounds. Scientists investigated a novel dynamic cold spraying process to apply the conductive copper



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coating directly on to the cable as it is extruded.

Researchers identified the acceleration of metallic particles during spraying as a key enabling technology, and designed and fabricated powder-accelerating nozzles. They then investigated cable materials with enhanced

hardness to improve the cold gas dynamic deposition of the conductive copper coating. Compounding of silicone rubber with various fillers yielded promising fire-resistance properties, but uniform copper deposition was challenging and did not form electrically conductive coatings.

With their focus moving to promising fire-resistant elastomer compounds, scientists sought to develop formulations for emergency circuits with superior char strength to avoid cracking, in accordance with the British Standard (BS) EN 50200:2006 and BS 8434-2:2003 tests. They demonstrated that silicone compounded with a combination of boehmite, precipitated calcium carbonate and glass flake, worked together to give very interesting results. Work is under way to optimise the proportion of each filler.

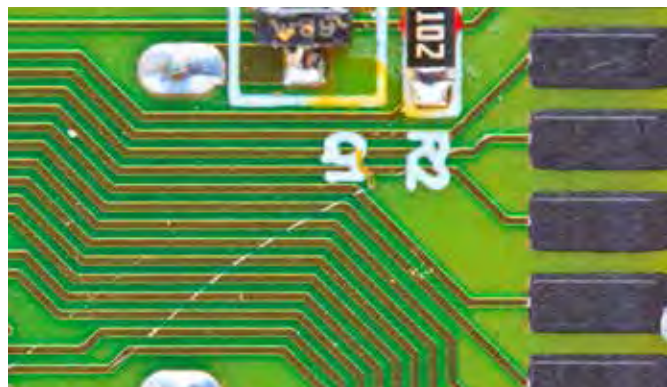
FIRE SHIELD scientists expect to deliver fire-resistant cables for emergency power and data transmission circuits superior to those currently available on the market. The technology will

significantly enhance the competitive position of numerous small and medium-sized enterprises (SMEs) working in the field and protect lives and property in the event of fires.

The project was coordinated by Ventcroft Ltd in the United Kingdom.

- 1 'An innovative soft skinned fire-resistant cable for fire-safety applications manufactured using integrated cold-gas dynamic spraying and polymer extrusion technologies'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/result/brief/rcn/12391_en.html
 Project website:
www.fireshield.uk-matri.org



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Technological innovation for dried food

Dried food offers many benefits in modern food processing, although the drying methods have certain limitations. The EU has funded research to address these problems, which often make it difficult for small manufacturers to survive in the food industry.



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Aiming to help small and medium-sized enterprises (SMEs) in the dried-food industry to remain competitive, the ULTRAVEG¹ project developed technology for low-cost, fast, effective and quality drying of fruit and vegetables. Project partners focused on the potential of 'high-power ultrasound' (HPU) for the dehydration of porous materials. Earlier investigations had indicated that this may be

an effective process for the treatment of heat-sensitive materials such as foodstuffs.

A powerful technology that can be used to increase the drying rate of materials, HPU is also safe, environmentally friendly, efficient and economical. The project advanced a novel approach to the application of HPU to drying processes, achieving a significant reduction in

times, for both hot-air drying and accelerated freeze drying.

Two ULTRAVEG prototypes were designed, in compliance with most of the industrial requirements and meeting most of the needs expressed by the SME partners. Following positive lab-scale results, the different design components were scaled up to a size close to the industrial scale, and assembled for use in industrial validation trials. The current prototype design is intended to meet industry needs and the requirements of a new drying technology.

ULTRAVEG trials showed that an accelerated drying curve does not diminish the nutritional and sensory qualities of foods tested. The approach promises enhanced production capacity, is affordable, easy to install and maintain, and can be operated with minimal effort and without special skills.

Various dissemination activities succeeded in communicating

project efforts, results and details of the developed technology. A patent application regarding the novel ULTRAVEG approach is pending, and industry response to the results has been positive, indicating that the time is right for the introduction of this new technology which can boost SME operations.

