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Special feature:

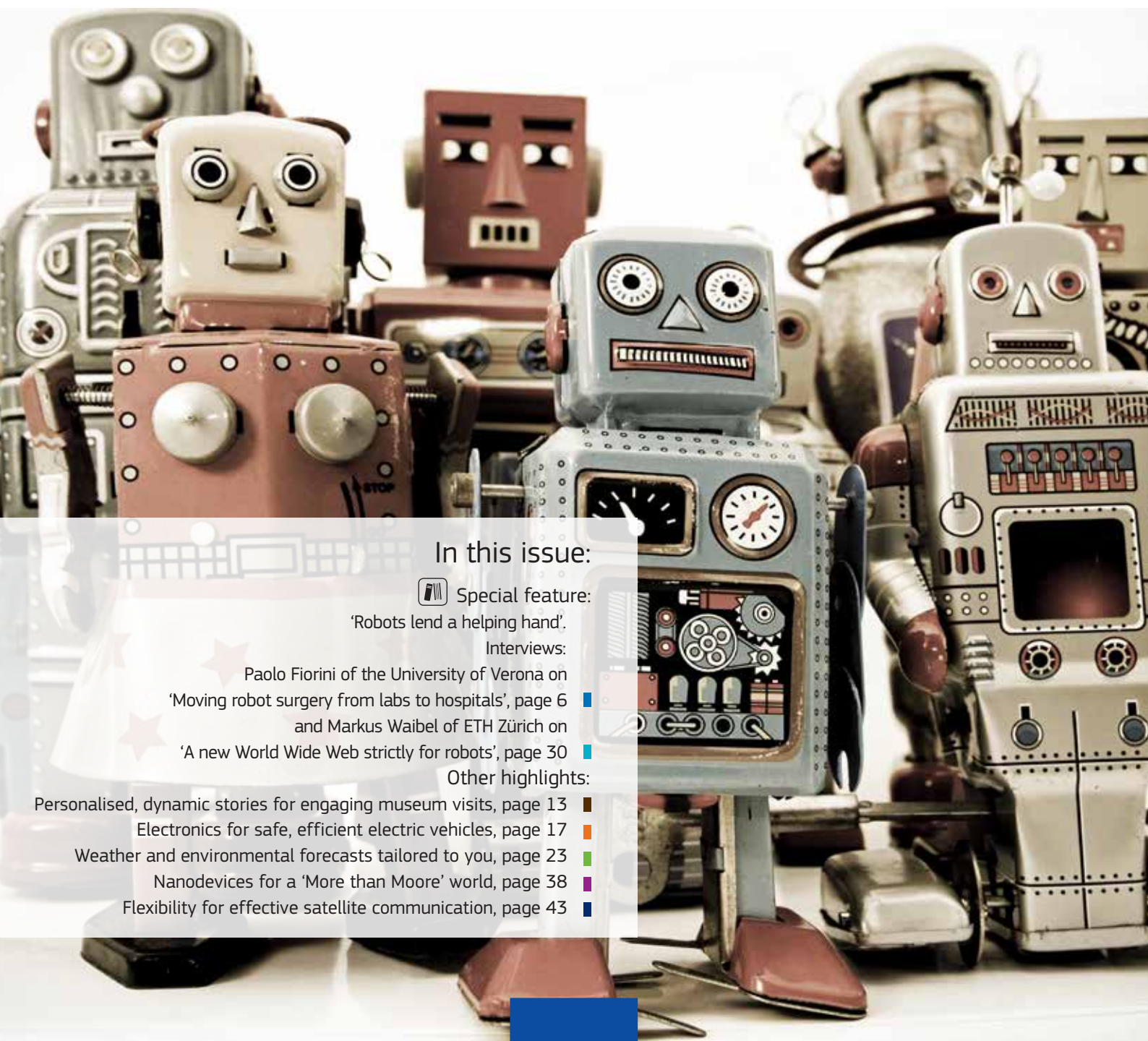
'Robots lend a helping hand'.

Interviews:

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and Markus Waibel of ETH Zürich on
'A new World Wide Web strictly for robots', page 30 ■

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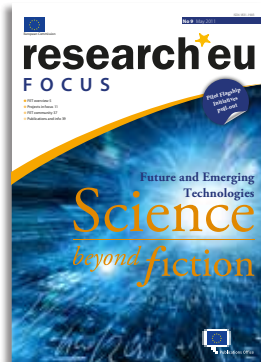
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A robot for every situation

Robots have been fascinating children and adults alike for decades. But since the first one made its appearance on the movie screen in 1927 — in the film *Metropolis* — science fiction authors' imagination has been increasingly challenged by the emerging science of robotics. Industrial and service robots are now commonplace, rovers are rolling around Mars, humanoid entertainment robots are getting more and more sophisticated, and robots are now used for tasks as precise and crucial as surgery.

In 2013, there were over 1.1 million industrial robots worldwide. And the figures are even more impressive when it comes to service applications, such as smart vacuum cleaners and medical robots. Over the next three years, the International Federation of Robotics (IRF) predicts that globally there will be about 22 million robots for private use. In such a booming market, EU investment in research and innovation can make a difference. Horizon 2020 notably aims to tackle market fragmentation and the gap between innovation and market impact, the two major issues currently faced by researchers.

To celebrate European Robotics Week, which took place from 25 November to 1 December, the *research*eu results magazine* gives the floor to some of the minds behind new EU-funded robot concepts across Europe. This issue includes an interview with Dr Paolo Fiorini, who presents the results of EUROSURGE, a project pioneering the resolution of obstacles in the field of robotic surgery (page 6). Then Dr Markus Waibel tells us more about the ROBOEARTH project and the new area of 'cloud robotics', which aims to create a World Wide Web strictly for robots to share their knowledge and experiences (page 30).

Other topics include, in the 'social sciences and humanities' section, 'Personalised, dynamic stories for engaging museum visits' on page 13. The latter is followed by the 'energy and transport' section which starts with 'Electronics for safe, efficient electric vehicles' on page 17, then the 'environment' section which kicks off with 'Weather and environmental forecasts tailored to you' on page 23.

The 'industrial technologies' section begins with 'Nanodevices for a "More than Moore" world' on page 38, while the 'space' section focuses on 'Flexibility for effective satellite communication' on page 43.

The issue ends, as usual, with a list of events and upcoming conferences.

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 29 of *research*eu results magazine* — a special dossier called 'Shaping the future of air transport'.

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BIOLOGY AND MEDICINE



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Moving robot surgery from labs to hospitals

What if, in a few years from now, human surgeons were only needed for the most delicate operations, leaving more common tasks to robots? This not-so-fictional future is the dream of Dr Paolo Fiorini, who coordinated the EUROSURGE project, which ultimately targets the commercialisation of newly developed technologies in this sector.

Resources are becoming a more pressing concern every year for hospitals across Europe, while an ageing population, and higher expectations, are increasing the demands on healthcare services. Technology is one of the ways that we can hope to “square the circle” of improving the quality of care during surgery, while ensuring that such services remain accessible for patients.

In this context, investment in robotic surgery has become a growing trend in EU research. Soon, researchers expect to bring to market technologies that could perform surgical interventions automatically, or even robotic arms performing such interventions under the supervision of an actual surgeon located thousands of kilometres away. But while this all sounds very exciting, there is still a long

way to go before such technologies reach your nearest city hospital.

Paolo Fiorini, a former scientist at NASA, has spent more than 20 years bridging gaps between research institutions and pushing for the commercialisation of newly developed technologies. His latest project goes by the name of EUROSURGE¹, which aims to build a pan-European community of researchers, simplify software development, and create an online platform that would act as the voice of scientists in this sector.

In an exclusive interview with the *research*eu results magazine*, Dr Fiorini explains the difficulties currently faced by EU scientists and his hopes for the future of this promising area of research.

What are the main objectives of EUROSURGE?

EUROSURGE is a Coordination Action (CA) that has the goal of forming a community of research laboratories and companies active in the field of robot-assisted surgery — often referred to as robotic surgery. While working on community building, I also felt that this was a good area to address the issues related to ‘cognitive robotics’ which was one of the main focuses of robotics in FP7.

What is new or innovative about the project and how it addresses this topic?

To build a community of researchers, I thought that it was necessary to develop methods to ensure that they could cooperate, perhaps on some common

hardware/software platform. Although a CA does not have the money to develop hardware platforms, we addressed a number of issues that are related to the project's objectives.

As a first step we carried out an investigation on 'who is doing what' in Europe in the field of robotic surgery. We came up with a map that links all centres performing research in robotic surgery and identifies their main research topic. The map is already used by stakeholders to identify possible partners and reviewers of European projects.

The second step was to develop a technology that would simplify the development of software for robotic surgery. The focus here is on modularity, so that different groups can write components that are compatible with the software developed in other laboratories. We suggested guidelines both for the design and the implementation of software packages.

To satisfy the strict regulation of medical devices, all software needs to undergo severe validation and benchmark phases. In our vision, the design should be 'ontology-based', i.e. based on a formal description of the functions and connections of the components of a surgical robotic system, coupled with the description of the tasks the system will perform. The implementation should then be 'component-based' with specifications that can be automatically derived from the ontology description. We based our work on the ROS² and OROCOS³ packages, already well known and used in the robotics community, and enhanced them with the concept of 'component supervisor' which allows each software package to identify itself and its function among other components and to let a test script verify whether all components are compatible with each other.

The last topic addressed by EUROSURGE is the analysis of the 'non-technical' road blocks, i.e. the issues related to common language, patents, regulations, ethics and laws in different European countries. Here we have developed a new website, called SurgiPedia, which publishes white papers and position statements on robotic surgery, and has a dedicated web search engine to collect information about patents related to robotic surgery.

What first drew you to research in this area?

From 1985 to 2000, I worked on teleoperation for space applications at NASA's Jet Propulsion Laboratory in Pasadena (CA-USA). When I returned to Italy in 2001, I found that space research was not too popular, and after a few attempts to work with the Italian Space Agency I decided to use my background in teleoperation for robotic surgery. It was a

good idea since I was able to participate in and coordinate a number of projects in this area, develop new technologies and train students. I also started a couple of companies developing technologies for robot-assisted surgery.

What were the main difficulties you faced in advancing robotic surgery?

Of course, the main difficulties are not the technical problems. The main difficulty is the lack of a sustained stream of resources to reach a good level of maturity with a technology. The example is one of my start-up companies: after the good results of the European project ACCUROBAS⁴, I decided to apply the experience acquired to make a new surgical robot that could address some of the problems identified during the project. I was also able to get some significant venture capital for the company, but it was not sufficient to reach the market. We succeeded in developing a new product, in carrying out animal tests and in certifying the technology. But then the money ran out and we could not find other investors ready to support the human clinical trials. This is a common problem for all European projects. We develop great technologies that have no impact on the economy because they never reach the market. Hopefully, this problem will be addressed in Horizon 2020, but there is no easy solution, given the lack of risk investments in Europe.

The second problem is the difficulty to find surgeons interested in cooperating 'seriously' on an engineering project. They are all interested in the beginning, but when we need their time to test the devices, to give us advice and to propose new features, somehow they disappear. I guess because a prototype is still too far away from the application that they lose interest during the development process.

How do you expect EUROSURGE to help in this regard?

I think that, besides the points listed above, we have been very successful in creating a community of researchers in robotic surgery. I do not want to say that everybody is involved and participates in the project activities, but a good number of researchers do. We had a successful workshop in Verona, in September, attended by about 70 researchers, and now we have a booth at the iREX International Robot Exhibition in Tokyo, where I will present the main results of all EU programmes developing robotic surgery technologies to the visitors. Thus, we have been able to involve in our activities even researchers who did not participate in the EUROSURGE project and we have established very good relations with all of them.

In the future, we certainly hope that the workshop, the SurgiPedia website and patent



© Dr Paolo Fiorini

Dr Paolo Fiorini

search engine, the software design and implementation approaches, as well as the validation methods will continue to be developed by the project partners — even after the end of the project. We all hope that we will be able to get another project funded by the EU and therefore keep this initiative alive.

What are the next topics for your research?

My other active project in the field is about automation in robotic surgery. The name of this project is I-SUR⁵. We are developing technologies for the automatic execution of simple surgical actions, such as puncturing, cutting and suturing. In this case, too, we have just scratched the surface of the problem and next year we will try to get funds to continue the research. Another project recently ended, SAFROS⁶, pointed out the need for better training in robotic surgery. Therefore, we started a new company to commercialise the training software XRON (<http://metropolis.scienze.univr.it/xron>) which can help reduce the risk of accidents during robot-assisted interventions. Finally, the most difficult goal is to continue developing the surgical robot, since there is a great need for new products, but there are no new offerings on the market.

The project is coordinated by the University of Verona in Italy.

- 1 'European robotic surgery'.
- 2 'Robot operating system'.
- 3 'Open robot control software'.
- 4 'Accurate robot assistant'.
- 5 'Intelligent surgical robotics'.
- 6 'Patient safety in robotic surgery'.

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

BIOLOGY AND MEDICINE

Simultaneously diagnosing and treating cancer

Cancer is the leading cause of death in Europe, surpassed only by cardiovascular disease. Scientists have developed novel technology that could yield a one-step diagnosis and treatment for cancer.

Aside from the impact on patients, cancer places a heavy burden on carers and health-care systems worldwide. As the population ages and diagnostics improve, the recorded incidence is expected to continue increasing.

Development of targeted therapies is a critical yet challenging task. Many agents successful *in vitro* have limited efficacy *in vivo* due to the inability to reach the treatment site (targeted location). Increasing the dose in an effort to compensate often leads to side effects and other complications.

NANOTHER¹, an EU-funded project, addressed this issue by using functionalised nanoparticles (NPs) for diagnosis, therapy or both.

The NPs incorporated targeting molecules (such as antibodies), contrast agents or fluorescent labels and drugs in current use. This enabled the binding of NPs to cancerous cells for detection and imaging of tumours followed by the release of pharmacological agents at the site. Throughout the project, a comprehensive effort was focused on determining NP efficiency and toxicology.

The scope of the project in terms of the types of cancer addressed and the drugs used was quite broad. Continued research is needed to fully evaluate efficacy of the various combinations *in vivo* and preclinical trials are currently under way. Nevertheless, NANOTHER has made a significant



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contribution to the transformation of EU medicine and related industries from resource-intensive to knowledge-intensive.

Partners have delivered technology and scientific data valuable in their own right that will positively impact EU competitiveness in numerous related fields. These could also be of critical importance in the detection, diagnosis and effective treatment of cancer. Outcomes are thus expected to benefit the health of EU citizens as well as the economy.

The project was coordinated by GAIKER in Spain.

- 1 'Integration of novel nanoparticle based technology for therapeutics and diagnosis of different types of cancer'.

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/11505_en.html
 Project website: <http://www.nanother.eu/>

Understanding cell-wall regeneration in bacteria

Bacteria lacking a cell-wall, also known as L-form bacteria, are believed to play an instrumental role in relapsing or chronic infections. European scientists wanted to understand how these bacteria regain their ability to synthesise a cell wall and how this regeneration is linked to an infectious condition.

The cell wall structure forms the outermost layer of some bacteria, algae and fungi, but is missing from animal cells. The absence of the cell wall from L-form bacteria makes them highly abnormal in size and shape, sensitive to osmotic shock but highly resistant to antibiotics that work on the cell wall.

At a certain stage, L-form cells revert to the walled state and disease resumes in patients with persistent or recurrent infections. Thus, it is hypothesised that blocking regeneration may be one way to tackle these infections. However, our knowledge concerning the mechanisms that are implicated in this reversion is limited.

The EU-funded REGENERATE¹ project aimed to provide insight into the biology of L-form bacteria by focusing on their ability to revert to their cell-walled state. Given the difficulty in generating and propagating L-forms, scientists used advanced genetic methods and mutant strains previously developed in the host lab. These tools enabled them to reproduce L-forms from laboratory strains of *Bacillus subtilis*.

Proteoglycan (PG), the main constituent protein of the cell wall, is believed to require a primer for its synthesis, thus bacteria completely devoid of PG propagated for a period of time would be unable to regain their original shape. To



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test this hypothesis, REGENERATE scientists shut down PG synthesis in L-form bacteria and propagated it for many generations of the microbes' reproductive cycle. Then, by turning these genes on again, they observed that L-form cells could resume PG synthesis and revert to the cell-walled state, thus disproving the priming theory.

A better understanding of the cell-wall regeneration process should provide important insight into the possible role of L-forms as causative agents of chronic infections. Through a delineation of the

mechanisms implicated in the transition of L-bacteria to the walled state it will be possible to design novel anti-bacterial therapies to tackle such infections.

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

- 1 'Molecular biology of cell-wall regeneration in L-form bacteria'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12022_en.html

Rapid, early diagnosis of multiple diseases

Scientists have developed a novel platform for high-throughput screening for numerous biomarkers of multiple diseases. Capable of analysing a biological sample directly, it is generating intense commercial interest.

In the search for disease biomarkers, a range of separation and sorting protocols exist to identify components of cells or fluids. Many of these depend on tagging or labelling the molecule of interest, and the entire process from protein expression to tagging

to purification and recovery can be time consuming, costly and laborious.

Scientists initiated the EU-funded project ASSAY FOR BIOMARKERS¹ to develop a novel tag-less diagnostic technology. The assay is

capable of capturing the biomarkers directly from the analyte solution and separating and detecting biomarkers of interest all in one step.

The technology exploits nanoparticles (NPs) with paramagnetic or optical properties functionalised with aptamers (small, single-stranded target-binding nucleic acid molecules) or antibodies and combined with novel nanopore technology. The NPs bind to the biomarkers of interest within the analyte itself. Given the use of both aptamers and antibodies, the system can screen numerous biomarkers of interest with a large range of molecular weights and functionalities. The tuneable nanopore technology based on multicomponent metallic nanorods

enables biomolecular separation and analysis.

ASSAY FOR BIOMARKERS delivered a novel, one-step process for high-throughput screening of multiple disease biomarkers directly from biological samples. The work, which resulted in 22 publications and three patent applications with promising commercial interest, is expected to have significant impact on the early diagnosis and treatment of disease with greatly improved patient outcomes.

The project was coordinated by University College Dublin in Ireland.



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1 'Magnetic nanoparticles for multiplexed assays for low and high molecular weight biomarkers'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11948_en.html

Helping to unravel the mysteries of the genome

Genetics is an area of scientific research that is opening up a world of new possibilities. For example, genotyping — the process of determining differences in genetic make-up by examining DNA sequences — could lead to new treatments for hereditary diseases. Investment in the Estonian genome project at Tartu University should place Estonia at the cutting edge of this research.

Refurbishment of the Estonian Genome Centre at Tartu University (EGCUT) has been carried out via OPENGENE¹, a project funded by the FP7 Research Potential programme. Three major objectives were identified initially: the purchase of a new genotyping system to increase EGCUT's research potential and competitiveness; the recruitment of experienced researchers from abroad and organisation of international workshops; and increasing the visibility of EGCUT within Estonia and Europe.

Prioritising know-how

'One of the main aims of the project was to facilitate the exchange of know-how and researchers between EGCUT and

the wider European academic community,' explains project coordinator Prof. Andres Metspalu of the University of Tartu. For example, a visit to the University of Helsinki (Finland) proved crucial in providing help in bioinformatics, at a time when EGCUT was having difficulty analysing whole genomes. Similarly, a visit to the KORA bio-bank in Munich (Germany) was important in helping to harmonise the Estonian bio-bank design for the follow-up study.