The application of promising project results will help European SMEs in the dried-food industry to withstand global competition and survive alongside large multinationals. Furthermore, the EU economy stands to benefit from increased sales of high-powered ultrasound components and equipment.

The project was coordinated by Gökser Makina in Turkey.

- 1 Development of a high-power ultrasound system for the low-cost, fast, effective and quality drying of fruit and vegetables'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/result/brief/rcn/12388_en.html



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Preventing space overpopulation from man-made debris

The amount of debris already orbiting the Earth — and its increasing volume — means that the 'gravity' of the problem is rising. Scientists are developing novel technology exploiting the Earth's magnetic field to deorbit man-made debris without propellants or a power supply.

The majority of orbiting junk is the result of collisions and explosions of man-made devices. While small, these objects can inflict damage to orbiting spacecraft and their valuable equipment, in the worst case causing system failures that endanger human lives. The problem is now becoming more prominent to the extent that it recently informed the plot of the Hollywood film *Gravity*.

The total amount and mass of space debris is steadily rising, highlighting the urgent

need for more efficient mitigation measures. Objects in 'low Earth orbit' (LEO), up to 2000 km from the Earth's surface, require a dedicated deorbiting system as air drag is negligible. This is also the area where the majority of artificial satellites do their work, so it needs to be debris-free.

Scientists are developing a system to be launched on every new satellite. This will provide thrust or drag with no propellant or power supply, while generating power for

on-board use. The EU-funded BETS¹ project could be the answer to the space debris problem.

An 'electrodynamic tether' (EDT) system consists of two objects in orbit connected by a conductive wire that moves through the Earth's magnetic field. When a conductive wire moves in a magnetic field, current is produced and the magnetic field exerts a force on the wire opposite to the direction of its motion. In this case, ➤

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drag is produced on the tether. The conductive ionosphere completes the circuit for electron flow into and out of the wire at opposite ends.

During the previous reporting period, scientists manufactured a tether tape prototype that has already undergone extensive testing. Modelling of tether dynamics pointed to the need for a non-trivial control strategy that has been validated through preliminary deployment simulations. Experimental and simulation data have

been used to prepare for tests on current collection by the tape tether.

BETS will prevent development of the Kessler Syndrome, whereby colliding debris objects in LEO create a cascade of further collisions, and uncontrollably increasing space debris. Avoiding this scenario — one in which the satellites so critical to communication and security would be unable to fly — will benefit industry, governments and the global population as a whole.

The project was coordinated by the Technical University of Madrid (UPM) in Spain.

- 1 'Propellantless deorbiting of space debris by bare electrodynamic tethers'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/12181_en.html
 Project website: <http://www.thebetsproject.com/>

Helping space assets survive stormy weather

EU-funded scientists are collecting data and continuously updating a new model of a poorly understood component of space weather. The model will enable more accurate space weather forecasts to ensure the security of space missions.

The Earth's radiation belts are regions of high-energy particles, mainly protons and electrons, held captive by its magnetic field. During a geomagnetic storm, space assets such as satellites are in danger for a period of time. This is related to electron-loss mechanisms (as opposed to electron sources), particularly 'relativistic electron precipitation' (REP). REP is indirectly related to properties of the plasmasphere, a relatively dense region of low-energy electrons and protons.

Plasmaspheric properties modulate interactions between plasma waves and radiation-belt particles, making detailed understanding fundamental to

the protection of space assets. Currently, there are few regular measurements of plasmaspheric properties and existing models lack plasmaspheric structures that are known to exist. EU-funded scientists launched the PLASMON¹ project to systematically measure and monitor the changing plasmasphere composition. Data is being used to develop accurate data-assimilative (continuously incorporating new measurements) models of space weather and thus support the protection of space assets.

During the current reporting period, scientists purchased hardware, developed software and set up new stations

to monitor electron densities, equatorial plasma mass densities and ionisation changes in the radiation belt. Researchers have started running the data-assimilation plasmasphere model and made initial comparisons between model results and observations. They have also begun development of a REP model with the goal of describing the influence of plasmasphere on electron precipitation.