'The success of these visits (and many more!) can be seen in the fact that since then there have been twice as many top-level scientific publications and ten times more EU joint grant applications

compared to the project plan,' says Metspalu.

In addition, special workshops on genetics and ethics have helped to increase the centre's visibility and consolidated scientific expertise by attracting outstanding speakers, researchers and scientists from abroad. Estonian scientists have also been able to visit leading European laboratories to learn about new technologies and to work on cutting-edge scientific problems. 'All these visits are investments in our future success,' explains Metspalu. 'Knowledge and networking, these are prerequisites for participating in European programmes.'

A global presence

Indeed, OPENGENE has already transformed Tartu University's ability to push the boundaries of genome research. 'We have been able to attract several excellent scientists back to Estonia because we can now offer competitive salaries and a very good research environment — a large bio-bank and the best genotyping technology,' acknowledges Metspalu. 'As a result, we have published about 15 papers in *Nature* and *Nature Genetics*, and over 50 papers in other journals since 2010.'

EGCUT has also been invited to participate in many FP7 projects, and has even established close collaboration with the



BIOLOGY AND MEDICINE

Harvard Medical School and the Broad Institute, one of the leading human genomics institutes in the world.

'Our researchers have presented their research results at many international scientific conferences in Europe and elsewhere. For example, Krista Fischer gave an overview of our findings at a recent conference in Montpellier (France), Tõnu Esko presented new data at the European Society of Human Genetics conference in Gothenburg, while Liis Leitsalu gave a presentation at an American Society of Human Genetics meeting in Montreal (Canada).' EGCUT's presence at such conferences has helped to enhance the list of potential partners and collaborators.

Long-term benefits

EGCUT has become an internationally competitive and

recognised research institute, and is looking to consolidate its position as a centre of excellence. By the end of April 2012, a new laboratory building will have been completed, allowing the facility to carry out even more experiments.

'Basic research into human genetics and genomics and functional analysis of the complex mechanisms of the translation of genetic information will be the main topics in coming years,' says Metspalu. 'In addition to human diseases, we will work on other traits, like behaviour and cognition, circadian rhythms and physical fitness. We are always open to new directions and our researchers can follow their own scientific instincts in order to fully use their creativity, energy and knowledge. 'In short, thanks to OPENGENE, we have finally



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made a breakthrough in human genomics research, and are regarded as one of the genome centres with three essential components: over 51 000 patient samples with medical records, top genomic technology, and analytical expertise in bioinformatics and statistics.'

The project was coordinated by the University of Tartu in Estonia.

- 1 'Opening Estonian genome project for European research area'.

Funded under the FP7 specific programme 'Capacities' under the research theme 'Stimulating the realisation of the full research potential of the enlarged European Union Community' (Regional potential).

<http://ec.europa.eu/research/infocentre>search>31213>

Project website: <http://www.geenivaramu.ee/opengene/about-the-project.html>

Inhibiting microRNAs for targeted drug therapy

Regulators of gene transcription and protein expression have immense potential in targeted drug therapy applications. Scientists have developed potent inhibitors of a molecule in one class of regulators that plays a role in numerous disease processes.

The cellular pathways and chain of events from gene to protein are complicated. However, one family of short RNA molecules, called microRNAs, is implicated in the disease process for diabetes, neurological disorders and cancer. MicroRNAs regulate gene expression post-transcriptionally — after transcription where the genetic code is passed from a

DNA template to messenger RNA (mRNA). They effectively silence gene expression by preventing translation of the mRNA template into the sequence codes required for protein production.

Chemically engineered molecules have been shown to inhibit microRNAs but do not have the appropriate pharmacokinetic

properties for targeted therapy. With EU funding for the MICRORNA FBDD¹ project, scientists investigated a specialised family of RNA-binding proteins (Argonaute) that mediate the microRNA silencing processes.

Recent evidence has demonstrated that the Argonaute 2 protein regulates microRNA. Argonaute 2 binds to the microRNA's 'seed region', facilitating binding of the complex to mRNA to block translation and silence gene expression. Scientists developed novel microRNA-specific Argonaute 2-inhibitors that bind first to the microRNA seed region and then to the active site of the Argonaute 2 protein. This active site binding for protein-inhibition technique opens up novel avenues for development of targeted drug therapy that was not possible with engineered inhibitor molecules.

Using their model for rational drug design, the researchers synthesised inhibitors targeting microRNA-122, which plays a role in hepatitis C infection. The

inhibitors were very effective at preventing binding of the natural ligand at low concentration. The search is now on for highly specific inhibitors for therapeutic use.

MICRORNA FBDD developed a novel family of microRNA inhibitors that are much more effective and possess the appropriate pharmacokinetics for targeted drug therapy. The techniques for rational design will facilitate the rapid development of microRNA-inhibiting drugs for treating several diseases to benefit the EU economy and its citizens.

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

- 1 'Towards microRNA modulators by fragment-based drug-discovery (FBDD) approaches'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcv12021_en.html



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Early-life behaviour affects late-onset dementia

With an increasing elderly population worldwide, the incidence and prevalence of dementia is on the rise. An EU-funded project has contributed to research in this area by determining biomarkers for early detection and prediction as well as for monitoring when the disease is already present and treatment is necessary.

TAR-DNA-binding-protein-43 (TDP-43) is a protein-aggregating biomarker of dementia first implicated in the biology of the disease in 2006. However, its relevance to the population remained unknown. The STPRD¹ project was set up to assess the significance of TDP-43 in relation to dementia, in a population-based sample of elderly people.

Making use of the European Clinicopathological Studies in Europe (Eclipse) database as well as project-generated neuropathological data, STPRD investigated behavioural and biological correlates of a diagnosis of clinical dementia in late life, and factors that affect disease progression. Findings on the significance of TDP-43 pathology for dementia in late life, along with associated

symptomatology and neuropathology, are under review by various scientific journals.

Among other results and findings, the study emphasised that although dementia only manifests later on in life, health and behaviour over an individual's entire life course affect its onset and progression. For example, those enjoying more early-life education are at lower risk of dementia in late life, as they are better able to cope cognitively with the presence of neuropathological problems. STPRD research also indicated that the underlying neuropathology of late-life dementia is more complex than originally thought.

Another project finding pointed to some sleep characteristics — for example, napping and excessive day-time sleepiness



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— being predictive of cognitive decline in late life over a 10-year period.

Project findings will enhance our understanding of the pathological basis of late-life dementia and have important implications for the diagnosis, management and treatment of related syndromes. They will also contribute to lessening the socio-economic burdens associated with the disease.

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

1 'Significance of TDP-43 in the population in relation to dementia'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn12049_en.html



Stronger and longer-lasting tuberculosis vaccines

Perceived by the general public as a disease that has largely been tamed, tuberculosis kills about 1.5 million people worldwide each year — including an average of one person every seven hours in Europe. Faced with 9 million new infections annually, and mutating strains of the tuberculosis bacteria that confound the medical community, a high-profile European Union research project is working to coordinate the development of stronger, longer-lasting vaccines.



The EU-funded NEWTBVAC¹ project has helped advance 7 of the 14 tuberculosis (TB) vaccine candidates currently in clinical trials. Another 36 vaccine candidates are in the discovery phase or preclinical development. These advances bring hope to countries such as China, India, Indonesia and South Africa, where up to four people per 1000 have the airborne disease.

The NEWTBVAC project is coordinated by the Tuberculosis Vaccine

Initiative (TBVI) in the Netherlands. Part foundation and part network, TBVI is a non-profit organisation — set up at the suggestion of the European Commission — that is working to facilitate the development of new TB vaccines that are accessible and affordable for all people.

Why are new vaccines needed? 'Because the type of vaccine that is most commonly used today (BCG) was developed nearly a century ago, and provides only limited protection,' explains TBVI Executive Director Jelle Thole. The result is that TB is making a devastating comeback.

'By 1993, it was very clear that tuberculosis was not



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under control. The World Health Organization (WHO) declared a global emergency,' continues Thole. That year, in fact, more people died from the disease than any previous year in history, according to the WHO.

'About half a million people are infected with a drug-resistant strain of the bacteria,' Thole says. 'We need better drugs to help these people. We need better diagnostics to diagnose the disease quicker and more accurately. And, above all, we need new vaccines to protect people from getting TB, including drug-resistant TB,' Thole concludes.

About 2 billion people are infected with the Mtb bacterium, some 10% of whom will develop the disease.

'In addition to the loss of life, there is a huge economic cost of the disease,' says Thole. Some patients require medical treatment — both pills and injections — for up to two years, which can cripple a family's productivity.

Primarily composed of European partners, TBVI financially supports and provides expertise to an integrated network of universities, institutes and companies. Many promising discoveries have been made already, and the

organisation's track record illustrates that these urgently needed vaccines can in fact be developed.

'Ten years ago there were no vaccines being tested in clinical trials,' according to Thole. 'Now, there are 14.' Successful clinical trials could mean that new vaccines may be available by 2025, he says.

Importantly, Thole stresses, the organisation works with expert teams with backgrounds in private industry, which helps convert breakthroughs into vaccines more efficiently. 'This "product thinking" has really helped along a number of vaccines,' he says, 'by making

better decisions about whether and when to bring potential vaccines forward.'

The project was coordinated by Stichting Tuberculosis Vaccine Initiative in the Netherlands.

1 'Discovery and preclinical development of new generation tuberculosis vaccines'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Health'.
http://ec.europa.eu/research/info/centre_search/31193
 Project website: <http://www.tbvi.eu/projects/newtbvac.html>

Disrupting human odour detection in mosquitoes

Malaria, spread by female anopheline mosquitoes, causes around 1 million deaths every year. Treatments such as insecticides and insecticide-treated bed nets have proved ineffective as well as being toxic and ecologically unfriendly.

The multinational, multi-disciplinary ENAROMATIC¹ project funded by the EU has developed control products to prevent the spread of malaria by disrupting human odour sensing in insects. Natural and synthetic compounds that act on odorant-binding proteins (OBPs) and odorant receptors (ORs) in mosquitoes were isolated using modelling and rational design.

Several milestones were achieved during the project. Twelve OBPs and 11 ORs predominantly found in female olfactory sensilla were cloned and expressed in bacteria and lepidopteran insect cells.

Insect cell-based high-throughput screening (HTS) assays proved particularly useful in rapidly screening compounds for OR-specific ligands and elucidating ligand-dependent olfactory receptor function and behaviour modifiers. These assays are robust, information-rich, user-friendly and reliable for pharmacological characterisation of mosquito receptors, as well as testing ligand-matched OBP-OR pairs.

Whole mount fluorescence *in situ* hybridisation (WM-FISH), confocal laser-scanning microscopy and immuno-histochemistry

helped elucidate the distribution of OBPs and ORs in mosquito antenna sensilla. High titre antisera, mRNAs and OR/OBP-specific riboprobes were generated. Immunolocalisation studies demonstrated the role of OBP-OR pairs in odour detection based on sensillum type.

Gas chromatography-coupled electroantennograms (GC-EAGs) combined with a warm body repellent assay for *Anopheles gambiae* females was used to test 82 extracts from various aromatic plants. Twenty-one tested oils (extracts) demonstrated strong reduction in mosquito landings on a warm body. Five strongly repellent extracts were structurally analysed using GC mass spectrometry to understand behaviour-modifying constituents and derivatives.

X-ray crystallography of 10 promising OBPs demonstrated variation in binding cavities and other properties that are responsible for differences in OBPs and their binding specificity. Computational models were also built to study protein-ligand interactions in OBPs of interest; results were validated using site-specific mutagenesis. The studies should optimise compounds for effective alteration of human odour detection.

Mammalian neuronal network microelectrode array (MEA)

neurochips assessed the cytotoxicity and neurotoxicity of the selected repellent compounds in comparison to widely used DEET and EBAAP. Tests revealed no toxicity with intended dosages for external application and adverse effects only in the case of ingestion.

Model huts and field conditions in Nigeria were used to test female mosquito (anophelines and culicines) behaviour on exposure to odour-disrupting repellent compounds. Researchers avoided human or animal contact with mosquitoes by using mosquito traps. The set-up proved ideal for studying mosquito behaviour and testing new control tools.

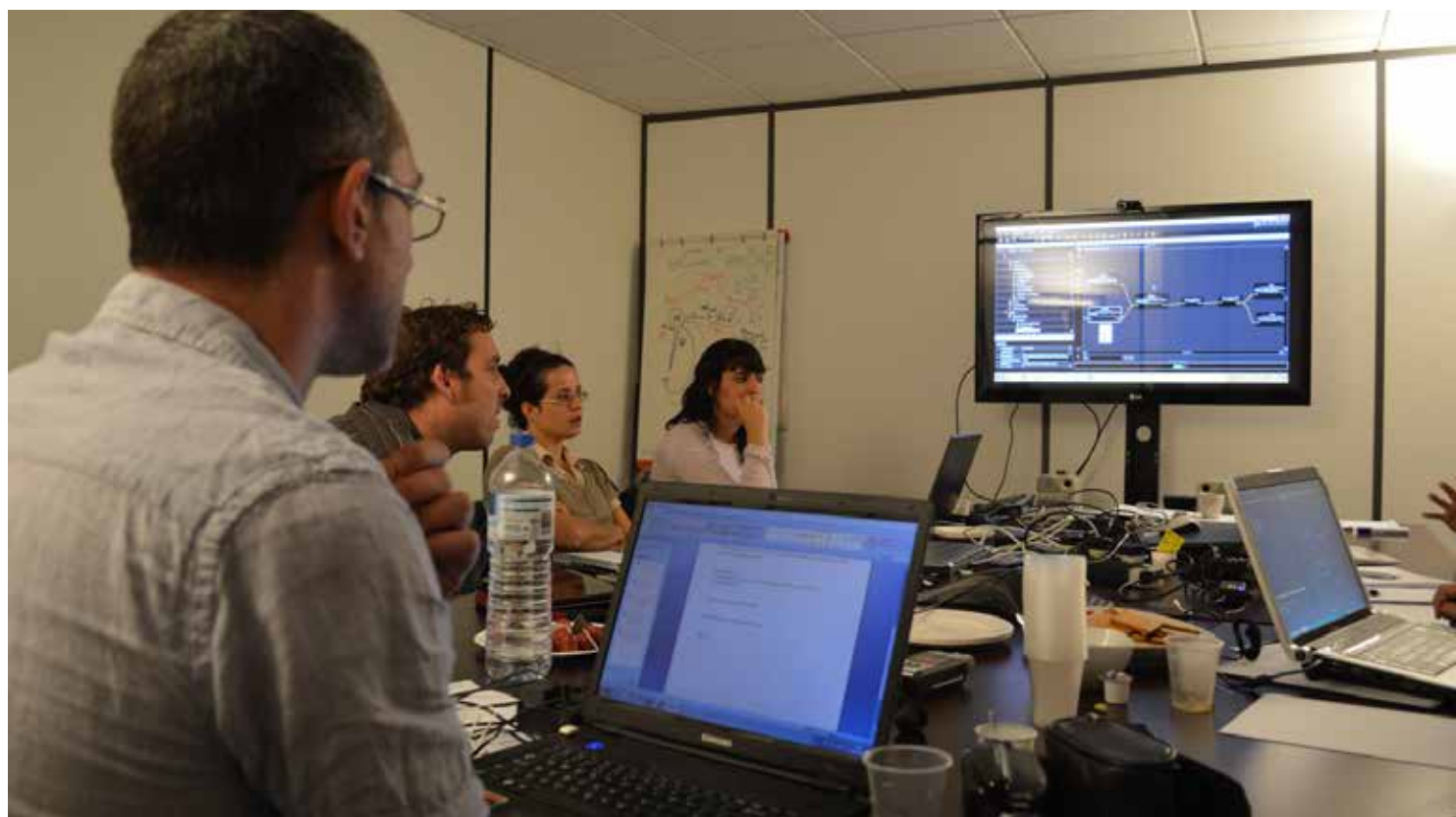
ENAROMATIC researchers have successfully demonstrated the feasibility of olfaction-based modification of mosquito behaviour in reducing malaria transmission.

The project was coordinated by the National Centre for Scientific Research "Demokritos" in Greece.

1 'European network for advanced research on olfaction for malaria transmitting insect control'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Health'.
http://cordis.europa.eu/result/brief/rcn6056_en.html





© CHES project

Personalised, dynamic stories for engaging museum visits

Stories are an integral part of our lives. From bedside tales for children to a good book, film or a chat with friends, stories help define our social activities, culture and history. EU-funded researchers are exploiting the power of good storytelling to engage museum visitors, helping people delve deeper and gain a clearer understanding of everything from history to science.

There are around 55 000 museums in the world. Some are small and quirky, covering obscure and offbeat topics of interest to a select number of people. Others comprise vast repositories of historical heritage — many deemed to be among the most important cultural institutions in the world — including the heritage of the Industrial Revolution or more recent science, technology and space exploration. But in the modern digital era, all of them face a similar challenge: how to attract visitors, engage them and provide an experience not available elsewhere.

‘Previously, museums were gatekeepers of the past and potential sites for tourists’ visits, but now museums are actual enterprises, with the same challenges SMEs face: sales, profitability and adequate resources. Today, museums have to remain attractive, and to attract people not only during vacation periods but also all year long. They have to demonstrate their value and relevance in contemporary life,’ explains Martine Julien,

the head of the RTD Department, Simulation and Virtual Reality Division, at DIGINEXT in France. She says people can find dynamic, digital, multimedia and interactive activities all around them, whether outdoors or at home, so museums and cultural institutions have to reinvent their offer, becoming digital themselves. With high maintenance costs to support, gaining revenue can be a matter of survival for many museums.

Museum websites offering visitors digital audio guides or installing interactive displays for exhibitions help, but they do not go far enough towards offering the immersive, highly interactive and, above all, personalised experiences museum visitors, especially younger people, are seeking now.

One solution, now being validated in trials at the Cité de l’Espace museum in Toulouse, France, and at the Acropolis Museum in Athens, Greece, focuses on providing precisely that personalised, unique and immersive experience. By giving each visitor their own

narrative to follow, via a tablet computer, it offers a personalised story linking museum artefacts and information — exhibits and external resources that take into account each visitor’s interests and preferences.

‘We decided to research and develop a solution centred on the visitors themselves, using digital tools to create unique experiences for each person. Even coming several times to a museum, a visitor can live a new experience during each visit; then they can report their experiences to family and friends, as none of them will live the same experience,’ says Ms Julien, who oversaw development of the solution as coordinator of the CHES¹ project, a three-year initiative supported by more than EUR 2.8 million in funding from the European Commission.

Unlike a human museum guide who will usually tell a generic story to different groups of visitors, in the CHES experience each visitor is told a dedicated story, focused on the exhibits most relevant to their interests ➤

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and mood, with many or few details, and reactive to their own behaviour and actions in the story. According to the stories written and personas chosen by the museum, the visitor can be told a more or less innovative story, ranging from a more traditional one enhanced with multimedia, 3D and 'augmented reality' to a story where objects talk and invite visitors to interact with them.

'One of the most innovative aspects of our approach is to consider that the people best placed to know the museum exhibits, as well as the profile of museum visitors, are people from the museum itself. Instead of subcontracting the creation of digital applications, the museum teams should be able to produce stories and digital applications by themselves. The solution proposed is thus first visitor-centred then museum-centred,' the CHESS coordinator says.

Visitor-centric, then museum-centric

To achieve that, the CHESS team developed several innovative tools and applications.

First, the 'CHESS visitor survey' (CVS) identifies the characteristics and interests of the visitor. The tool allows museums to create surveys with single- or multiple-choice questions in a variety of presentation formats and to link answers with a persona, i.e. a character representative of the visitor's profile. The storytelling will be adapted first to the persona, then to the visitor's behaviour.

The 'CHESS authoring tool' (CAT) is designed to allow non-IT professionals such as museum curators and staff to easily develop multi-path dynamic storylines integrated with multimedia content. The content itself is maintained by an 'asset manager' tool that provides easy access to different media elements and enables them to be adapted and reused for different stories.

Finally, the 'Storytelling engine' runs the story according to the paths defined in the CAT and adds the personalised and adaptive aspects of the storytelling, updating the visitor profile right through the course of the story according to their individual choices.

'At the end of a visit, the visitor will also find souvenirs from their own story on the museum website, where they will have an after-experience memory to look at and share with family and friends. For young people, stories can deliver specific memories to share, such as a journal customised with their name, featuring the results of a game they played or with photos they took, for example,' Ms Julien continues.

The personalised storytelling approach has been highly valued by visitors at the two trial sites. In the Cité de l'Espace museum, visitors have been invited to discover objects in ways they have never seen them before, including information about teamwork and life within the Mir space station, the interior of the Ariane rocket displayed using augmented reality, games about the solar system, and other interactive features.

At the Acropolis Museum, visitors have been able to discover the museum through animal stories, such as the representations of horses, snakes and owls that feature heavily in the Archaic Gallery and their connection with the Olympic Games, war and Greek mythology.

In light of the success of the trials and the positive feedback from visitors of all ages, and museum curators themselves, the CHESS team is looking to apply their system in more museums across Europe, initially targeting technical museums that focus on areas such as science and industry.

'The more ancient the objects exhibited are, the more difficult the introduction of the storytelling will be, as archaeological history is long, complicated and often still the subject of top-level research,' Ms Julien notes.

In addition, the two CHESS industrial partners have plans to commercialise technology developed in the project. DIGINEXT is looking to develop a commercial version of the CAT tool as a scenario editor and mobile publication system to be distributed with a licence-based business model, including support, training and services. Real Fusio, meanwhile, plans to distribute its patented algorithms dedicated to the optimisation of 3D displays, while their Asset Manager may be commercialised under a licence-based scheme.

'The CHESS experience was designed as an individual one; the next step would be to offer visitors a shared version with linked digital devices enabling a common experience for families and groups,' Ms Julien says. 'It is the challenge DIGINEXT and its partners will face in the MAGELLAN² FP7 project that will begin soon.'

The project was coordinated by DIGINEXT in France.

- 1 'Cultural-heritage experiences through socio-personal interactions and storytelling'.
- 2 'Multimodal authoring and gaming environment for location-based collaborative adventures'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
http://cordis.europa.eu/result/brief/rcn/12054_en.html
 Project website: <http://www.chessexperience.eu/>



Making European industry more competitive

A global outlook is crucial to making European industry more competitive. This could be achieved through improved policies that encourage firms to become more competitive and reach international markets.

If European industry does not penetrate foreign markets effectively in the global arena, trade opportunities could be lost in the face of tough external competition. The EU-funded project EFIGE¹ studied different aspects of European firms in an effort to overcome this challenge.

While examining the internationalisation of these companies and related policies, the project studied factors such as size, productivity, type of ownership, employment and innovation.

To achieve its aims, EFIGE combined the latest theoretical and



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empirical research through a cross-country survey. The project also produced seven country reports covering Germany, Spain, France, Italy, Hungary, Austria and the United Kingdom. It identified the features within European firms helping them to successfully compete abroad, and focused on more successful countries in international trade.

One important aspect of the project involved examining companies' ability to compete in foreign markets, looking at their

reliance on local and global production networks, too. Other key aspects included a better understanding of the effect of the euro on European firms, how these companies have weathered the crisis, and identifying the barriers to steady growth.

In effect, the project produced a thorough assessment of the internationalisation patterns within European firms. In addition to the country reports and cross-country report identifying the triggers to competitiveness,

project results also included 62 working papers and four policy briefs.

The overall findings could have a profound effect on policy-making in Europe and on improving competitiveness. If new policies are developed, sound competitiveness will improve at the country level, while also spurring a positive socio-economic impact on a pan-European scale. European companies will then have a much better chance of becoming world leaders in their respective fields.

The project was coordinated by Bruegel in Belgium.

- 1 'European firms in a global economy: Internal policies for external competitiveness'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Socio-economic sciences and humanities' (SSH).
http://cordis.europa.eu/result/brief/rcn/11661_en.html
 Project website: <http://www.efige.org/>

The role of popular culture in regionalisation

An EU-funded project has explored the connection between the commodification of culture and the dynamics of regionalisation in east and south-east Asia. A study was made of the activities within the popular culture industries in the region over the last two decades.

The ASIANPOPCULTURES¹ project endeavoured to extend research beyond state-centric explanations of regionalisation and to develop a theoretically plausible explanation for how the commodification of culture

can affect regional development. Research focused on Chinese, Japanese and Korean popular cultures, investigating their emergence, activities, expansion to other markets in the region, interaction with

each other, and their relations with the state.

Taking a unique approach, ASIANPOPCULTURES provided a comprehensive account of the production and distribution networks which put cultural commodities into circulation. Popular culture products include and relate to regional collaboration in the production and marketing of movies, music, animation and television programmes — all of which are having a major impact on local cultural markets.

While most studies in the field have typically taken an interpretive approach (focusing on the content and images of particular cultural products), ASIANPOPCULTURES research takes a comparative perspective instead. The project works from a variety of primary sources (e.g. through research visits to major cities in the region) and is based on insights from within the Asian region as a whole.

The researchers carried out market surveys and interviews with personnel in local cultural industries, and used the collected data to analyse and evaluate cultural and media

markets. In addition, ties were established with local scholars who share similar research interests.

ASIANPOPCULTURES studied production and distribution mechanisms in an effort to provide a bigger picture of the dramatic changes which have taken place in regional cultural production and circulation. Project work represents the first major attempt to offer a comprehensive understanding of the production, circulation and acceptance of these cultural industries in the Asian market. By highlighting the role of popular culture in regionalisation, project outcomes present an alternative approach to better understanding how regions are being constructed and conceptualised.

The project was coordinated by the Hebrew University of Jerusalem in Israel.

- 1 'Popular culture and regionalisation in east and south-east Asia'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11861_en.html



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The demographic behaviour of immigrants

Research into the demographic behaviour of immigrants has provided fresh insight into Europe's growing diversity.

The EU-funded MIGFAM¹ project has furnished policy-makers with a new appreciation of the demographic dynamics of immigrants — a topic that has received little attention up until now.

Past research on Europe's foreign-born population has focused mainly on how the country of origin influences immigrants' life choices in the host country. MIGFAM, however, looked at the host country to see how it influences immigrants' demographic behaviour. By doing so, MIGFAM filled a large knowledge gap about immigrants' demographic behaviour.

Project members found that while immigrant couples have

a lower divorce risk than non-migrant couples, mixed couples (non-immigrants married to immigrants) have a much higher likelihood of divorce. According to project members, this may be due to the fact that mixed couples face more social discrimination in the host country and are usually forced to cope by themselves with little support from social networks.

Also of interest are the findings related to family planning patterns. One example is immigrants' fertility behaviour. The project team found that immigrants widely adapt to the local fertility behaviour of their host country. They tend to have fewer children in low-fertility countries,



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like Germany and Switzerland, and more children in Sweden and the Netherlands (countries with high fertility rates).

By studying immigrants' demographic behaviour, MIGFAM has generated new scientific and policy-oriented knowledge to better understand Europe's growing demographic and cultural heterogeneity.

The project was coordinated by the University of Rostock in Germany.

1 'International migrant families'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11868_en.html

Are international marriages more likely to fail?

Intermarriage is considered to be an indicator of the integration level of a society. New data has shed light on the marital stability of international couples in Europe and North America.

As microcosms of increasingly diverse societies that challenge people's idea of 'us and them', intermarriages are considered to be an indicator of integration, with a higher number of

mixed couples suggesting the existence of a higher social cohesion in a geographical area. But very little is known about the success rate of these mixed unions.

The EU-funded INTERMAR¹ project set out to build and test a theoretical model in which individual, cultural and environmental factors interact to predict the marital stability of international couples (i.e. unions in which partners are born in different countries).

Preliminary findings based on in-depth interviews with international couples and ex-couples in Canada suggest that cultural differences and social pressure may break up mixed unions. INTERMAR researchers expect the results of their final survey, which is being conducted in Canada, the United States, France and Spain, to confirm and expound on the preliminary findings.

INTERMAR's research goal is to understand why international couples are less likely to remain together compared to co-national

couples. They are also looking at how this phenomenon impacts society as a whole. For instance, as an indicator of integration between immigrants and natives, higher divorce rates among international couples compared to co-national couples may suggest a failure in such integration procedures.

Insights gained from INTERMAR research results can help EU policy enhance integration policy-making.

The project was coordinated by Malmö University in Sweden.

1 'Integration of international marriages: empirical evidence from Europe and North America'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11885_en.html



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Electronics for safe, efficient electric vehicles

For decades, futurists have been predicting that the use of electric vehicles (EVs) will overtake conventional vehicles, providing clean, green and cheap transport for all. Although increasing numbers of electric vehicles are being sold in Europe, the internal combustion engine still remains king of the road. EU-funded researchers are trying to change that, developing technology that promises to significantly improve the range and efficiency of EVs without compromising comfort or safety.

As battery and electric motor technology has advanced in recent years, manufacturers have started to produce more commercial electric vehicles, from buses to cars and bikes. But while sales are rising rapidly, there are still fewer than 100 000 purely electric vehicles on Europe's roads — compared to more than 250 million conventional vehicles, 90% of which are passenger cars.

Several factors are holding back the electric vehicle market, despite its promises of cheaper transport, less noise, reduced fuel imports and lower emissions of CO₂ and other pollutants.

'The most obvious barrier that explains the hesitation of consumers to choose an electric vehicle is the cost-performance ratio which, compared to conventional vehicles, is not very attractive,' says Dr Volker Scheuch,

a researcher at German automotive electronics group Intedis. 'One of the drawbacks on the performance side is the short range of electric vehicles due to battery technology, which is still at the beginning of its evolution, and vehicle concepts that still use ideas from times when the economical use of resources was not really a topic.'

Often, the design and many of the components of electric vehicles still borrow features from their conventional predecessors that may not be optimised for EV efficiency or safety. But simply optimising each component individually is not sufficient — the overall architecture and the interactions between components also need to be addressed if EVs are to meet their full potential.

Several new EV concept vehicles employ parallel motors — offering not only greater

manoeuvrability and performance compared to more conventional single-motor designs, but also increased energy efficiency. However, controlling two motors safely at the same time is a considerable challenge, requiring a novel system architecture and a range of electronic devices, from sensors to control units.

The issue is being tackled by a team of researchers working under the direction of Dr Scheuch in the EFUTURE¹ project, which received EUR 4 million in funding from the European Commission. Their goal is to prepare the next generation of electric vehicles by creating intelligent software that minimises energy needs while still being able to dynamically optimise decisions between safety and energy efficiency.



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'Today's vehicles have a very high level of operational safety which needs to be kept for the electric generation,' according to Dr Scheuch. 'New challenges arise when more than one motor driving the wheels comes into play. This is what we investigated in EFUTURE: which additional requirements are to be met for two parallel front motors and how can they be implemented into a system safety concept?'

Among other key innovations, the team implemented central decision units in such a way that motor controls are subject to redundancies in case of failures, based on the concept of 'functional safety' — which means that any component or system must include the safe management of any likely operator errors, hardware failures or environmental changes.

The team was thus able to demonstrate an electric prototype vehicle that is not only safe, but also more efficient. They have therefore achieved a potentially much longer range than most existing EVs, achieved 'virtually' through the use of software alone.

Increasing the range and attractiveness of EVs

'We have therefore demonstrated the feasibility of creating a "virtual range extender", which has no hardware associated with it, by using new driver-assistance functions, founded on a lean architecture, while keeping a superior level of operational safety,' Dr Scheuch explains.

Novel 'Advanced driver assistance systems' (ADASs) developed by the EFUTURE team include a green 'Autonomous cruise control'

system (Green ACC) that automatically adjusts vehicle speed, depending on traffic and road conditions, while improving efficiency, and an 'ECO mode' that coaches the driver to adopt driving habits that use less energy.

Less visible to drivers, but no less significant are other EFUTURE innovations such as an automatic vehicle observer sensor system to enhance safety, and a torque vectoring functionality that improves driving stability and comfort. Torque vectoring also extends the 'Anti-lock braking' (ABS) and 'Electronic stability control' (ESC) functions to normal driving, thereby extending the dynamic range of the vehicle.

'There are also functions not visible to the driver, such as the vehicle energy management system, and decision units that define trajectory and actuator control, which also contribute to the overall efficiency,' Dr Scheuch says.

The project manager explains that one of the biggest challenges the team had to overcome was adapting a first-generation electric vehicle to meet the project requirements — exemplifying the problem of the use of legacy components based on systems used in conventional cars.

'To convert our architecture concept into hardware we substituted the core components with new ones: the vehicle control unit, the battery control unit, the battery and motors. Furthermore, we added a complete system for ADAS functionality (cameras and radar), and implemented an entirely new set of control software for all components. In

short, we converted a very basic vehicle to a highly instrumented car full of innovative functions,' Dr Scheuch observes.

The prototype concepts and systems developed by the project partners, which includes the European Technical Centre of Tata Motors, are expected to find their way into future generation EVs.

'Many of the ideas of EFUTURE will be found in future products and services of the partners. The domain architecture of the vehicle controller, the algorithms, the green ADAS functions, safety concepts and many more will be part of new research projects or are already part of new hardware products for future vehicles,' the project manager says.

'The more innovative concepts for efficient driving exist, the higher the impact on the vehicle market in Europe, and EFUTURE is one part of it. Economically, we have shown a feasible way towards a higher EV range, thus enhancing consumers' acceptance of electrically driven cars — they will get more value for their money.'

The project was coordinated by Intedis in Germany.

1 'Safe and efficient electrical vehicle'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
http://cordis.europa.eu/result/brief/rcn/12055_en.html
 Project website: <http://www.efuture-eu.org/>

Developing a cheaper, alternative solar cell for Europe

With climate change threatening and worldwide CO₂ emission levels higher than ever, the need for renewable energy technologies is now critical. But for widespread market acceptance, these new technologies have to be cheap, suitable for mass production and easy to implement.



Ultimately, a balance has to be struck, minimising greenhouse emissions without harming future economic growth and quality of life.

The EU-funded project SCALENANO¹ aims to produce high-efficiency photovoltaic (PV) cells based on alternatives to standard silicon technologies. A PV cell or solar cell is an electrical device that converts the energy of light directly into electricity.

Professor Alejandro Perez-Rodriguez of the Catalonia Institute for Energy Research, SCALENANO's project coordinator, says the researchers are focusing on chemical processes that, unlike most industrial technologies, do not require complex and very expensive machinery and equipment.

'The development of thin-film-based technologies will allow high photovoltaic conversion efficiencies with a significant lowering of fabrication costs,' he says.

SCALENANO, says Professor Perez-Rodriguez, will apply innovative processes based on the

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electro-deposition of nanostructured precursors, as well as alternative processes with very high potential throughput and process rates. These include printing techniques with novel nanoparticle ink formulations and new cost-effective deposition techniques.

'To achieve our ambitious objectives, we are exploring new cell architecture concepts based on nanostructured zinc oxide layers,' he says. 'In addition, in order to improve process yield and reliability of the new manufacturing process, techniques are being developed for quality assessment and process monitoring. These are non-destructive techniques that have to be able to provide relevant information, if possible in real time, as we move forward with the fabrication of the solar cells and modules.'

Eighteen months into the 42-month project, Prof. Perez-Rodriguez says some interesting results have already been achieved. The

researchers have demonstrated the scalability of electro-deposition-based processes for the synthesis of very homogeneous large areas of thin-film chalcogenide absorbers. They have already produced medium-area solar modules with cell efficiency of up to 15.4%.

He adds: 'Meanwhile, we have also defined scalable routes for the synthesis of nanoparticles to be used in inks for solar-cell precursor fabrication using very fast and simple printing processes, similar to those used to print a newspaper.'

The researchers have also identified processes, including chemical-bath deposition and new 'electrostatically spray-assisted vapour deposition' (ESAVD) processes for the synthesis of 'transparent conductive oxide' (TCO) layers, an essential part of the solar cell.

SCALENANO's work could be an important step towards increasing the share of renewable energy

sources in the EU's energy mix, and help make solar cell manufacturers more competitive.

'We are talking about helping to develop a new energy production model, which constitutes a key challenge for the 21st century,' says the professor. 'Competitive PV technologies will allow average citizens to become energy producers, paving the way to self-production of electricity. This will definitely contribute to a more decentralised energy model where people play an active role.'

SCALENANO has received around EUR 7.5 million in EU funding and is scheduled to complete its work in July 2015.

The project is an active member of the EU PV Clusters, the European Clusters of projects on nanotechnology and photovoltaics, a unique and important initiative at the European level aimed at bringing together all the projects on

photovoltaics to discuss industrial strategies and highlight the leading role of nanotechnology.

SCALENANO hosted the Second Workshop and General Assembly of the EU PV Clusters (Barcelona, November 2013).

The project is coordinated by IREC in Spain.

- 1 'Development and scale-up of nanostructured based materials and processes for low cost high efficiency chalcogenide based photovoltaics'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Nanosciences, nanotechnologies, materials and new production technologies' (NMP).
http://cordis.europa.eu/news/rcn/36210_en.html
 Project website: <http://www.scalenano.eu/>

Advancing aerospace materials

Researchers have developed a simulation system to design advanced composite materials based on liquid resin infusion technologies. The innovations should increase performance and cut the costs of building the large structures required by the aerospace industry.

Materials used by the aerospace industry need to be extremely strong, light and durable. Manufacture of these materials currently uses pre-impregnated composite materials, tape-laying technologies and autoclave curing.

These techniques produce excellent mechanical stiffness, strength and fatigue resistance. However, they are also expensive and have limited shape ability, are complex to manufacture and have a short materials life.

'Liquid resin infusion' (LRI) technologies — with resin infused after all the dry textiles are preformed — overcome many of these limitations. But their use is limited, as LRI involves a high degree of trial and error.

An EU-funded research project, INFUCOMP¹, set out to solve this problem. The project team designed a simulation system for the manufacture of large aerospace structures using LRI.

After extensive testing of materials to determine their characteristics, the project developed appropriate simulation software, adapting existing solutions used in resin transfer moulding.

INFUCOMP achieved a significant extension of scalar computing capabilities in this area, allowing full three-dimensional infusion modelling of tens of millions of elements.

A key feature of the system is that it allows engineers to investigate trade-offs between costs



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and performance at an early stage.

The researchers validated their system in four industrial demonstrations, testing different infusion processes to ensure the validity of a range of applications. INFUCOMP results should lead directly to lower-cost manufacturing and more efficient aircraft for the aerospace industry, and should spur innovations in numerous other industrial sectors.