The project has made important progress, as witnessed by eight publications in peer-reviewed journals with two more in press and three in review. Outcomes have been presented at numerous conferences, several

seminars and public talks and in local media.

Space-weather modelling is an important global undertaking requiring contributions from ground-based observatories at locations around the world at a single point in time for accurate conclusions. PLASMON is increasing that capability worldwide. In addition, the project's modelling work represents an area not currently addressed elsewhere, providing the opportunity for development of an EU leadership role. Outcomes will facilitate more accurate predictions of space weather, leading to an early-warning capability to protect valuable space assets.

The project was coordinated by the Eötvös Loránd University in Hungary.

- 1 'A new, ground-based data-assimilative modeling of the Earth's plasmasphere — a critical contribution to Radiation Belt modeling for space weather purposes'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/12384_en.html
 Project website: <http://plasmon.elte.hu/>



Space-weather warning system

Orbiting satellites and electrical grids on Earth are vulnerable to space weather in the form of high-energy particles coming from the Sun. An EU-funded initiative is developing an alert system to forecast these geomagnetic storms.

During the solar cycle, the Sun goes from a quiet condition to levels of high activity, displaying phenomena such as 'coronal mass ejections' (CMEs) and 'solar energetic particles' (SEPs). These are accompanied by the explosive release of mass, magnetic flux and energetic particles that can damage satellites and on-board detectors. In extreme cases, ground-based systems such as power grids are at risk, and if astronauts are to travel to Mars or return to the Moon they must be protected from these events.



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The COMESEP¹ project developed tools for forecasting geomagnetic storms and SEP radiation storms. Researchers used scientific data analysis and computer models to investigate the propagation of SEPs and CMEs, and developed an operational space-weather alert system based on the COMESEP definition of risk. The project also investigated very large events from the pre-satellite era using historical ground-based observations, including geomagnetic records, sunspot data, solar images and drawings.

Project partners investigated and selected automation detection algorithms for the

alert system and examined different solar wind models for use in interplanetary CME propagation tools. A novel technique based on remote-sensing observations and *in-situ* measurements was also created for determining the movement and direction of interplanetary CMEs. In addition, an analytical model was developed to calculate the arrival time and speed of an interplanetary CME hitting an orbiting space craft.

COMESEP scientists used measurements of heavy ion flux by the Ulysses and Advanced Composition Explorer (ACE) spacecraft to investigate the evolution of SEP characteristics in the area around

the Sun known as the heliosphere. The impact of large-scale interplanetary magnetic field structures on SEP profiles was also studied. In addition, researchers developed a test particle model to study SEP propagation from the Sun and included the results in space-weather models.

The work carried out by COMESEP increased international and European collaboration on space-weather research and forecasting. It also complemented the European Space Agency's (ESA) space situational awareness activities for security of space assets from space-weather events. The alert system will

help mitigate the impact of space weather on vulnerable technologies in space, such as satellite communication and navigation systems as well as ground communication and electrical grids.

The project was coordinated by the Belgian Institute for Space Aeronomy in Belgium.

- 1 'Coronal mass ejections and solar energetic particles: forecasting the space weather impact'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/9795_en.html
 Project website:
<http://comesep.aeronomy.be/>

Earth spies on distant black holes

A smarter way of looking at black holes in deep space is set to reveal more accurate data about these captivating marvels. This knowledge could help change the laws of physics as we know them.

Black holes are fascinating interstellar phenomena that could potentially challenge everything we know about physics. Phenomena in outer space that could help global research teams investigate

black holes include 'active galactic nucleus' (AGN) feedback, cooling flows and the behaviour of nearby galaxies.

Against this backdrop, the EU-funded CAFEGROUPS¹

project is studying the energy transferred from super-massive black holes at the centres of galaxies to 'intergalactic medium' (IGM). Bringing together a global team of researchers from India, Italy,

the United Kingdom and the United States, the project is looking at novel high-tech ways to tease out the secrets of black holes.