The project was coordinated by ESI in Germany.

- 1 'Simulation-based solutions for industrial manufacture of large infusion composite parts'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Transport'.
http://cordis.europa.eu/result/brief/rcn/11647_en.html

ENERGY AND TRANSPORT

Optimising waste-heat utilisation for refrigeration and electricity generation

Cogeneration of power and refrigeration increases energy efficiency by taking advantage of low-grade waste heat. Scientists have developed a novel improved two-stage cycle in a compact system for small-scale applications.

Scientists working on the EU-funded project ADSOR-RESOR CYCLE¹ have developed a novel adsorption-resorption cogeneration cycle with improved performance compared to conventional methods. The project team will investigate the adsorption-resorption refrigeration cycle, intensification of the heat transfer of the adsorbents, and construction of the power generation system.

Investigators constructed a test unit for the two-stage adsorption refrigeration cycle. It utilised two different salts: calcium chloride (CaCl_2) as the high-temperature salt (HTS) and barium chloride (BaCl_2) as the low-temperature salt (LTS). These

changes optimised the coefficient of performance (COP) showing an improvement two to five times better than conventional adsorption refrigeration techniques.

Researchers carried out heat and mass transfer tests, focusing on the consolidation of salts with expanded natural graphite (ENG) to intensify heat transfer. Thermal conductivity was quite low for pure salts. However, ammonium chloride (NH_4Cl) was the best choice for an LTS, CaCl_2 for a middle-temperature salt (MTS) and manganese(II) chloride for an HTS. When consolidated with ENG, the increase in thermal conductivity corresponded to ENG amounts. Optimal thermal



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conductivity was 10 times better than with the granular adsorbents.

Finally, experiments on the demonstrator cogeneration unit showed that the novel resorption cycle improved the energy efficiency of electricity generation by 40-60%. Furthermore, it increased the low COP of the refrigeration cycle to the power of 10.

ADSOR-RESOR CYCLE delivered a novel two-cycle system with enhanced energy efficiency for power production and increased refrigeration performance. Simplifying the system could further reduce costs, while the use

of consolidated solid adsorbents saves space. These advances are expected to have a big impact on small-scale applications.

The project was coordinated by the University of Newcastle in the United Kingdom

1 'A new type adsorption-resorption cycle for the combined power generation and refrigeration driven by low grade heat'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12044_en.html

Enhancing ship safety through better design

EU-funded researchers have enhanced probabilistic damage stability regulations for dry cargo and passenger ships, as outlined in the 2009 International Convention for the Safety of Life at Sea. Project work focused on formulation improvements for calculations of RoPax and the survival probability of mega cruise vessels.

Backed by EU funding, the GOALDS¹ project set a number of objectives aimed at enhancing the current approach to safety for passenger ships, particularly

mega cruise ships. The innovation in and rapid rate of shipbuilding are creating unprecedented challenges that call for a new paradigm: one that treats safety as

a design objective. The 'prescription' approach, whereby ships are understood to be safe based on their compliance with rules and constraints, has been discarded as

it does not ensure a reliable minimum level of required survivability and, as such, requires changes to be made.

A key GOALDS objective was the development of an integrated formulation for assessing the survivability of passenger ships that have been damaged. Project partners developed an accidents database, expanding the information currently available for analyses in other databases. Statistical analyses of the gathered data enabled team members to highlight shortcomings in existing formulations and to develop new ones.

The GOALDS team investigated, for the first time, the mechanism of flooding and subsequent loss



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of the vessel resulting from damage to a ship's bottom. One project conclusion was that damage caused by grounding should not constitute a significant threat to the survivability of a well-designed and properly operated passenger vessel, both in calm water and in waves.

In addition, they advanced new software for damage stability calculations based on their development of a new survival factor. The new formulation was

programmed and tested by end-users, with all parameters and criteria thoroughly discussed among the consortium members. This was done to achieve precise definitions regarding the practical use of the formulation.

Other project efforts advanced the establishment of a risk-based damage stability requirement and innovative ship concept designs based on this requirement. Project results were assessed for the

submission of relevant reports to the International Maritime Organization (IMO).

Developments and progress realised during the GOALDS project offer a basis for improving current damaged stability regulations, and should lead to higher safety levels for ship passengers. The outcomes of such EU-funded projects also enhance the visibility and importance of the Union in international maritime rule-making bodies such as the IMO.

The project was coordinated by the National Technical University of Athens in Greece.

1 'Goal-based damage stability'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Transport'.
http://cordis.europa.eu/result/brief/rcn/9944_en.html



Rail safety comes under closer inspection

The increasing popularity of train travel in Europe has put an extra strain on the rail infrastructure, leading to higher inspection and maintenance costs. An EU-backed project has developed a fast-track system that not only speeds up the inspection of rails but is safer and more reliable than its predecessors.

After a long period of decline, the European rail sector is now well on track to recovery. Not only have technological advances made travelling by train more comfortable and faster, but it is widely regarded as a cleaner, greener and more convenient alternative to road and air travel.

However, rail travel is becoming the victim of its own success, with infrastructures cracking under the strain of the extra traffic and loads. This has resulted in a greater need for inspections

and maintenance. Although these costs have risen, the industry's safety record has not improved significantly.

One major cause of catastrophic accidents is rail failure, which is likely to become a more significant factor as loads, speeds and traffic continue to increase. With financial support from the EU's Seventh Framework Programme (FP7), the INTERAIL¹ project has taken the ambitious goal of eliminating rail failure through an integrated high-speed system for

the fast and reliable inspection of rail tracks.

INTERAIL integrates in a single vehicle different advanced, state-of-the-art inspection techniques that can be used in a modular and data-integrated way to check on the safety and integrity of different rail components.

Once successfully rolled out, the INTERAIL system will ensure that rail inspection practices are on the fast track to improving the European rail industry's already high safety record. The project consortium estimates that their innovative system could reduce inspection times and associated costs by up to 75 %.

The project was coordinated by ISQ in Portugal.



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1 'Development of a novel integrated inspection system for the accurate evaluation of the structural integrity of rail tracks'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Transport'.
http://cordis.europa.eu/result/brief/rcn/12050_en.html
Project website:
<http://www.interailproject.eu/>

Towards more efficient bioethanol production

Production of bioethanol from forestry and agricultural residues is a promising and sustainable way to provide liquid fuel for the transport sector. Scientists are addressing important materials and processing issues for greater market uptake.

The EU is at the forefront of technology development and deployment in the use of lignocellulosic biomass for fuel production. The main barrier to widespread implementation concerns the high costs associated with using enzymes for the

conversion of sugars into ethanol from crops such as corn.

Scientists initiated the EU-funded project HYPE¹ to address this issue. They investigated process improvements and consolidations to reduce enzyme use and

energy consumption. Enzymes capable of higher yields of important pentoses (5-carbon sugars) and hexoses (6-carbon sugars) from the biomass as well as efficient hydrolysis and fermentation were sought. Straw, an important and widely available feedstock that does not compete with food production, was chosen as the case study.

Researchers developed a steam pre-treatment method that uses

only steam, produces few degradation by-products and provides a carbohydrate-mix well suited to the next hydrolysis step. Various techniques were used to screen and characterise enzymes suitable for liquefaction of viscous biomass (low water content, high biomass content). Although conventional dilute systems are not cost-effective, in the past they were necessary because of issues with processability, >

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enzyme inefficiency and build-up of degradation products.

The team then optimised the conditions for simultaneous saccharification and fermentation (SSF) to reduce enzyme use through appropriate operating

conditions as well as recovery and recycling. Finally, the project integrated SSF with product recovery through a novel distillation process based on mechanical vapour recompression (MVR). This technique significantly reduced energy

consumption and associated production costs.

A demonstration plant is currently implementing the integrated or consolidated process developed by HYPE with an expected increase in ethanol

yield of around 50 %. In the ultimate consolidated process, the same organism (producer of the enzymes) will hydrolyse the biomass and ferment the resulting sugars. Until then, the impressive increases in ethanol production expected by HYPE's upgrades should be more than enough to fuel a transportation transformation.

The project was coordinated by the University of Helsinki in Finland.

- 1 'High efficiency consolidated bioprocess technology for lignocellulose ethanol'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Energy'.
http://cordis.europa.eu/result/brief/rcn/10251_en.html

An aircraft sensor for atmospheric hazards

Researchers have developed a sensor for aircraft for the real-time detection of wind shear and wake vortex — two little-understood atmospheric hazards. The innovative system will improve passenger and crew safety as well as airport efficiency.



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Two major hazards for aircraft are wake vortex — powerful turbulence that follows behind an aircraft in motion through the air — and wind shear — rapid horizontal or vertical changes in wind speed. Both of these are major causes of accidents, especially at the critical phases of take-off and landing. However, little is understood about either and until now the main measures to reduce risks have involved mandatory spacing between aircraft, which reduces airport efficiency.

An EU-funded research project, GREEN-WAKE¹, designed innovative technologies to provide real-time detection of these atmospheric hazards and a new concept in three-dimensional (3D) visualisation for aerospace applications.

Researchers from industry and institutes in different European countries collaborated on the four-year project. They developed an on-board sensor for aircraft based on a light detection and ranging (Lidar) system, using remote sensing with reflected lasers and two ultra-lightweight mirrors.

GREEN-WAKE team members also developed an innovative system for the 3D visualisation of atmospheric hazards and carried out extensive testing in wind tunnels to refine their system in real-life conditions.

The project has enabled, for the first time, the real-time detection of atmospheric hazards at short range. This should enhance the safety of air travel for citizens as well as improve the efficiency of airports. In addition, there is potential for the technology to be exploited in other aeronautics and space applications.

The project was coordinated by Sula Systems in the United Kingdom.

- 1 'Demonstration of LIDAR based wake vortex detection system incorporating an atmospheric hazard map'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Transport'.
http://cordis.europa.eu/result/brief/rcn/11707_en.html
 Project website: <http://www.greenwake.org/>



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Weather and environmental forecasts tailored to you

Want to know what the weather will be like tomorrow? A simple internet search will provide a forecast or, more likely, many forecasts. And what if you also want to know the pollen count because you are allergic, or pollution levels because you worry about your child's asthma? EU-funded researchers are answering such questions with an innovative online platform providing easy access to comprehensive, accurate, localised and personalised environmental and meteorological information.

'Meteorological information is not only generated in abundance in Europe, but is also available on the web, to a major extent. In this sense, it is easy to access this information,' explains Professor Leo Wanner of the Catalan Institute of Research and Advanced Studies and Natural Language Processing Group at Pompeu Fabra University in Barcelona, Spain.

'However, the question of quality is unresolved for any user,' he continues. 'Thus, if one website forecasts the temperature to reach 30 °C the next day in Barcelona, another one 28 °C and the third 32 °C, two or all three of them must be wrong.'

But the accuracy of meteorological information on the web is not the only issue. For people concerned about more than just the

weather — atmospheric dust, chemicals and CO₂ emissions, for example, or the pollen count of the different flora varieties they may be allergic to — the challenge is even greater.

'Environmental information is more difficult to access. Public administrations might have access to it, in accordance with environmental legislation, but for businesses and citizens it is often a challenge to find the corresponding data for the geographical area of their interest,' Prof. Wanner says.

In other words, most web services follow a 'same information for all' philosophy, providing all the information that may be relevant to any user, but not for one person in particular. And some offer information only relevant to a default user, who is almost always

a healthy citizen. In the first case, the user is expected to be able and willing to browse through all the available information and decide which is relevant to them; in the second case, a user with specific needs will often not come across the information they are looking for.

Supported by almost EUR 2.8 million in funding from the European Commission, a consortium of universities and research institutes in five EU countries have risen to the challenge. Coordinated by Prof. Wanner, the team has developed Europe's most advanced intelligent personalised environmental and meteorological information service aimed at the needs of citizens, companies and public administrations.



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Developed over the course of three years in the PESCADO¹ project, the web-based system is designed to provide information specifically relevant to each individual user depending on their profile, preferences and location.

Meaningful data a click away

'The platform communicates with the users to get a clear idea of their needs and to understand how it can support them in their decision-making; it searches for relevant high-quality meteorological and environmental web sources, merging data from different sources. It interprets the data in the context of the needs of the user, selects the content that it considers important for the user, and generates a textual and graphical bulletin for the user in the language of preference,' Prof. Wanner explains.

In effect, the PESCADO platform generates a personalised weather and environmental report at the push of a button. To achieve this, the researchers combined cutting-edge technologies in domain-dependent search, uncertainty and confidence metrics, image content extraction techniques, fuzzy reasoning, and multimodal and multilingual information-generation techniques into a service-oriented architecture.

The backbone of the PESCADO system is a knowledge base that contains all information necessary for intelligent decision support related to environmental data, such as environmental background knowledge, data extracted from environmental services on the

web, and user profiles. Individual tasks, such as extracting data, assessing its quality and generating the bulletin for users, are carried out by one or more web-based services.

'In each of the tasks we addressed, a number of challenges had to be met,' the project coordinator explains. 'For instance, the extraction of content from image material such as weather maps has been a major challenge. The development of metrics for the assessment of the quality of the given data, and extrapolation of air-pollutant concentrations measured at a specific spot into the surrounding area and taking into account the morphology of the landscape was another. Reasoning over environmental data and user needs, as well as the development of a fast, high-quality multilingual text generator, were also big hurdles we had to overcome.'

In the case of environmental data in particular, there is also the issue of comprehension. 'For example, what does it mean that the ozone concentration reached 170 micrograms per cubic metre for me personally? Especially for people with health problems or allergies who are sensitive to elevated air pollution or elevated pollen concentrations, it is not clear how they should interpret the concentrations they find on the web,' Prof. Wanner notes.

With a clear user interface and personalised and localised output, the PESCADO system is valuable not only for helping individual citizens plan their daily activities, but also for

public administrations looking to keep pollution levels under control and companies trying to comply with environmental legislation.

'European legislation demands that Member States and regional governments comprehensively inform the citizens about local environmental conditions in terms they understand. PESCADO is an instrument that could greatly contribute to the implementation of this legislation,' Prof. Wanner points out.

The prototype system currently covers Finland and is available in the English, Finnish and Swedish.

Having elicited interest from different public administrations across Europe, Prof. Wanner says the team's goal now is to seek further funding to expand the area of geographical coverage, incorporate additional languages and add more domains such as water-quality data and traffic conditions.

The project was coordinated by the Pompeu Fabra University in Spain.

1 'Personalised environmental service configuration and delivery orchestration'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
http://cordis.europa.eu/result/brief/rcn/11853_en.html
 Project website: <http://www.pescado-project.eu/>

Biological control helps fight pests

Increased pest resistance and invasive species are both major challenges facing modern agriculture. An innovative EU-funded project addressed these using the natural enemies of arthropod crop pests to combat them in a process known as biological control.



The IPRABIO¹ project supported the integration of molecular characterisation techniques into seven biocontrol programmes. It strengthened links between researchers and used complementary morphological and genetic characterisation methodologies to identify pests and select the most suitable biocontrol agents.

Project partners used DNA, morphology and ecology to characterise pests and their natural enemies, resulting in a number of scientific publications and the identification of a new species

of mealy bug. Microsatellite genotyping was employed to investigate the origin and invasion pathways of the pests *Tuta absoluta* and *Pseudococcus viburni*, which were previously unclear.

Utilisation of molecular characterisation techniques had a direct impact on the implementation of several programmes, for example the two combating *Pseudococcus viburni* and *Planococcus ficus*. Here, two non-EU regions, Egypt and South America, were surveyed and shown to be infested by pest populations that showed significant genetic divergence from the population targeted in Europe; they could even be a different species.

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Project findings indicate the natural enemies collected from outside the EU may not be effective against the target population in Europe. Therefore, research was redirected to other areas where pest populations are genetically similar to those in Europe. In these programmes, the release of the biological agent was delayed to ensure safety and greater probability of success, which were the two main priorities of IPRABIO.

Quality control was carried out on the rearing of biological control agents and an investigation conducted into biotic and abiotic conditions affecting the

establishment of introduced populations of biocontrol agents.

Several international collaborations were initiated, including the COLBICS² project that linked IPRABIO partners with the commercial sector through the development of research and development programmes. IPRABIO also collaborated with research institutes from Chile to investigate factors affecting the success of the introduction of biological control agents.

A research proposal was submitted with the University of California into the effect of ants on the establishment

of parasitoids. In addition, IPRABIO supported the training of young researchers who have gone on to become key members in the collaborative projects, thanks to their contact with molecular ecology and entomology laboratories.

IPRABIO used molecular techniques not only to identify biological material but also for quality control in order to increase the success of biological control agents during their introduction, production and release. The work conducted by project partners will help European agriculture to become more sustainable and provide a viable

alternative for the control of agricultural pests.

The project is coordinated by INRA in France.

- 1 'Integrating new practices in programmes of biological control against agricultural pests'.
- 2 'Intersectoral collaborations to boost research and development dynamics in biological control of agricultural pests'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12012_en.html

Recycling technologies for nuclear waste

Minimising waste and maximising the use of natural resources are key components of the next generation of nuclear energy systems. EU-funded scientists have developed new technology to address these challenges.

As progress in nuclear energy fosters increasing public support of this clean and renewable alternative form of energy, significant attention is now being paid to the radioactive waste products from energy generation. One of the most promising technologies for reducing environmental impact involves separating radioactive species and converting them to safer forms. Partitioning and transmutation (P&T) products are less hazardous and some can even be reused in nuclear reactors, thus reducing the volume of waste as well.

The EU-funded project ACSEPT¹ investigated two means of separation: technically mature aqueous and state-of-the-art dry (pyrochemical) processes. By the end of the project, ACSEPT scientists had carried out hot-test demonstrations of four aqueous P&T processes designed for use with future Generation IV (Gen IV) nuclear energy systems. They were either modified versions of existing processes or ones specifically developed within the scope of ACSEPT. Flowsheets were made available for all



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four. In addition, ACSEPT continued work on two pyrochemical processes with a focus on selected key process steps, and demonstrated their viability as options for future recycling of radioactive waste.

Gen IV technologies, slated to hit the market in 2030, are focused on enhanced safety, minimisation of waste and

better use of natural resources. ACSEPT has made an important contribution to these objectives with its technologies and tests, and has also highlighted important future research directions for the nuclear industry.

The project was coordinated by the Atomic Energy and Alternative Energies Commission in France.

- 1 'Actinide recycling by separation and transmutation'.

Funded under the FP7 specific programme 'Euratom' under the research theme 'Nuclear Fission and Radiation Protection'.
http://cordis.europa.eu/result/brief/rcn/11379_en.html
 Project website:
<http://www.acsept.org>

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Modelling the future behaviour of oceans and atmosphere

Over the past century, the atmosphere and ocean have warmed, sea-ice extent has reduced and greenhouse gases have increased. How future changes will evolve and how humankind can protect itself from possible calamities depends on the implementation of effective political measures and scientific insight. These are major challenges that require international collaboration.

The EU-funded project COMBINE¹, which is now nearing completion, has contributed significantly to improved Earth system models.

'COMBINE's major contribution is in increasing our ability to project and predict climate change,' says project manager Elisa Manzini of the Max Planck Institute for Meteorology in Hamburg, Germany.

The project brought together leading European Earth system modelling researchers with the aim of achieving a better understanding of how atmosphere, land and oceans behave and interact.

Indeed, the project has been hugely successful, enabling the European climate community to participate in the international Coupled Model Intercomparison Project Phase 5 (CMIP5) of the World Climate Research Programme (WCRP).

COMBINE addressed the challenge of coupling nitrogen and carbon cycles in land and ocean ecosystems, which will help

scientists study ocean denitrification in response to a predicted decline in marine ecosystem productivity.

A particularly interesting aspect of the project focused on modelling the evolution of the Greenland ice sheet in response to CO₂ increases in comprehensive climate models.

Incorporating sea-ice observations in climate predictions is leading to more accurate simulations of the past and possible future of Arctic sea-ice evolution.

COMBINE also investigated the climate impact on water availability and agriculture, and has contributed to the assessment of vulnerability and adaptability of the Earth system.

Scientific results gleaned from the project have been disseminated among the international research community through peer-reviewed articles. Indeed, throughout the project, COMBINE's research goals have been consciously aligned to boost international research activities.



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As a result, the project's findings will support international climate research well into the future, including assessments carried out under the Intergovernmental Panel on Climate Change (IPCC).

COMBINE, which ran until October 2013, received EU funding of EUR 7.9 million.

The project was coordinated by the Max Planck Society in Germany.

- 1 'Comprehensive modelling of the Earth system for better climate prediction and projection'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Environment'.
http://cordis.europa.eu/news/rcn/36191_en.html
 Project website:
<http://www.combine-project.eu/>

Automated measurement of marine primary production

A recent EU-funded project developed automated tools to measure primary productivity in European seas.

Primary production forms the basis of all ecosystem processes. Key to the management of marine ecosystems is understanding how primary production responds to pressures such as environmental change.

The measurement of primary productivity is, however, not included in most routine programmes as current measuring

methodologies are not suitable. The PROTOOL¹ project aimed to address this issue by developing better methodologies and tools for future programmes.

Project partners developed three automated instruments: a fluorometer, the 'Point-source integrating-cavity absorption meter'(PSICAM), and a reflectance module. The instruments



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measure the photosynthetic activity and phytoplankton biomass, light absorption by various water constituents, and water colour to determine water quality.

An important step in the project was to test the developed instruments under realistic field conditions. Researchers carried out field tests in a variety of water types, including Dutch estuaries, the Baltic and North Seas, and the

Atlantic Ocean. The equipment proved to be highly functional and reliable.

Data generated during the field tests are stored in various databases. Researchers have used the data to evaluate conversion factors, which can be applied to instrument measurements in order to convert them to informative measurements for stakeholders.

PROTOOL results are expected to have major socio-economic impacts and the data generated are available to the international community for future studies. In addition, researchers are planning a related project, PROTOOL-2, to develop similar, smaller equipment for other platforms.

The project was coordinated by the Royal Netherlands Institute for Sea Research (NIOZ) in the Netherlands.

- 1 'Productivity tools: Automated tools to measure primary productivity in European seas'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Environment'.
http://cordis.europa.eu/result/brief/rcn/12078_en.html
 Project website:
<http://www.protocol-project.eu/>

New tool validated for better sonar seabed mapping

Sustainable management of marine resources, under pressure from climate change and human activities, requires the rapid and inexpensive collection of high-resolution seabed data. New research has looked into how well multi-beam sonars can be used to achieve this, using measurements of macrophytes (algae) from around the world.

All aquatic plants large enough to see with the naked eye, like seaweed, algae and kelp, are called macrophytes. They stabilise surrounding habitats, maintain biodiversity and are used in chemical, pharmaceutical and food industries. However, macrophytes are highly sensitive to environmental changes. In the Arctic, where climate change is the most readily visible, macrophytes are important indicators of habitat health and glacier melting.

Scientists use sonars to map macrophyte populations. The

EU-funded AIM-HI¹ project set out to investigate the performance of an emerging technology: multi-beam echo sounders (MBES). The tool analyses acoustic echoes from the seabed and any overlying vegetation, looking at wide expanses away from the survey vessel.

The advantage of MBES over older 'single-beam echo sounders' (SBES) is that larger portions of seabed can be surveyed at faster speeds. This is important in ecologically sensitive areas, and in remote and physically challenging regions. Researchers

wanted to determine the best way to process large MBES datasets, and assess the accuracy of results and the variations in different types of MBES tools. They used datasets from Arctic macrophytes in Kongsfjord (Svalbard) and temperate macrophytes from British Columbia and European shores along with still images and biological samples to answer their questions.

AIM-HI found that depending on the sonar used, up to 30 % of MBES measurements in the centre beams can be lost or affected by noise. However, this can

easily be corrected by averaging several measurements, taking advantage of the higher imaging rate of MBESs. Also, MBES can provide 'snippets' of the acoustic returns along the full water column, thereby enabling better characterisation of macrophyte cover and seabed substrates.

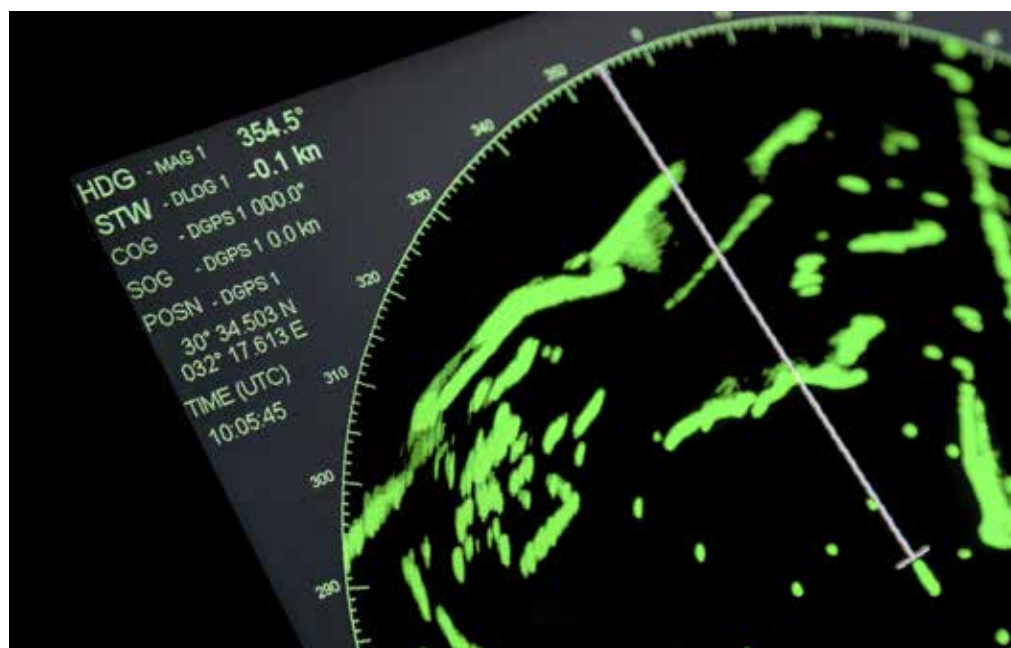
In terms of reliability, MBES can image further away than SBESs. There is however a 'dark zone' over an intermediate range of angles in which acoustic returns from macrophytes disappear.

This research identified a common processing methodology applicable to all depths or environments and adaptable to different sonar types. The results have already been shared with major sonar manufacturers. MBES technology should also prove useful to national marine institutes, environmental organisations and the macrophyte industry in general.

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

- 1 'Acoustic imaging of macrophytes and habitat investigation'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11899_en.html



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Measuring the impact of ocean noise on whales

New research on how to measure the impact of ocean noise on acoustically sensitive sea predators could help guide marine conservation efforts.

Noise from human activities in oceans — like marine shipping traffic, offshore oil and gas activities, and renewable energy generation — has drastically increased over the last few decades. The EU-funded CONCEAL¹ research project sought to quantify the impact of ocean noise on specific species using rigorous, repeatable and standardised methods.

Biologists, acousticians and statisticians worked together to gauge the consequences of a reduction in whale prey due to human-generated noise. They focused on fin, humpback and killer whales.

The team analysed captive feeding records and prey abundance, body condition and pregnancy rate data from

North Atlantic fin whales. They also developed advanced statistical models of whale populations in response to changes in prey availability due to human activities.

Major outcomes of the project included a partnership with Danish scientists to compare the acoustic behaviour of harbour porpoises in Danish

and Canadian waters. In addition, a research partnership with American, Australian and Canadian scientists was set up to develop methods for incorporating shipping noise into marine spatial planning processes.

Overall, the CONCEAL project has convinced major role players to define ocean noise as an anthropogenic stressor to marine mammals, and to consider its environmental impacts. From a scientific point of view, a number of research papers have been published and long-term collaborations established.

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

1 'Chronic ocean noise: Cetacean ecology and acoustic habitat loss'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11911_en.html



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African birds reveal climate change impacts

Most conservation research has focused on northern regions, although the greatest biodiversity is found in tropical ecosystems. Now, a recent EU-sponsored Marie-Curie actions programme has identified the mechanisms behind climate change impacts on bird species in Tanzania.

The SAVBIRD¹ project aimed to identify and understand the processes that drive changes to the geographical areas (ranges) that are home to species of east African savannah birds. The research investigated how recent changes in distribution of 139 Tanzanian savannah bird species were connected to climate change, protected area status and land degradation.

SAVBIRD used a statistical approach to develop and apply new methodologies for analysing the distribution of species and distribution changes, which can be applied to any region of the world. In addition, a field-based approach focused on understanding the specific mechanisms responsible for changing the range distribution of birds in Tanzania's savannahs.

Project work also found that recent studies have often underestimated the uncertainty in models estimating species distribution. SAVBIRD therefore identified and developed areas where the creation of new statistical tools could improve predictions from distribution models now and in future work.

Methods for data analysis — where no direct measure of

observer effort was available — were also investigated. Great care must be taken when modelling distributions as a lack of records could merely be because no one visited a particular area to search for species.

The SAVBIRD project developed a new technique for modelling distributions which, in tests using simulated data, proved to be a significant improvement

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on current methods. A paper describing these methods was drafted. Field research was based on observation data fed into the model and applied using the new methods so as

to better understand recent changes in the distribution of Tanzanian savannah birds.

The effect of climate change on protected areas is one of

the most important questions in conservation. SAVBIRD findings suggest that climate-driven shifts in species distribution leave protected areas impoverished and species without adequate protection. However, other results suggest that intact ecosystems within protected areas will be able to resist change.

The project also found the first evidence of climate-driven range shifts for an African bird community and showed furthermore that distribution changes are related to protected area status and the degree of land degradation. Importantly, the SAVBIRD project concluded that maintenance of protected areas is the best conservation response to climate and environmental change.

Project findings were widely shared with conservation managers and climate change policy-makers in Tanzania and beyond with the aim of protecting biodiversity from the effects of climate change.

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

- 1 'Climate change and birds in the African savannah'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11834_en.html

How the changing climate affects evolution

Biologists working on an EU-funded initiative have investigated how natural populations will evolve in the face of environmental threats resulting from climate change.

How quickly can natural populations respond to human-induced selection pressures? A major aspect of predicting how species evolve in response to external pressures is an understanding of genetic adaptation and the ability of an organism to change its phenotype (known as phenotypic plasticity) and the associated molecular changes. Phenotype can be defined as a composite of an organism's observable physical traits. Although phenotypic plasticity might play an important role in how a species evolves, evolution ultimately requires adaptive changes in gene frequencies.

The GEBACC¹ project tested the ability of wild populations to respond to anthropogenic environmental change. Frogs are particularly sensitive to environmental fluctuations. Therefore, the ecologically relevant trait of locomotion was studied in the wild-caught frog *Xenopus tropicalis*, a species commonly used

as a model organism in developmental biology and genetics.

Habitat destruction has caused a dramatic decline in frogs and other amphibians, particularly in tropical forests. Such changes are expected to favour those frogs that are able to move to suitable new habitats. GEBACC recreated this selection event in the laboratory by selectively breeding *X. tropicalis* over several generations for increased endurance under different temperature conditions. Genetic, epigenetic, physiological, biochemical and morphological changes in response to selection will be monitored.

The impact of selection will also be examined for another trait, immunity, given that natural populations always face a number of threats simultaneously and amphibians around the world are currently at risk from an infectious disease known as chytridiomycosis. This will



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enable scientists to determine to what extent the response to one selection pressure affects the response to another.

Due to initial difficulties with *X. tropicalis*, the model system was changed to the butterfly *Pieris brassicae*, which was phenotyped and bred for the endurance trait. The insects were examined for the association between expression patterns of associate genes and differences in phenotype, together with the heritability of endurance.

Project work has already given rise to four publications. GEBACC's highly integrative and multi-disciplinary approach is crucial to gaining clearer insight into the intricacies of molecular

and phenotypic responses of natural populations to environmental perturbations. The project will therefore help scientists predict how natural populations will adapt to climate change.

The project was coordinated by CNRS in France.

- 1 'Genetic and epigenetic basis of adaptation to climate change'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11928_en.html

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© ROBOEARTH

A new World Wide Web strictly for robots

To date, each robot constructed needs to be programmed, or go through its own learning process from scratch. New robots are like newborn babies who need the humans creating them to teach them everything, or learn gradually themselves. However, this could all change. Thanks to ROBOEARTH, robots will soon be able to share knowledge with their peers almost instantly instead of 'living in a bubble'.

Anyone who saw the box-office-topping movie *I, Robot* in 2004 will feel a little familiarity towards the concept behind the emerging field of 'cloud robotics'. Just like in the movie, it involves connecting existing robots to an alternative version of the World Wide Web so that they can all share information about new learnings or problems solved. However, unlike the sinister plot of the film, this field of science will be beneficial to the sector. The project is expected to result in less development time, with all robot knowledge remaining readily available instead of disappearing when the robot storing it becomes obsolete.

The ROBOEARTH¹ project is pioneering the field of cloud robotics. Started in 2009, the four-year project aimed to create a giant network and database repository where all robots could store and share information about their behaviour and their environment. Such data can include software components, maps for navigation, task knowledge such as action recipes and manipulation strategies, as well as object-recognition models. In a few words, its use in all robots could help the sector move away from situations where robots are not capable of understanding and coping with unpredictable environments to scenarios where each robot can easily find

its way around new problems by instantly accessing the knowledge of its peers.

In an exclusive interview with the *research*eu results magazine*, Dr Markus Waibel sheds light on the project's outcomes and their importance for the development of robotics.

What are the project's main objectives?

The goals of ROBOEARTH are to prove that connection to a networked information repository greatly speeds up the learning and adaptation process that allows robotic

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systems to perform complex tasks, and to show that a system connected to such a repository will be capable of autonomously carrying out useful tasks that were not explicitly planned for at design time.

What is new or innovative about the project and how it addresses this topic?

Today's robots do not use the Internet — each robot is an island. ROBOEARTH is pioneering cloud robotics: the idea that robots can tap into the huge benefits of converged infrastructure and shared services, much in the same way that personal computers benefitted when they became connected to the internet. ROBOEARTH is a World Wide Web for robots: a giant network and database repository where robots can share information and learn from each other about their behaviour and their environment. In addition, ROBOEARTH allows robots to outsource computation to the ROBOEARTH cloud engine (aka Rapyuta), which allows robots to take advantage of the rapid increase in data transfer rates to offload tasks without hard real-time requirements. This is of particular interest for mobile robots, where on-board computation entails additional power requirements which may reduce operating duration and constrain robot mobility, as well as increase costs.

What first drew you to research in this area?

Today, robots are mostly relegated to highly controlled and predictable environments like manufacturing plants, but have made few significant inroads into the human sphere. The human world is just too nuanced and too complicated to be summarised within a limited set of

specifications. Thus far, robots have been operating in isolation from each other. If they are decommissioned, all that learning is lost. Even more disconcerting to researchers is the question: why are thousands of systems solving the same essential problems over and over again anyway?

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

One of the problems we tackle in ROBOEARTH is: how can robots with different hardware and software share knowledge and benefit from each other's learning? To address this challenge we divided the problem into two parts: high-level knowledge in ROBOEARTH is stored in an XML-based language, which is independent of specific hardware or software requirements. This interfaces with specific robots via a specific interface (a so-called Hardware Abstraction Layer). For example, robot actions are stored as high-level, general action recipes that can be translated to low-level, robot-specific motion primitives.

What are the concrete results from the research so far?

The project has produced a series of six demonstrators that show how ROBOEARTH can improve robot performance, learning, and autonomy, from serving drinks in a hospital setting to cloud-based mapping using a very-low-cost robot (USD ~300) equipped with a camera and wireless dongle.

What do you expect in terms of main outcomes from this project?

One main outcome has been the birth of a new research field. 'Cloud robotics' was unheard of when we started, and is now a rapidly evolving field of robotics that has



© Markus Waibel

Dr Markus Waibel

attracted large players from major universities around the world to companies like Google. It allows robots to benefit from the powerful computational, storage, and communications resources of modern data centres. In addition, it removes overheads for maintenance and updates, and reduces dependence on custom middleware.

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

- 1 'Robots sharing a knowledge base for world modelling and learning of actions'.

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



An integrated approach to health- and social-care services

Across Europe, providing health- and social-care services is becoming increasingly complex and costly. An ageing population, a multitude of public and private stakeholders, together with a myriad of e-health systems and technologies create numerous hurdles to the provision of efficient and cost-effective care. A team of EU-funded researchers and practitioners are helping to get these services off the ground.

In broad terms, 'Integrated eCare' consists of getting actors from health-care and social-care services to collaborate on multiple levels — from private doctors to public hospitals and from home carers to emergency centres for the elderly. They require efficient structuring, awareness of their specific roles in the value chain and, most significantly, must

be able to share information effectively.

'Health-care and social-care services are often delivered independently today. This leads to inefficiencies, duplication of resources, and potentially to reduced quality of care,' explains Ingo Meyer, a research consultant at Empirica in Germany.

'Older people are particularly affected by this situation, since they often need both types of services, such as support with daily activities and chronic disease management'

Empirica coordinated a consortium of 11 partner organisations from five European countries in the COMMONWELL¹ project,

a three-year-plus initiative to develop and deploy integrated care models and supporting technology. The project, co-funded with EUR 2.68 million from the European Commission, proved so successful that the systems and services it developed are still being used at COMMONWELL's four pilot sites, and plans are under way to extend the



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integrated care model to other areas.

'The idea of integration between health-care and social-care goes back a couple of decades, but it is really gaining momentum now, in part because people are demanding more services and providers are realising that so much time and effort is being wasted because tasks are being performed in parallel by different providers — so the same things get done twice or other things get lost in translation, so to speak,' Meyer says.

He points to the example of someone being discharged from hospital but the hospital failing to inform their home-care provider that their bandages need to be changed the next day or medication given at a certain time — oversights that can affect the patient's health and waste health and care providers' time, money and resources.

At the heart of COMMONWELL's solution are systems and technologies to greatly improve and manage information exchange between organisations. The model encompasses everything from establishing a protocol for email exchanges between hospitals and home-care providers to sharing the output of home-monitoring systems and linking it with patients' medical and social-care data.

To address the technological challenges of getting different ICT

systems to communicate, the consortium developed a modular software architecture that provides standard open integration points for collaborating systems to access and share information. Taking advantage of service-oriented approaches to systems design, the COMMONWELL architecture manages real-time and batched event and health data acquired from widely available modules — such as telemonitoring platforms in people's homes. The information is then made accessible to different actors over a series of COMMONWELL web services.