SPACE

The technological solution envisioned looks at combining data from opposite ends of the electromagnetic spectrum in order to investigate black holes more closely. Specifically, it involves low-frequency radio observations to track the history of outbursts from the black holes, and X-ray data to determine

their effects on the 10-million-Kelvin gas of the IGM. Capitalising on Europe's most sophisticated equipment, such as the European Space Agency's (ESA) XMM-Newton X-ray observatory and key facilities worldwide, CAFEGROUPS has now begun studying black holes in unprecedented detail.

Project members are proceeding successfully, having brought on-board a powerful team of experts to exchange knowledge, work with new analysis techniques and combine different areas of expertise. The team has published several articles in peer-reviewed journals with more

on the way, in addition to giving 12 presentations at seven international conferences. It has also established the project website, which reveals interesting insights into black holes and other key resources. More exciting results are expected to emerge by the time the project ends.

The project is coordinated by the University of Birmingham in the United Kingdom.



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1 'Cooling, AGN feedback and evolution in groups'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12283_en.html



Governance of security satellites

The 'Global monitoring for environment and security' (GMES)/Copernicus services for security applications are approaching operational maturity. An EU project is investigating the implications of several options for the continuation of effective governance of this facility.

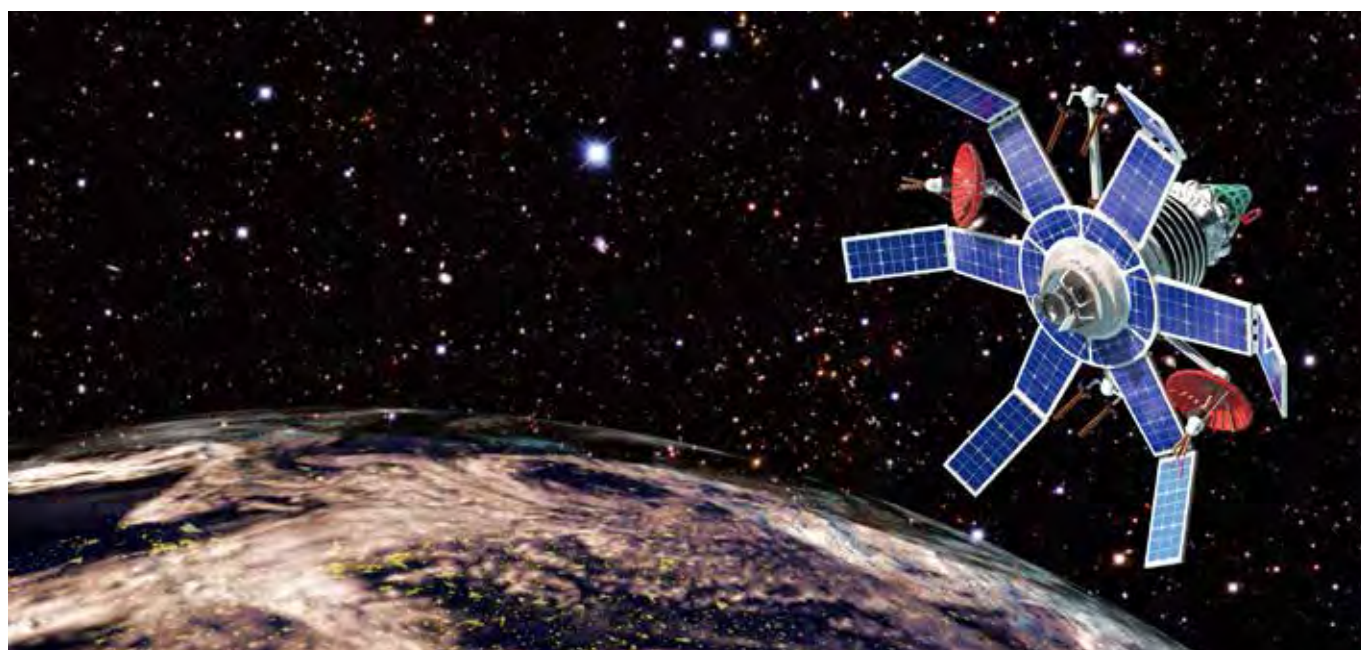
Satellite systems allow rapid analysis of information on huge regions from an office. Such a capability is invaluable for security applications, especially border control and maritime surveillance.