Protecting patient privacy

Crucially, the system is designed to isolate safety critical and non-safety critical elements, and protect patient data in line with data protection laws.

'Patient data is highly sensitive, and rules on who can see it and what can be done with it vary from country to country,' Meyer notes. 'So for each of the pilot sites in Germany, Spain, the Netherlands and the United Kingdom we had to begin with a legal analysis and figure out ways to adapt the system and the sorts of data we could use and share accordingly.'

He points to the example of providing social carers with vital-signs data from telemonitoring systems. In most countries, only the patient's doctor, nurse or hospital can access this information.

However, a way round this was found so that the system could automatically check the data to determine if the person's blood pressure or blood sugar, for example, falls within the recommended parameters set by their doctor and inform the social carer that the patient's vital signs are ok. If something changes, the system can inform the carer immediately that, for example, their heart rate is too high, but without giving them access to the sensitive raw data from the monitoring system.

The system was deployed at pilot sites in Milton Keynes in the United Kingdom and Eindhoven in the Netherlands to support health- and social-care providers treating people with 'Chronic obstructive pulmonary disease' (COPD) and 'Chronic heart failure' (CHF). The architecture and subsystems were primarily aimed at improving communication and collaboration between different providers, thereby helping to reduce anxiety and improve health outcomes for people with chronic conditions and patients requiring support immediately after leaving hospital.

Coupled with telemonitoring solutions, the COMMONWELL system was used with hundreds of older people at both sites. Besides showing the potential to reduce so-called 'revolving door' hospital admissions, where a patient is discharged only to return to hospital a few weeks later, the better coordination and communication

enabled by the COMMONWELL system resulted in a notable improvement in patients' sense of security, support, mental health and general well-being.

In Bielefeld, Germany, the COMMONWELL partners worked with Johanneswerk which provides social-care services to around 550 people in the city. The organisation's nurses have to deal with about 100 to 150 hospital admissions and discharges per year, most of them relating to one specific hospital. Previously they used paper forms to provide patient data to the hospital — a time-consuming procedure. With the COMMONWELL system now in use, the information is digitised and shared automatically, reducing the complexity of hospital admissions so patients can get treatment faster and costs are lowered for providers.

And in Spain, COMMONWELL technology was deployed via ASSDA, the Andalusian government's social-services provider, which currently operates one of the largest social-care call centres in Europe with over 175 000 clients across the Andalusia region.

'ASSDA call-centre operators would often have to deal with emergency situations, but in order to dispatch an ambulance to a caller's home, for example, they would have to hang up on the caller and relay their information by phone to the emergency services. This took time, and created a lot of anxiety for the caller as they had to wait for the ambulance service to call them back,' Meyer says.

With the COMMONWELL solution in place, ASSDA operators are now able to send caller data, such as name, address and health condition, to the emergency services at the click of a button, saving potentially vital minutes for the patient, and reducing the workload on both ASSDA operators and emergency service staff.

To operate continuously and sustainably over an extended period of time, the business model must be right — so COMMONWELL services underwent a rigorous cost-benefit analysis. In general,

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the system led to faster handling of emergency calls, more efficient patient admission, and more targeted service response. When calculating the system's socio-economic benefit, the project found that there was a positive return that paid for the investment within around two years of starting the pilot.

The COMMONWELL system continues to be used at all four pilot sites, while a parallel project called INDEPENDENT² has sought to extend the integration model to

include not only public and private health- and social-care providers but also volunteer organisations and informal carers. Empirica is also in the process of publishing a book, 'Achieving Effective Integrated E-Care Beyond the Silos', on the organisation's experiences in both projects and elsewhere in Europe that will address the challenges of establishing integrated eCare services and offer potential solutions.

In addition, a follow-up initiative, SMARTCARE, will involve several

of the COMMONWELL partners and dozens of municipalities across Europe which are keen to adopt models of integrated care.

'Integrated care has been talked about for years, but it seems that with initiatives such as these, people are realising that it is time to take action and do it,' Meyer concludes.

The project was coordinated by Empirica in Germany.

- 1 'Common platform services for ageing well in Europe'.
- 2 'ICT-enabled service integration for independent living'.

Funded under the European Commission's 'Competitiveness and Innovation framework Programme' (CIP) under the operational programme 'ICT Policy Support Programme'.
http://cordis.europa.eu/result/brief/rcn/11854_en.html
 Project website: <http://commonwell.eu>



A glimpse into the future of robotic technology

Replicating human behaviour in robots has long been a central objective of scientists working in the field of information and communication technologies (ICT).

However, a major obstacle towards accomplishing this has been controlling the interaction between movement and vision. Indeed, achieving accurate spatial perception and smooth visual-motor coordination have proved elusive.

Tackling this issue was the main aim of an EU-funded project EYESHOTS¹. By simulating human learning mechanisms, the project successfully built a prototype robot capable of achieving awareness of its surroundings and using its memory to reach smoothly for objects.

The implications of this breakthrough are not limited to potential improvements in robotic mechanics — they will also help to achieve better diagnoses and rehabilitation techniques for degenerative disorders such as Parkinson's disease.

The project began by examining human and animal biology. A multi-disciplinary team involving experts in robotics, neuroscience, engineering and psychology built computer models based on neural coordination

in monkeys (very similar to how human coordination works).

The key was recognising that our eyes move so quickly that the images produced are in fact blurred — it is up to the brain to piece together these blurred fragments and present a more coherent image of our surroundings.

Using this neural information, the project built a unique computer model that combined visual images with movements of both eyes and arms, similar to what occurs in the cerebral cortex of the human brain.

In effect, the project was built on the premise that being fully aware of the visual space around you can only be achieved through actively exploring it. This, after all, is how humans learn to understand the physical world — by looking around, reaching out and grabbing things.

In everyday life, the experience of the three-dimensional (3D) space around us is mediated through movements of the eyes, head and arms, which allow us to observe, reach, and grasp objects in the environment. From this perspective, the motor system of a humanoid robot

should be an integral part of its perceptual machinery.

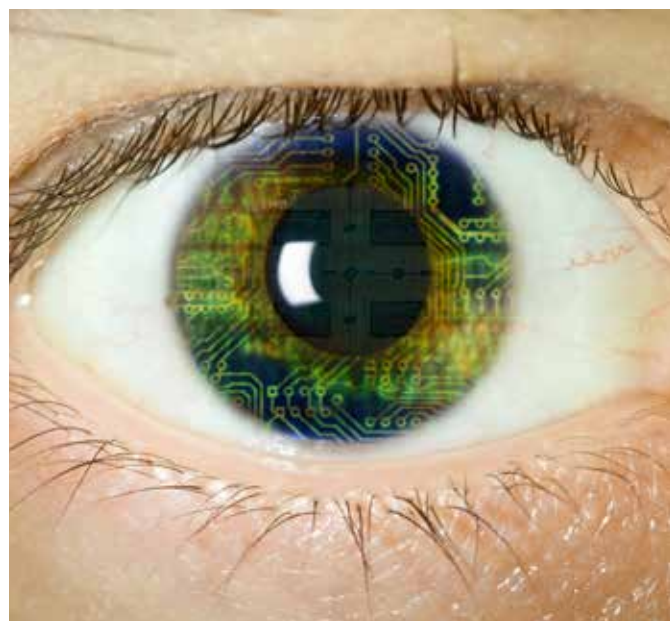
The end result of this approach is a humanoid robot that can move its eyes and focus on one point, and even learn from experience and use its memory to reach for objects without having to see them first. The robotic system comprises a torso with articulated arms and a robot head with moving eyes.

Through the application of neuroscience, the EYESHOTS project, completed in 2011, successfully identified a means of giving robots a sense of sight similar to human vision. This represents an important milestone in creating a humanoid robot that can interact with its environment and perform tasks without supervision.

The project was coordinated by the University of Genoa in Italy.

- 1 'Heterogeneous 3-D perception across visual fragments'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
http://cordis.europa.eu/news/rcn/35996_en.html
 Project website: <http://www.eyeshots.it/>



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From pizza-maker to physiotherapist: Italian robot's promising skills

Have you ever thought about the complexity of making pizzas: stretching the dough, tossing, seasoning, and baking it with dynamic turning — it is a real art. A robot — named RODYMAN — will soon have the required dexterity to reproduce this 'gastronomic choreography'.

This original and challenging idea was born in the mind of a leading scientist in robotics, Professor Bruno Siciliano, and is funded by the European Research Council (ERC). With unprecedented manipulation skills and an enhanced ability to work in human environments, the future looks bright for RODYMAN¹. From assisting elderly people to repairing a human limb, the potential applications of RODYMAN are numerous and could greatly improve our daily lives.

The Naples region does not only host Mount Vesuvius, but it is also the home of a worldwide renowned laboratory in robotics, the PRISMA Lab. It is headed by Prof. Siciliano, an expert in robotics, author of several bestsellers and former president of the most important professional association in the field.

The professor is a son of the Neapolitan soil. He obtained his PhD from the University of Naples Federico II in 1987 and then became a professor there. The idea of a robot making pizza came to him quite naturally. 'Beyond the real technical challenge, it is also a way to honour and keep track of a tradition. I have colleagues in Japan who have developed robots able to reproduce ancestral dances. Cultural heritage plays a role in robotics, and vice versa,' he explains.

Dexterous, mobile and safe

RODYMAN — the acronym for Robotic Dynamic Manipulation — is a service robot that will be able to mimic complex human tasks with a level of dexterity and mobility never seen before. 'The manipulation of non-rigid,

deformable objects — food or clothes in our daily lives, soft tissues such as muscles and skin in medical operations — has not been investigated much so far and offers an important challenge to the robotics community,' comments Prof. Siciliano. RODYMAN will be composed of a torso, two lightweight arms and multi-fingered hands. It will not have legs but it will be mounted on an omni-directional platform with wheels. Its head will be equipped with a stereo camera system and a structured lighting set-up. It will have proximity and range sensors, as well as tactile sensors.

Interaction with humans is at the core of the project. 'For this reason, safety is a key feature of the new system,' says Prof. Siciliano. 'This autonomous robot should be able to control the flow of events in the task, react to and learn from its environment. It will be able to deal quickly with unexpected situations, such as the presence of humans or obstacles.'

Ready in five years

The project is at the crossroad of different disciplines, involving not only mechanics and engineering but also cognitive science and artificial intelligence. As a result, Prof. Siciliano's team includes different profiles. 'With the ERC grant, I plan to hire four postdocs and three PhD students, who will tackle the challenge of tossing the pizza dough and turn the peel into the oven by using a mobile dual-arm/hand robotic platform,' he explains.

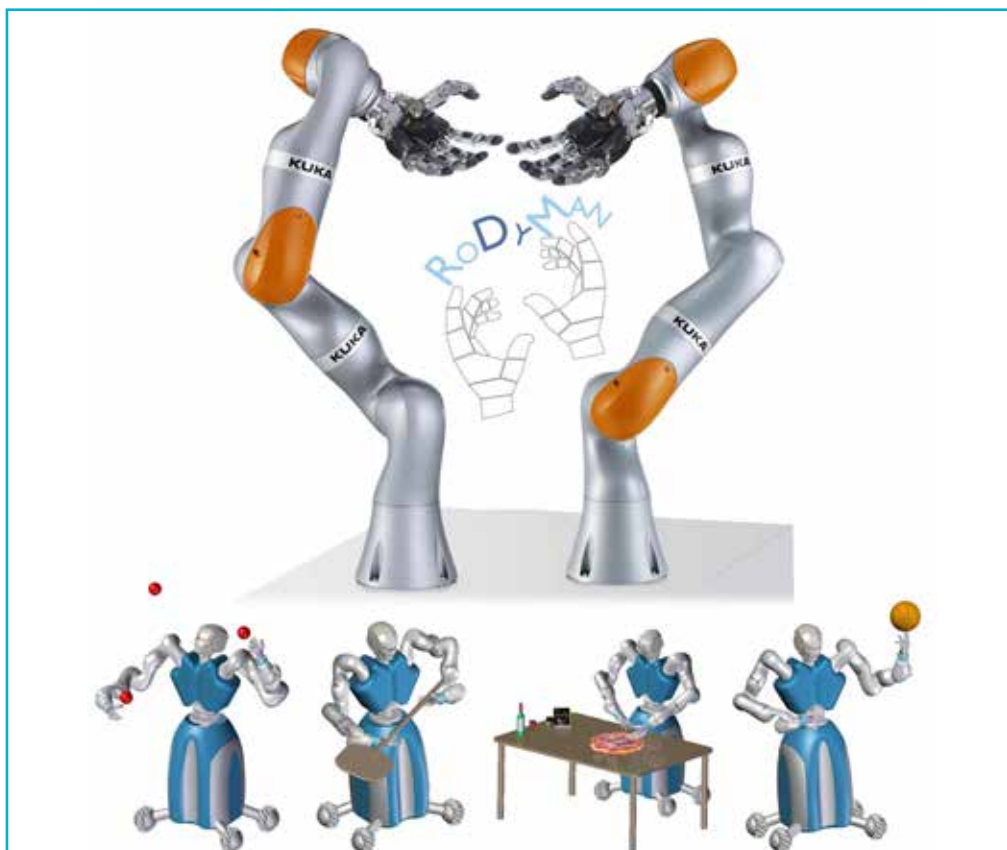
At a later stage, this robot might be in your home, helping you with your daily tasks. 'Service robots are tomorrow's computers,' says the professor. Demand is on the increase. According to data from the International Federation of Robotics, about 2.5 million service robots were sold for personal and domestic use in 2011, 15% more than in 2010. 'The ageing population will drive the application of robotic technologies that improve the quality of life and assist people to live longer and more comfortably in their houses,' continues Prof. Siciliano. Applications in the medical field, notably in physiotherapy, can also be foreseen.

In the next five years, RODYMAN's challenge is to make pizzas. Asked whether they will be as tasty as those of Neapolitan pizzaiolos, Prof. Siciliano replies: 'That is nearly impossible! Yet we will involve one of the best pizzaiolos in town and learn the skilled and artistic movements directly from him through the use of a biokinetic sensorised wearable suit and a 3D motion capture system'. The tasting session is planned for 2017!

The project is coordinated by CREATE in Italy.

1. 'Robotic dynamic manipulation'.

Funded under the FP7 specific programme 'Ideas' (European Research Council).
<http://erc.europa.eu/> > Projects and results > ERC Stories
 Project website: <http://www.rodyman.eu/>





New underwater robot swims and senses like a fish

In recent years, robotic underwater vehicles have become more common in a variety of industrial and civil sectors. They are used extensively by the scientific community to study the ocean. For example, underwater robots have been used to discover or study a number of deep-sea animals and plants in their natural environment.

Now, a new class of underwater robot has emerged that mimics designs found in nature. These 'biomimetic' vehicles can achieve higher degrees of efficiency in propulsion and manoeuvrability by copying successful designs in nature.

The EU-funded FILOSE¹ project is addressing a key bottleneck for underwater robotics, namely the problem of understanding how fish sense the underwater environment.

A fish swimming in its natural environment is able to sense the flow of water around it and react to changes in flow patterns. FILOSE project partners, led by Tallinn University of Technology's Centre for Biorobotics, believe that once they understand how a fish works, they can potentially apply that knowledge to the development of better underwater robots.

A crucial experimental tool for FILOSE has been a robot prototype that looks and acts like a fish. The

'FILOSE fish' resembles a rainbow trout in shape but also in its behaviour — trout are 'subcarangiform swimmers', i.e. fish that move forward by creating undulations in the rear part of the body while the front remains almost rigid.

The FILOSE fish's tail is actuated by a single servomotor located in its thorax. It creates an undulating wave that travels along the body and pushes the robot forward. FILOSE researchers can change the fish's tail to investigate how material properties alter the robot's efficiency and swimming pattern. Meanwhile, the head of the robot is watertight and contains sensors and electronics to control the fish.

The experiments were done in the lab using a flow tank. Project researchers determined that robots equipped with such features not only seek out areas where disruptive currents are weakest, but they can also use eddies to actually help push them forward.

The results of the FILOSE project have been ground-breaking. Researchers have successfully developed the first-ever flow-sensing underwater robot with flow-aided and flow-relative navigation. A key step in the design of the

robot was the development of an artificial hair cell that mimics natural hair-cell sensing physiology.

The project has also established new hydrodynamics research facilities and trained personnel who are continuing the work begun under FILOSE.

Taken together, the results promise to lead to new underwater technologies that could help the oil and gas industry, underwater humanitarian demining, environmental monitoring, search-and-rescue operations, anti-terrorist activities, harbor surveillance, coastal security and fisheries management, and more. All will feel the impact of more efficient and better-performing underwater robots.

The project was coordinated by the Tallinn University of Technology in Estonia.

1 'Artificial fish locomotion and sensing'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
http://cordis.europa.eu/news/rcn/35903_en.html
 Project website: <http://www.filose.eu>



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Flying robots get off the ground

Attaching a platform to a high-rise building to evacuate people in an emergency, or creating a landing stage for an aircraft on uneven terrain — these are just two areas in which flying robots could have a huge impact — potentially saving lives.

The ARCAS¹ team is 18 months into a four-year project to develop such machines. The team is working on the first-ever cooperative free-flying robot system able to assemble and construct structures in inaccessible sites, including in space. The project is funded under the Information and Communication Technologies strand of the EU's Seventh Framework Programme (FP7), having received EUR 6.15 million from the European Commission.

Advances in five key areas are needed to get the robots up and flying: the helicopters or quadrotor systems themselves; motion control for transportation and assembly; robot perception; cooperation between multiple robots; and tools to allow human intervention.

The team has already developed prototypes. The first is a quadcopter with a robotic arm and a 'hand' designed to grasp cylindrical

objects. Keeping the arm's weight as low as possible was a priority; the result is minimal impact on the quadcopter's stability.

The second prototype is an electrical helicopter fitted with a gripper mounted on an arm able to bend in any direction.

Each robot will be equipped with a manipulator able to grasp objects. The team is working on motion-control techniques for this manipulator, which must include coordinating the control of multiple flying robots grasping the same object during a construction task.



© ARCAS

Perception is key to any task-oriented robot. For the ARCAS robots, this includes scene recognition, fast three-dimensional model generation, simultaneous localisation and mapping by multiple aerial robots, accurate 3D



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positioning and tracking so that assembly operations can be guided, and cooperative perception for assembly — the robots must be able to work together.

Cooperative planning will ensure safety during the simultaneous operation of multiple flying robots during assembly, disassembly or inspection tasks, while human operators must be able to intervene in this autonomous perception, planning and control when necessary. They will do this using virtual reality haptics

— technology operated through touch.

Once the concepts, methodologies and algorithms are in place, they will be tested in three different ways. Autonomous quadrotors and an integrated system for positioning will be assessed for basic manipulation and assembly functions. These tests will take place indoors. More advanced manipulation devices with integrated force sensors mounted on autonomous helicopters will be tested outdoors. And multiple robot arms will be

used to simulate free-flying objects manipulating objects in space.

The project is expected to lay the foundations for designing and developing cooperating flying robots with various physical characteristics that could be used in a range of applications. ARCAS' industrial partners will be the first to adopt the project's technologies, providing a path to commercialisation, whether in inspection, maintenance, repair, satellite servicing or structure construction.

The project is coordinated by FADA in Spain.