Providing a full analysis of GMES administration, the BRIDGES¹ project is examining various satellite-security governance options in terms of their technical, financial and legal implications. The

project plans to support the establishment of future guidelines, via stakeholder dialogue, including a possible role for the European Union Satellite Centre. This is the only agency capable of handling large

amounts of geographic data in ways that can support decision-making.

In its first year, the project completed a preliminary analysis of existing models, identifying alternatives for operational service delivery. These cover the complete range of stages, from request to delivery, and specify areas



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of responsibility for various participants. Numerous stakeholders have been involved via various committees and forums. Building on these results, governance scenarios are under preparation. Work in this area constitutes the second project phase.

The third planned phase will focus on analysing legalities

as well as impacts, technical implementation and cost benefits. BRIDGES has also carried out dissemination activities, including one workshop, plus publications and a website.

Further planned outcomes include: options for implementing a coordinated approach to security use of satellite data; overviews of national and

European stakeholder positions; and insights about how a civilian system under civilian control may contribute in operational security contexts. It is expected that the BRIDGES' analyses will produce concrete protocols.

The project was coordinated by the European Union Satellite Centre in Spain.

- 1 'Building relationships and interactions to develop GMES for European security'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/12261_en.html
 Project website: <http://www.gmes-bridges.eu/>

Miniaturisation expands capacity of future space-exploration missions

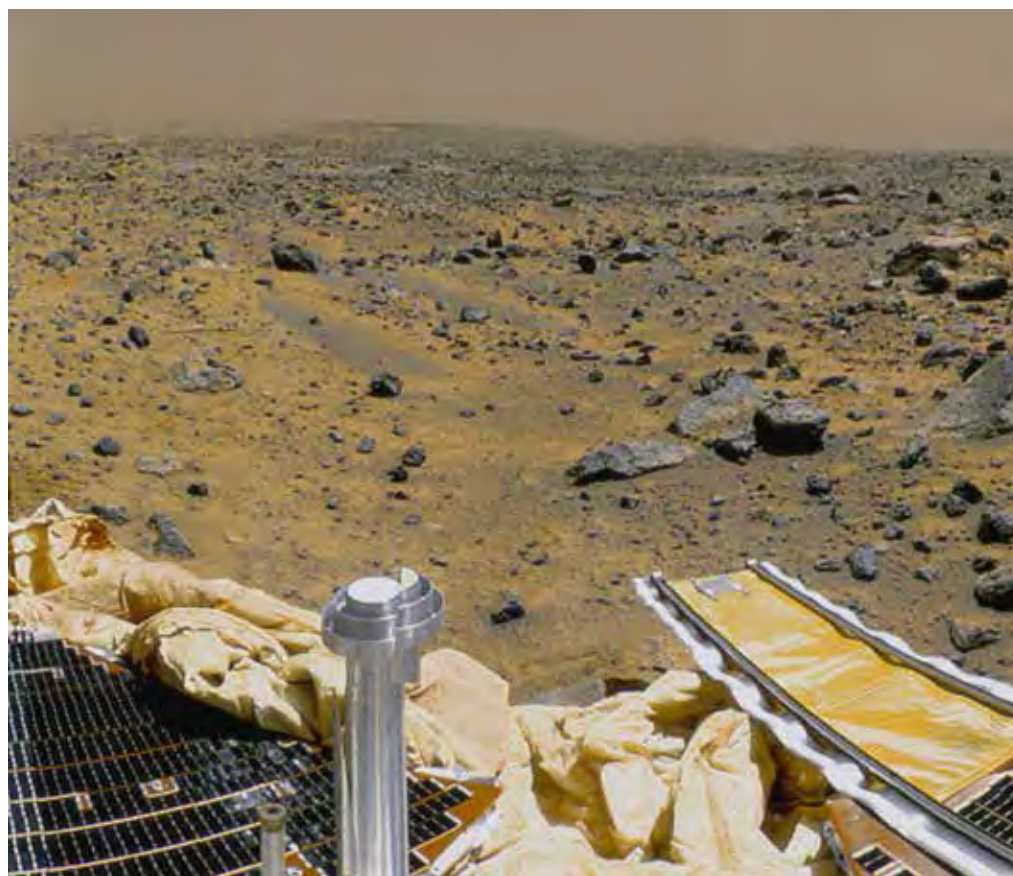
European researchers are developing low-weight navigation tools for future space-exploration missions. Combining hybrid sensors with micro- and nanotechnologies, the innovative systems will enable unmanned vehicles to bring samples from space bodies back to Earth.