- 1 'Aerial robotics cooperative assembly system'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
http://cordis.europa.eu/news/rcn/35804_en.html
 Project website:
<http://www.arcas-project.eu/>

Scaling up breakthrough optical-fibre micro sensors for market

Scientist Davide Iannuzzi and his team have developed a method to place novel miniaturised mechanical devices on the tips of optical fibres. The technology has many applications, such as providing a new generation of small, super-sensitive sensors for research, medical and industrial applications.

The team received support from the European Research Council (ERC) in the form of two grants. The first EU-funded project was called FTMEMS¹ and he secured the second one, called FTBATCH² to demonstrate that the technology could be scaled up to market competitively.

Iannuzzi likens the round end of the optical fibre to a swimming pool and the 'fibre-top cantilever' to a diving board. Inspiration for the idea came to Iannuzzi, who is based at the Vrije Universiteit Amsterdam, while he was conducting experiments in fundamental physics. The usual approach of shining a laser beam on to a cantilever proved unwieldy and was not always accurate.

'Commercial instruments were causing spurious effects,' recalls Iannuzzi. 'After some searching around it struck me — why not fabricate the cantilever on to the end of an optical fibre?'

This innovative idea offers a number of clear advantages. By combining the mechanical reliability of microelectro mechanical systems (MEMS) with the precision of optical-fibre interferometers, it is highly sensitive. In addition, its all-optical

sensing and portable size means it can function in extreme conditions and be controlled remotely.

Without the backing of the ERC, Iannuzzi would have had a much harder time proving the commercial worthiness of his innovative ideas. ERC support helped the researcher to scale up the production processes and analyse the market potential of different applications.

One of the most promising uses of this technological breakthrough is as ultra-versatile, super-sensitive sensors. For example, fibre-top cantilevers can be used, without the need for bulky and expensive equipment, for atomic-force microscopy (AFM) to record, 'like the stylus of a record player', the surface of an object with a nano-scale resolution.

Numerous other promising avenues exist for the fibre-top cantilever, such as minimally invasive surgery. With all this potential at stake, Iannuzzi discovered that being in the lab was not enough and decided to take his idea to market.

Drawing on the Italian tradition of design excellence and small-scale innovation and the Dutch acumen for transforming ideas into profitable products, in 2011, Iannuzzi

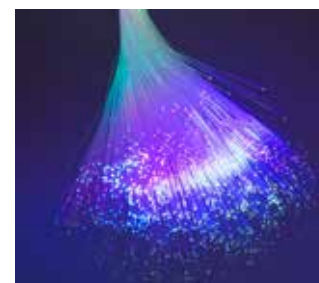
established a start-up called Optics11.

'The company is going very well,' he reports, with evident pleasure. 'We have three employees and are about to hire a fourth, on top of the two founders. We're expanding our range of applications.'

In fact, the firm is pursuing a customer-driven approach to its patented technology. Through interactions with scientists and researchers in various fields, says Iannuzzi, Optics11 is able to identify exciting new ideas for applications.

In addition to benefiting society and provide the basis for new business and jobs, this also has a benevolent feedback effect. 'This helps the academic perspective as well, by generating ideas for new research avenues. For example, after talking to neuroscientists, we are now exploring ways to apply the technology in the neurosciences,' he says.

What advice would this scientist-entrepreneur give other researchers wishing to take the leap into business? 'It requires a change of mindset. You have to know that this is not your field, so you have to be open to learning and getting the right help and advice,' he says. And this is exactly what Iannuzzi has done, seeking assistance from his university's technology transfer office and teaming up with a professional entrepreneur to run the firm.



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Iannuzzi has also become an unofficial adviser and mentor to fellow scientists at his university, helping them to consider the best way to bring their ideas to market.

While acknowledging the importance of innovation and commercialisation, Iannuzzi cautions against the dangers of overemphasising this aspect. 'It is important that we give scientists the opportunity to try academic entrepreneurship,' he says. 'However, it is wrong if everything is focused on that. Blue sky research is also necessary.' 'I don't want to live in a world without philosophers,' he concludes.

The projects were coordinated by VU University Medical Center in the Netherlands.

- 1 'Fibre-top micro-machined devices: ideas on the tip of a fibre'.
- 2 'Small, but many: scalability to volume production in fibre-top technology'.

Funded under the FP7 specific programme 'Ideas' (European Research Council).
http://cordis.europa.eu/news/rcn/36202_en.html



Marine navigation systems for robot 'buddies'

Robots could soon accompany humans on scientific and commercial missions to low-visibility underwater areas like the ocean floor. One team of scientists has developed a system to track and control the movements of a diver and his or her 'buddy' robots.

Researchers came up with a mission concept to develop their system as part of the EU-funded CONMAR¹ project. Their idea was to use a small group of autonomous surface vehicles to supervise and guide a human diver along a prescribed path.

The diver receives commands from the robots as patterns of light from light-emitting diodes (LEDs) installed on the diving mask. The robots send the commands using an acoustic channel.

To achieve their mission goal, researchers had to develop an acoustic system capable of estimating the position of the vehicle relative to transponders or

a ship. These must then be able to transmit the estimated position of the underwater vehicle back to the vehicle itself using an acoustic modem. It is not only the position that is important, but also the corresponding velocity and course angle.

Researchers advanced a measurement model that performed well during diving mission simulations. The tool will become an integral part of NetMarSyS, a software suite for the simulation of cooperative multiple-vehicle navigation and control systems.

CONMAR culminated in sea trials in Lisbon, Portugal with three autonomous surface robots and a



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human diver. The robots navigated cooperatively, meaning that they shared resources to increase the performances of their individual navigation systems. This approach provides a robust system able to deal with acoustic outliers and temporary communication losses between the diver and the surface craft.

Overall, tests indicated that the prototype system worked extremely well under real conditions, so it has the potential to move from the laboratory into the real world. The offshore industry and marine scientists, among others, stand to benefit

from the navigation system as it brings them closer to cooperative human-robot missions at sea.

The project was coordinated by Instituto Superior Técnico (IST) in Spain

- 1 'Cognitive robotics: Cooperative control and navigation of multiple marine robots for assisted human diving operations'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/11882_en.html



Robot inspections for human safety at sea

Rising to the challenges of increasing competitiveness in the maritime sector, a group of researchers set out to raise the bar for marine-vessel inspections. Project developments offer a new, value-added, high-tech vessel-inspection methodology.

The MINOAS¹ project was established with EU funding to introduce an innovative system concept aimed at re-engineering the overall vessel-inspection

methodology. The envisaged infrastructure minimises risk by taking humans out of potentially dangerous environments; instead, a fleet of robots on

board the ship would carry out inspections. The high locomotion-enabled robots provide information (data, images, videos) that can be processed and stored for future reference.

High-resolution tools will enhance the semi-autonomous procedure, with control techniques and algorithms supporting operation of the robot fleet. Graphic interfaces enable the 'teleported' inspector to process the harvested data online, thus also ultimately rendering the set of tools an effective decision-support system.

MINOAS partners effectively realised project objectives by integrating state-of-the-art technologies from fields of man-machine interface, robotics and visual perception. In cases where existing technologies could not meet certain requirements, they developed new platforms and

tools as needed. Platforms were prototyped during the project and evaluated in both the laboratory and in field trials.

Robots placed in the service of the surveyor will produce time and cost optimisation and will promote the surveyor from an on-site agent to a manager with task coordination and decision-making responsibilities.

The project was coordinated by Rina Services in Italy.

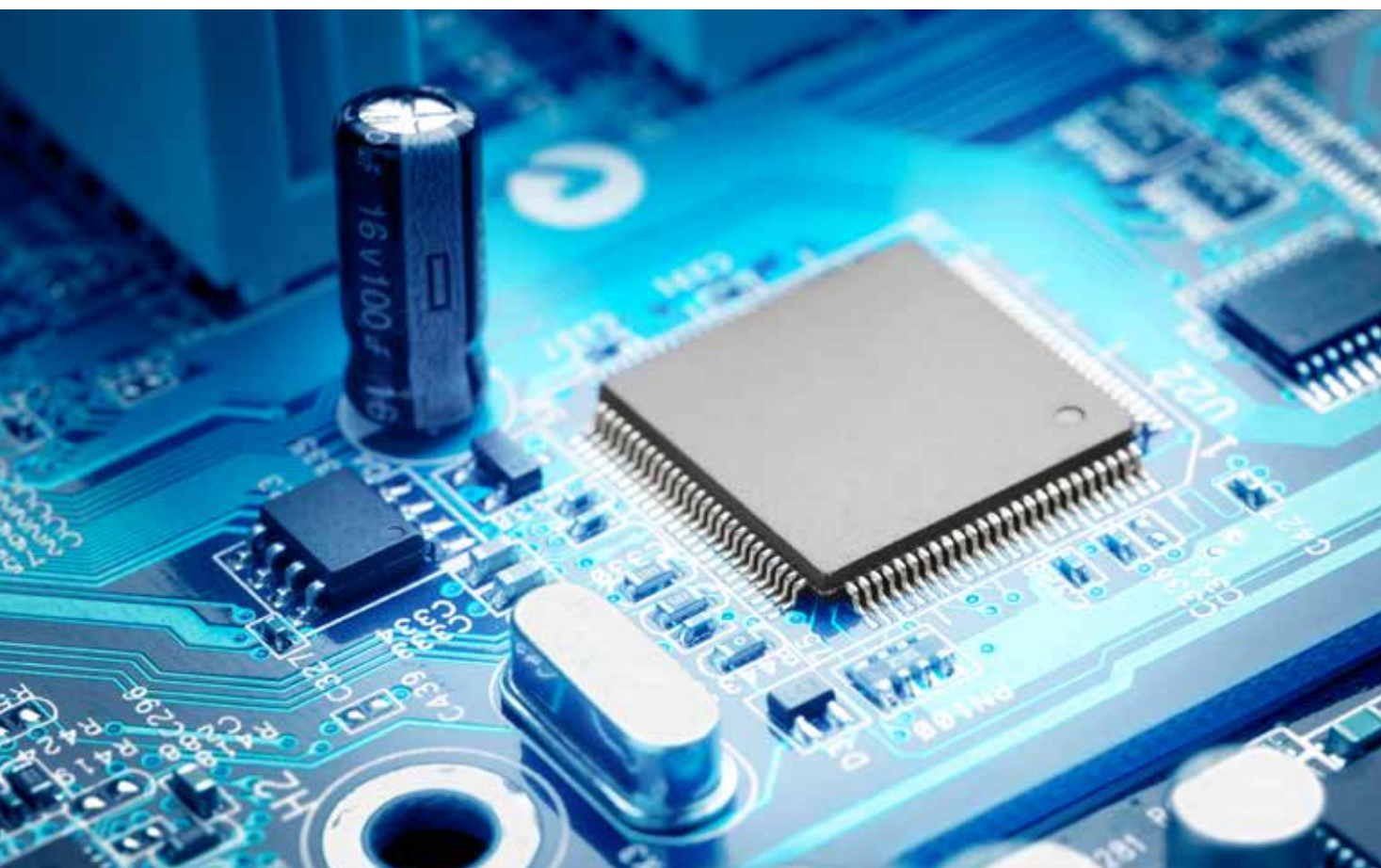
- 1 'Marine inspection robotic assistant system'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Transport'.
http://cordis.europa.eu/result/brief/rcn/10677_en.html
Project website:
<http://www.minoasproject.eu/>



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Nanodevices for a ‘More than Moore’ world

Moore's Law — which holds that the number of transistors on an integrated circuit, and hence its processing power, doubles every 18 months — has been the guiding principal of chip design for almost half a century. But with physical limitations to further transistor scaling being reached, Moore's Law may have met its match. We are entering a ‘More than Moore’ world in which EU-funded researchers are playing an important role.

Since Intel co-founder Gordon E. Moore described his theory in 1965, circuit designers have counted on the steady increase in transistor density to provide greater chip performance in ever-smaller packages. Now, however, some of the physical constraints to transistor scaling — such as overheating, energy dissipation and resistance — mean that conventional semiconductor design approaches are unlikely to produce the same rate of progress.

And that is not the only challenge in achieving more powerful and smaller electronic devices. Moore's Law only deals with integrated circuits, such as the ‘Complementary metal-oxide-semiconductor’ (CMOS) chips that live inside your PC, mobile phone or digital camera. A bulky array of additional discrete passive components — such as resistors, capacitors, inductors, antennas, filters and switches — interconnected over a printed-circuit board or two are still needed for

your phone to make a call or your camera to take a photo.

For real miniaturisation, a different approach is required: one based on advanced nanotechnology that promises seemingly infinite possibilities and unlimited potential applications. By integrating new functionality using tiny nanostructures such as nanowires and nanomaterials (each tens of thousands of times thinner than a human hair) into CMOS chips, the ‘More than Moore’ approach means electronics can keep getting smaller, more powerful and more efficient. So small in fact that a computer in pill form could monitor health and deliver drugs inside the human body, or a complete smart home-control system could be combined into a package about the size of a credit card.

‘In recent years, nanostructures and nanowires have received much attention for future CMOS.

Nowadays, activities devoted to using nanostructures, especially nanowires, to create innovative ‘More than Moore’ products are very promising,’ says Dr Francis Balestra, Director of the Sinano Institute of France's Centre National de la Recherche Scientifique (CNRS) and a researcher at INP-Minatec in Grenoble.

Devices on the nanoscale

In the NANOFUNCTION¹ Network of Excellence, Dr Balestra and a team of researchers from 15 academic and industrial partners in 10 European countries investigated how nanostructures can be integrated with CMOS chips to add a vast array of new functionalities on a tiny scale. Supported by EUR 2.8 million in research funding from the European Commission, the consortium focused in particular on ultra-sensitive nanosensors capable of detecting signals in molecules; nanostructures for harvesting

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energy for the development of autonomous nanosystems; nanodevices for spot cooling of integrated circuits; and nanodevices for radio-frequency (RF) communication.

'These nanodevices will be needed in the future for very-low-power or autonomous nanosystems for many applications, including health and environmental monitoring and the "Internet of Things",' Dr Balestra explains.

Nanoscale systems-in-package (SiP) or system-on-chip (SoC) devices, integrating processing power with sensors, RF communication and a range of other functionalities, for example, could be used to detect all manner of substances, toxic or benign, including chemicals in the environment, in food, and in the human body.

In the NANOFUNCTION project, the researchers advanced the current state of the art, developing a low-cost and highly efficient nanowire sensor array, which contains more than 1000 silicon nanowires and integrates different sensing elements to simultaneously detect various molecules. To test the array, the team designed effective functionalisation techniques for DNA grafting — a cutting-edge and highly experimental process in which a segment of DNA is removed and replaced by another form of the DNA structure.

The team further showed how nanostructures, as well as acting as sensors, can also provide critical improvements to existing sensor technology and other electronic applications. Working in an area known as 'cooltronics', the team proved that huge performance enhancements or new operation regimes are enabled when critical components in an electronic circuit are cooled to ultra-low temperatures. Their approach relies on a new type of 'electron cooler' that uses strained silicon (SSi) in

combination with a superconductor, and which has so far been tested on terahertz (THz) radiation sensors. This is an emerging technology operating in the frequency range between microwaves and infra-red light waves, which has many potential uses, including medical imaging, security and space applications.

Similarly, the consortium took a cutting-edge approach to using nanostructures for RF communications, exploring the potential for nanowires to be used as highly efficient RF interconnects and antennas — technology that could lead to much smaller communication devices.

Nano-power

But where would such a tiny device draw its power from? Conventional batteries are still a long way from reaching the nanoscale. The NANOFUNCTION researchers therefore investigated innovative ways to power nanoscale devices from their immediate environment, drawing energy from vibrations, movement, heat or solar power and storing it in active materials that can act as nano-batteries. The development paves the way for fully autonomous nano-devices able to power themselves.

'These nanotechnologies will be combined and integrated in future autonomous nanosystems, which will be needed for many applications. The main challenges include the development of CMOS-compatible technologies and the reduction of sensors' energy consumption, computing and RF communication, as well as increasing the energy harvested from the environment,' Dr Balestra says.

He notes that many challenges have been overcome in the NANOFUNCTION project, and that the team's work is helping open the door to further miniaturisation of devices.

'Miniaturisation remains a major enabler for price reduction, functionality multiplication, and integration with other electronics. In addition, nanoscale structures can improve devices' intrinsic performance or enable new functionality, such as ultra-high-sensitivity detection,' he explains.

In advancing the current state of the art and carrying out extensive dissemination activities among the European and international nanotechnology community, NANOFUNCTION's work constitutes an important benchmark in the field.

'It will benefit European industry and society by preparing long-term integration, which Europe can rely on to underpin research on advanced technology development in this strategic "More than Moore" field — in which Europe already has a strong position,' Dr Balestra says.

He notes, nonetheless, that it is likely to be 10 to 20 years before such advanced nanodevices make their way into commercial applications.

'For commercial exploitation, additional research will be needed in order to optimise these nanocomponents for very important applications for the European economy and society,' he says.

The project was coordinated by the Grenoble Institute of Technology in France.

1 'Beyond CMOS nano-devices for adding functionalities to CMOS'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Information and communication technologies' (ICT).
http://cordis.europa.eu/result/brief/rcn/11809_en.html
 Project website: <http://www.nanofunction.eu/>

Beer brewing comes clean

Behind a simple glass of cold beer lies a quiet industrial revolution promising to take the brewing industry by storm. Although the world's breweries have been recovering CO₂ from the brewing process for other industrial uses for almost two decades, the process can consume copious amounts of energy and water.



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Enter Union Engineering, an enterprising Danish company that has developed an ingenious and much more environmentally friendly brewing solution called ECO2Brew. Based on advanced CO₂ recovery technology, the initiative

was launched under the EU-funded project FICOB¹.

The innovative technology enables breweries to effectively capture the CO₂ in its fermentation tanks. It can then be used to make carbonated soft drinks in other beverage lines

or factories. ECO2Brew is designed to operate water-free and to use significantly less power — whilst recovering CO₂ at a higher rate than other technologies.

Embarking on a joint venture with Danish brewer Carlsberg, the team

at Union introduced the novel technology in 2012.

'We spent the first six to eight months running tests at the CO₂ production at Carlsberg,' says Union's chief sales officer Michael Mortensen. 'The test



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phase and the last adjustments were crucial for us prior to launching within the brewing market.'

An ECO2Brew plant with an output of 1000 kg/hour saves around 4600 cubic metres of water per year and has energy savings of 20%, explains Mortensen.

'This project has offered us the opportunity — with support from the EU's eco-innovation fund — to develop a new and ground-breaking technology for the food and beverage industry, which in certain ways is a mature industry,' he says.

In autumn 2012, the first ECO2Brew plant was officially launched at the Carlsberg brewery

in Denmark, and both Union and Carlsberg are impressed with the results. Union's subsequent live test results showed that the power and water savings expected were easily achieved.

'We are really, really happy about the plant, but most important is that Carlsberg is happy,' says Mortensen. 'Carlsberg has just awarded us the second ECO2Brew plant in Finland, which we consider as the real stamp of approval for the project'

For Carlsberg, capturing significantly more CO₂ will benefit its on-site soft drinks bottling plant, while cutting energy and water costs. For society at large, the technology is

likely to boost European competitiveness within the industry and create jobs.

'A project like this gives us the opportunity to increase our business and create employment possibilities,' says Mortensen.

As more breweries start to show interest in this new technology, Union Engineering's position as a pioneer in green brewing is now established. 'We're unveiling ECO2Brew this year at one of the industry's major global trade exhibitions, Drinktec in Munich, Germany,' continues Mortensen.