The SINPLEX¹ project is an EU-funded initiative to miniaturise the navigation subsystems of spacecraft. This will reduce mass and weight, thereby increasing the number of reachable target bodies and enabling a higher scientific return from space missions. These new technologies will enable several planned international space missions to send robotic vehicles to gather samples from the Moon, asteroids, planets and planetary moons.

Team members are adapting leading technologies in miniature optical sensors, inertial sensors and electronics for these new space applications. Using these devices, SINPLEX has developed integrated navigation architecture to cover all aspects of exploration missions, including approach, entry, descent, landing, rendezvous and capture.

A key aspect of the work is to enable different components to share parts of the assembly between different functions. Tailored software that integrates measurements from individual sensors will compensate for the weaknesses in some sensors by using the strengths of others.

SINPLEX technologies should reduce the mass of navigation systems by a factor of three or even more. This will cut travel



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time and improve the reliability of components operating in harsh space environments. Smaller vehicles will be able to land and be guided closer to scientifically interesting locations.

With ongoing work currently verifying the performance of its prototypes, SINPLEX will contribute to

future planetary exploration, such as a Mars sample return mission. Realising these ambitions in the near term will strengthen Europe's position as a major player in international space exploration.

The project was coordinated by the German Aerospace Center (DLR) in Germany.

- 1 'Small integrated navigator for planetary exploration'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/12262_en.html
 Project website: <http://www.sinplex.eu/>

EVENTS

'Virus-like particles' (VLPs) as vaccines, vectors and adjuvants

A conference entitled 'Virus-like particles (VLPs) as vaccines, vectors and adjuvants' will be held from 31 March to 2 April 2014 in Annecy, France.

Vaccines are playing a major role in reducing the impact of pathogens. However, alternative approaches are needed if drug development is to improve immunity to infectious diseases.

This meeting poses new questions on antigen design, regarding for instance the optimal and minimal size and structure needed for VLPs. It will provide an enriched environment for clinical researchers, pharmacological companies and health-care professionals in related disciplines to share research and explore future avenues of collaboration.

For further information, please visit:

<http://www.fondation-merieux.org/virus-like-particles-vlps-as-vaccines-vectors-and-adjuvants/>

International conference on sustainable human development

The annual 'International conference on sustainable human development' (ISHUD 2014) will be held from 2 to 3 April 2014 in London, the United Kingdom.

The conference aims to generate discussion on issues of importance to society at large. With a focus on sustainable cities, core areas include diversity, knowledge management, the economy, well-being as well as society and technology.

Through a structured programme of research presentations, seminars, posters, demonstrations and an exhibition, it is intended that participants will gain new insights, knowledge and competencies of relevance to the betterment of life in a sustainable way.

For further information, please visit:

<http://ishud2014.eduservgroup.com/wp/>

European conference on the Future Internet

The first 'European conference on the Future Internet' will be held from 2 to 3 April 2014 in Brussels, Belgium.

The event aims to bring together key stakeholders involved in shaping the networks and services of the future to discuss how Europe can achieve global leadership in ICT by 2020 through innovative internet technologies.

Participants will have the opportunity to network and connect with representatives from leading European organisations in the ICT domain and gain an overview of programmes aiming to accelerate the development and adoption of Future Internet technologies in Europe.

For further information, please visit:

<http://www.ecfi.eu/Brussels2014/>

Trees, people and the built environment

A conference entitled 'Trees, people and the built environment II' will be held from 2 to 3 April 2014 in Birmingham, the United Kingdom.

Urban trees and woodlands are essential elements of our green infrastructure and play a vital role in promoting sustainable towns and cities. The urban forest can provide numerous environmental, economic and social benefits, contributing enormously to the health and welfare of those who live and work in urban areas.

This conference aims to discuss research from industry practitioners, including environment advocacy groups, city planners and architects, to expand the knowledge base of sustainable urban planning.

For further information, please visit:

<http://www.charteredforesters.org/icf-events/icf-national-conference/>

International conference on forest change

The 'International conference on forest change 2014' will be held from 2 to 4 April 2014 in Freising, Germany.

Forests still cover 31% (4 billion hectares) of our planet's land surface. But major challenges connected with the management and preservation of forest ecosystems threaten to undermine forest areas.

The conference lays bare the key drivers of forest degradation. It will provide participants with a vested interest in environmental management with an opportunity to forge multilateral links.

For further information, please visit:
<http://www.fchange2014.wzw.tum.de//RMK>

Fuel cells 2014 science and technology

A conference titled 'Fuel cells 2014 science and technology' will be held from 3 to 4 April 2014 in Amsterdam, the Netherlands.

Thousands of fuel cells are being produced annually and sold commercially in a wide range of applications, but continued research is essential to help reduce production costs and increase durability.

The conference will bring together leading researchers and practitioners working in areas such as new materials, degradation processes and systems engineering to discuss the latest developments and research priorities in fuel-cell science.

For further information, please visit:
<http://www.fuelcelladvances.com/index.html>

International conference on cloud computing and services science

The fourth 'International conference on cloud computing and services science' (CLOSER 2014) will be held from 3 to 5 April 2014 in Barcelona, Spain.

The event sets out to explore the emerging area of cloud computing, inspired by recent advances in network technologies.

The event will present the case for the use of services science in IT-driven collaborations with an emphasis on how this field can provide techniques to design, analyse, manage and market cloud computing.

For further information, please visit:
<http://closer.scitevents.org/>

International conference on smart grids and green IT systems

The third 'International conference on smart grids and green IT systems' (SMARTGREENS 2014) will be held from 4 to 5 April 2014 in Barcelona, Spain.

The advent of smart grid technology gave rise to sustainable and efficient solutions for the production and distribution of electricity. The dynamic infrastructure of these models is well equipped to meet the concerns facing the 21st century, such as environmental damage and the rising cost of energy.

This conference aims to build on previous meetings by bringing together researchers, developers and practitioners interested in the latest advances and applications in the field of smart grids, energy-aware systems and communication technologies.

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

First calls under Horizon 2020

In December 2013, European Commission presented its first calls for project proposals under **Horizon 2020**, the European Union's new EUR 80-billion research and innovation programme.

Worth around **EUR 7.8 billion in the 2014 budget alone**, the calls are focused on the three key pillars of Horizon 2020: Excellent Science, Industrial Leadership, and Societal Challenges.

Find more information on Horizon 2020 at:

<http://ec.europa.eu/programmes/horizon2020/>



Participant Portal

Users can find and secure funding for research and innovation projects through the **Participant Portal**.

Non-registered users can search for funding, read the H2020 Online Manual and download the relevant legal documents. They can also check if their organisation has already registered to the beneficiary register, refer to the FAQs or contact the support services.

Registered users can submit their project proposal, sign the grant agreement and even manage their project throughout its life cycle.

Visit the Participant Portal at:

<http://ec.europa.eu/research/participants/portal/>



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