In the meantime, trade magazines are already welcoming the

concept in what could soon become a European-led green revolution in brewing.

The project was coordinated by Union Engineering in Denmark.

- 1 'Full-scale implementation of innovative CO₂ recovery plant for use in breweries'.

Funded under the European Commission's 'Competitiveness and Innovation Framework Programme' (CIP) under the operational programme 'Entrepreneurship and Innovation Programme' as part of the 'Eco-Innovation' initiative.
http://cordis.europa.eu/news/rcn/36198_en.html
 Project website:
<http://www.union.dk/HOME/NewBrew>



Automating European production processes in just 24 hours

While the automation of production facilities can lead to cost efficiencies and safer workplaces, the expense can be prohibitive. Plant managers, when weighing up the cost of halting production and putting in place expensive robotic technology, often opt for the safer option: carry on as normal.

While understandable, such decisions are holding back European industry at a critical time of economic difficulty and growing international competition. This is why a major EU-funded project was recently launched, to demonstrate that robotic automation need not be time consuming or prohibitively expensive.

The FACTORY-IN-A-DAY¹ project's ultimate goal is to reduce the installation time — and related cost of installation — from months to a single day. As part of the Commission's Economic Recovery Plan, this will help European manufacturing enterprises adapt to global competitive pressures by improving the technological base of manufacturing across a broad range of sectors.

In practice, the project will achieve the following. Before the robot is actually taken to the SME premises, a system integrator will analyse which steps in the process can be taken over by the robot. In most

cases, it can do repetitive while the human worker carries out more flexible, accurate tasks and deals with problem-solving.

New standardised arms, mobile platforms, and hands will be combined with three-dimensional (3D) printed custom parts, capable of being designed in a matter of hours from novel design templates. This will greatly reduce the time it takes plants to automate and be up and running. Furthermore, new self-calibration routines and a novel software framework will enable the easy interconnection of robot components and existing machinery.

The robot will be connected to machinery software through a brand-independent software system, and be taught how to perform tasks, such as how to grasp an object. For very specific application domains — such as, for example, mould finishing and assembly — a set of novel learnable skills — or apps — will allow for the rapid teaching of production tasks.



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These robots will be capable of collaborating safely with humans in a shared workspace due to safe robot arms with dynamic obstacle avoidance, made possible by novel proximity-sensing skin and online path re-planning algorithms.

Augmented reality will allow the robots to project their intended motion plans to inform the workers. These hybrid human-robot teams will be assessed through the performance of short-batch production work. And, most importantly, the new flexible, leasable and cheap FACTORY-IN-A-DAY robotic system can be set up in just 24 hours.

The consortium believes there is huge potential for this technology. Many production-line jobs are still done manually, from the packing and quality checking of fruit to the filling of spray-painting machines. This is mainly because automated processes that can do the job as well and as efficiently as a human worker are currently not available.

For these reasons, many SMEs in Europe do not use advanced robot technology, something that FACTORY-IN-A-DAY aims to change.

The four-year project has a budget of EUR 11 million, 7.9 million of which will be funded by the EU as part of the FP7 programme 'Factory of the Future'. The international consortium comprises 16 partners and the coordinating university is Delft University of Technology (TU Delft).

The project is coordinated by TU Delft in the Netherlands.

- 1 'Factory in a Day'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Nanosciences, nanotechnologies, materials and new production technologies' (NMP).
http://cordis.europa.eu/news/rcn/36164_en.html
 Project website:
<http://www.factory-in-a-day.eu/>

A foam sandwich to satisfy industry's appetite

EU-funded scientists investigated novel materials for producing large structural components. Lighter weight and enhanced durability at lower cost are some of the requirements for wind turbines or rail transport applications.

Wind-turbine blades are usually made from composite materials designed to be lightweight so as to increase efficiency. These composites are often in the form of a sandwich structure with balsa wood or polyvinyl chloride (PVC) foam in the centre. Increasing blade size for an increasing number of offshore wind farms has spurred the search for even lighter and more durable materials. This will enhance efficiency while decreasing maintenance costs.

The EU-funded project NANCORE¹ developed novel nanocomposite polymer foams. Air bubbles are trapped in continuous nanocomposite phases using polypropylene (PP) or polyurethane (PU) in these foams. The materials are a possible alternative to conventional ones for applications in wind turbines, yachts and railway components.

Developments included appropriate processing routes, characterisation, modelling and, of course, toxicological testing.

Scientists successfully delivered numerous novel formulations with mechanical properties meeting specifications. NANCORE also developed several characterisation tools, measurement techniques and modelling techniques that will be invaluable for studying PP- and PU-based nanocomposite foams. The outcomes of toxicological tests and advanced risk assessment should have an impact on handling during processing.

In addition, the large scope of the project enabled identification of important challenges to be addressed in future work. Specifically, the upscaling of PP processes for cost-effective



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production proved to be technologically difficult. Also, life-cycle assessment (LCA) indicated that PU foams have a higher environmental impact than balsa wood.

Overall, NANCORE contributed significantly to the knowledge base associated with nanocomposite polymer foams. This was accompanied by the development of novel materials, characterisation and measurement tools, and toxicology studies. In addition, the education of new scientists at the undergraduate and graduate levels in this field will no doubt enhance their career opportunities.

The project was coordinated by LM Wind Power in Denmark.

- 1 'Microcellular nanocomposite for substitution of Balsa wood and PVC core material'.

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/6566_en.html

New automatic welding system makes car production cheaper

European researchers have found a way make the automotive sector more eco-friendly, while at the same time cutting production costs. The EU-funded project SMARTDRESS is developing a fully automated control system to improve crucial welding processes.



The global automotive sector produces around 60 million vehicles per year. In the primary stages of vehicle construction, manufacturers rely heavily on resistance spot-welding (RSW), a process in which steel or other metal surfaces are joined by heat generated by an electric current.

In this phase of car production, manufacturers use RSW guns with electrode 'tips' — the elements placed directly in contact with the metal pieces to transmit current. When these tips become worn, weld quality can suffer, resulting in interruptions in production and, by extension, loss of revenues.

According to project partners, most spot weld quality problems can be traced to poor electrode tip dressing. This is a major cause of interruptions in the manufacturing process.

With a new vehicle typically rolling off a production line every one to two minutes, a welding tip issue causing even a five-minute line stoppage, once a day, can result in a loss of 10 vehicles per week, equating to about EUR 7 million in lost revenue per year.

Dresser systems for maintaining tip quality are already in use on many production lines, but current solutions require manual set-up, optimisation and continued monitoring during production, which cannot be efficiently



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performed for large production lines.

In addition, today's tip-dress systems cannot be used in the high-volume production of aluminium assemblies, preventing the use of RSW and requiring high-cost technologies such as self-pierced riveting.

The SMARTDRESS¹ system will be intelligent, automatically

optimising, monitoring and maintaining RSW electrode tip quality.

The new technology will, for the first time, enable aluminium welding which, until now, has not been done on a commercial scale. This technique will lower the cost of manufacturing vehicles made from aluminium. The widespread use of aluminium in the automotive sector would reduce

vehicle weight, and potentially help cut CO₂ emissions.

The SMARTDRESS system may provide a real competitive edge, allowing European automotive suppliers to sell more cars in an important global market.

The project has received over EUR 1.1 million in EU funding and will complete its work before the end of 2013.

The project is coordinated by Sinterleghe in Italy.

- 1 'Adaptive tip dress control for automated resistance spot welding'.

Funded under the FP7 specific programme 'Capacities' under the theme 'Research for the benefit of SMEs'.
http://cordis.europa.eu/news/rcn/36214_en.html
 Project website:
<http://smartdress-project.eu/>

Closing the carpet production cycle

Current trends show worldwide demand for carpet rising 5% annually, with production projected to reach 18.6 billion square metres per year by 2016. Good environmental performance and sustainability are now key priorities in this burgeoning industry.

To meet the challenge, the EU-funded project EURO2C CARPETCHAINS¹ has set up a pilot carpet return and recycling programme in cooperation with flooring manufacturers, flooring contractors and waste-collection and reprocessing companies.

'To close the production cycle, it is essential to be able to take back and process old carpets,' says Marco van Bergen of project coordinator Desso. 'Traditionally, the carpet manufacturing sector has operated in a linear fashion — virgin raw materials are transformed into yarn, backing and other elements used to make carpet. Later, at the end of its life, discarded carpet is simply thrown into municipal incinerators, cement kilns or landfill.'

The process is, by definition, unsustainable, as modern carpets are largely made from synthetic, fossil-fuel-derived materials, harmful to the atmosphere when burned, and non-renewable. 'Moreover,' says van Bergen, 'we are living in a resource-constrained world where the linear economy of "take, make and dispose" is unsustainable. There is a better way: reshaping businesses so that products are made to be made again in a circular fashion, as seen in nature.'

At Desso headquarters in the Netherlands, EURO2C

CARPETCHAINS researchers set up an innovative pilot plant for the sorting and separation of carpet waste.

'The first step is to determine the yarn type,' van Bergen explains. 'To do this we use a special near-infra-red analyser. In 2009, we developed Refinity, an innovative separation technique which enables us to separate the yarn and other fibres from the backing, thereby producing two main material streams which can be recycled. After an additional purification stage, the yarn, with the required purity, is returned to the yarn manufacturer for the production of new yarn.'

'In the process, some virgin material is needed to compensate for losses and process inefficiency. For polyamide 6 yarn, this process takes place at Aquafil, one of our yarn suppliers. They are able to turn recovered post-consumer polyamide 6 carpet fibres into new polyamide 6 again and again.'

The polyolefin-based layer of Desso's EcoBase backing is fully safely recyclable, whereas the bitumen backing currently used in most carpet tiles in Europe is reused in the road and roofing industry. All non-recyclable fractions can be used as secondary fuel in the cement industry.



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One of the key results of the project, he says, is the recovery of polyamide 6 carpet fibres into new polyamide 6 repeatedly. In this way, polyamide 6 can be reused for the production of new yarn, known as ECONYL yarn.

'We are continuing to develop the pilot installation,' van Bergen says. 'Further improvements will include efficiency upgrades and we will add necessary additional purification steps, but ultimately we do have high confidence that we can market the technology in the medium term.'

EURO2C CARPETCHAINS received about EUR 800 000 in

EU funding and was completed in July 2013.

The project was coordinated by Desso in the Netherlands.

- 1 'Towards closed-loop chains in Europe'.

Funded under the European Commission's 'Competitiveness and Innovation Framework Programme' (CIP) under the operational programme 'Entrepreneurship and Innovation Programme' as part of the 'Eco-Innovation' initiative.
http://cordis.europa.eu/news/rcn/36195_en.html



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Flexibility for effective satellite communication

Communications satellites are currently custom-made for specific purposes and future conditions that are often difficult to predict. Novel technology accommodating flexibility in frequency tuning will reduce costs and increase services.

Estimates suggest that there are now more than 500 operational satellites orbiting the Earth. Numbers will continue to rise as satellites play an increasingly important role in commercial telecommunications, global Earth monitoring and more.

Modularity and tunability of satellite communications microsystems, with respect to wavelength and frequency band exploited, would enable mass production of components together with important reductions in cost and mass.

Such technology is possible with flexible radio-frequency (RF) front ends under development by the EU-funded project SATURNE¹. Scientists are employing wide bandgap (WBG) semiconductors such as gallium nitride (GaN)-based monolithic microwave integrated circuits (MMICs) sporting RF-micro-electromechanical

system (RF-MEMS) switches to enable intelligent microsystems (IMS).

The reconfigurable and highly efficient communication satellite payloads will accommodate multiple-frequency bands (narrow-, multi- or wide-band channel allocation) for transmission and reception.

During the six months of the third reporting period, the team established processes to fabricate the MEMS structures on three types of WBG substrates, including GaN. Having characterised the resulting MEMS structures, partners proceeded with the design and fabrication of RF-MEMS circuits on the substrates and subsequent characterisation, which is currently in progress.

SATURNE expects to deliver the flexible and low-mass communications components

required for future multi-band satellites that will not only decrease the cost of individual satellites significantly, but also enable more users and services per satellite. Reducing dependence on technology currently under export restrictions from suppliers in the United States will also ensure continued European progress unimpeded by external limitations.

The project was coordinated by Thales in France.

1 'Microsystems based on wide band gap materials for future space transmitting ultra wideband receiving systems'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/9682_en.html
 Project website: <http://www.saturne-project.com/>

SPACE

Miniaturisation to push space exploration even further

Researchers have designed a miniaturised flow-control unit for noble gases such as xenon. The system will power new electric propulsion units for more efficient and capable space and satellite applications.



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Electric propulsion is a key technology for future space missions and satellites. These depend on controlled and steady flows of xenon gases to supply their thrusters and neutralisers. However, current flow-control units are heavy, accounting for much too high a proportion of total system mass, and therefore energy use, to be viable.

An EU-funded research project, μFCU¹, has enabled the development of an electric micro-propulsion system. The project adapted technologies from applications in fields such as those in the medical or chemical industries, modifying them for the operational and environmental demands of space applications. A major benefit of this

approach is that the components were already proven to be highly reliable.

The μFCU design outperforms existing technologies in terms of mass reduction, leak tightness, drift and long-term stability. The total mass of the system is below 60 g, compared with existing technologies of

around 400 g, whilst the cycle lifetime capability exceeds the typical satellite control application requirements by a factor of three.

Project members have also reduced the complexity of driver electronics and on-board computing systems and introduced greater modularity, which will result in lower costs.

With a consortium of partners from different European countries, the project has helped the EU space industry to gain a leading position in space gas fluidic control and distribution systems. The innovations pioneered during the project will enable new classes of space missions and applications.

The project was coordinated by AST Advanced Space Technologies in Germany.

1 'Miniaturized flow control unit'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/11922_en.html
 Project website:
<http://www.microfcu.com>



Perfecting the robot that could explore space

A powerful team of companies and scientists was put together to build crucial components for planetary exploration vehicles. The team focused on on-board vision-processing equipment.

Humankind has often wondered if we are alone in the Universe and has long hoped to find signs of life on other planets. The quest to find such signs of life is being supported with technology that will include robotic exploration of the surface of Mars. The EU-funded project PROVISCOUT¹ demonstrated the feasibility of scouting for life on other planets.

The project brought together experts and scientists from different fields and parts of the world to investigate robotic planetary space missions featuring rovers or aerial vehicles. Specifically, the project looked at imaging data and robotic vision, considering sensor technology, three-dimensional (3D) camera imaging, the power to search for scientific targets, and

the ability to combine science autonomy with navigation.

To achieve its aims, the project team addressed novel vision-sensor concepts, designed the interfaces between the various components such as a rover, vision system, navigation system, decision module and monitoring system. It conducted field tests in Spain and the United

Kingdom, integrating sensors and mobility hardware to a fully operational rover and control system for mapping, navigation and science autonomy. Sophisticated sensor technology was able to distinguish between the fluorescence of micro-organisms and host minerals, producing high-resolution images that would be crucial in determining if life exists beyond our planet.

Work also focused on building an off-board component to

SPACE



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monitor rover operations and decisions, as well as developing an aerobot camera on a balloon to capture images. All the components were rigorously tested.

Sophisticated testing took place in Mars-like environments such as the Arctic and the caldera in Tenerife on Spain's Canary Islands.

Overall, the project team successfully built a framework for on-board, robot-driven vision processing. It developed technology to autonomously select

sites of interest during missions and conducted successful field demonstrations. This will help raise public awareness of planetary robotic missions, representing an ambitious EU-led initiative in furthering our quest to explore space.

The project was coordinated by Joanneum Research in Austria.

1 'Planetary robotics vision scout'.

Funded under the FP7 specific programme 'Cooperation' under the research theme 'Space'.
http://cordis.europa.eu/result/brief/rcn/10008_en.html
 Project website:
<http://www.proviscout.eu/>

Shining a light on solar prominences

The surface and corona of the Sun contain magnetic structures called solar prominences, which are made of plasma expelled by a solar flare. Researchers have studied new solar data in great detail to advance our theoretical understanding of prominences.

Recent observations have provided unprecedented details about the nature and behaviour of solar prominences. This includes information gathered about waves, flows, oscillations and instabilities in the corona.

SOLPROM-SMS¹ was an EU-funded research project

geared towards using this new data to develop a better theoretical understanding of solar prominences. The project investigated the mathematics and fluid dynamics of these prominences over time.

In the first phase of the project, the team studied the wave properties of the solar prominences

and how they changed. Using this data, researchers improved their models of how prominences form, and established new laws that govern properties such as duration and frequency.

The second phase of the project investigated instabilities in the solar prominences. Several new conclusions were reached

on how the instabilities form, grow or decline, and it was shown that instabilities can occur at lower temperatures than previously thought.

Understanding solar prominences will advance our knowledge of the Sun and of space weather in general. SOLPROM-SMS has used new data on solar prominences to move our theoretical understanding of the Sun's atmosphere forward.

The project was coordinated by the Catholic University of Leuven in Belgium.



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1 'Solar prominences: Stability, magnetohydrodynamics, and seismology'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
http://cordis.europa.eu/result/brief/rcn/12019_en.html

EVENTS

International conference on computer vision theory and applications

The ninth 'International conference on computer vision theory and applications' (VISAPP 2014) will be held from 5 to 8 January 2014 in Lisbon, Portugal.

The International Conference on Computer Vision Theory and Applications aims to gather researchers, engineers and practitioners in the area of computer vision application systems.

The conference will feature five simultaneous sessions covering different aspects related to computer vision, including image formation, image and video analysis, motion tracking and applications and services.

For further information, please visit:

<http://www.visapp.visigrapp.org/>

International conference on model-driven engineering and software development

The second 'International conference on model-driven engineering and software development' (MODELSWARD 2014) will be held from 7 to 9 January 2014 in Lisbon, Portugal.

This conference aims to provide a platform for the dissemination of research results and development activities in using models and model-driven engineering techniques for software development.

It will tackle areas in modelling languages, process methodologies and applications in software development. Plenary speakers will include leading researchers in the fields of software engineering and computer science.

For further information, please visit:

<http://www.modelsward.org/>

International conference on physiological computing systems

The 'International conference on physiological computing systems' (PhyCS 2014) will be held from 7 to 9 January 2014 in Lisbon, Portugal.

As an international meeting point for engineers, computer scientists and clinicians interested in exploring tech-based approaches to health-care challenges, this conference aims to improve the use of technology in medical diagnosis. It will centre on areas including medical devices, human factors, technology applications, methodologies and hazards.

Participants will be offered the opportunity to attend thematic tutorials designed to provide a platform for a more scientific exchange amongst researchers interested in a particular topic. The event also offers workshop and demonstration panels that aim to complement technical sessions by providing participants with a broader overview of emerging trends.

For further information, please visit:

<http://www.phycs.org/>

International conference on photonics, optics and laser technology

The second 'International conference on photonics, optics and laser technology' (PHOTOPTICS 2014) will be held from 7 to 9 January 2014 in Lisbon, Portugal.

Optical systems are ubiquitous in modern society, with applications ranging from medical sciences and space exploration to numerous industrial and military uses.

The conference will feature three varied tracks to provide researchers, engineers and practitioners with options to tailor their programmes. It will include sessions on optics, photonics and lasers.

For further information, please visit:

<http://www.photoptics.org/>

Pharmaceutical microbiology 2014

SMI's third conference on 'Pharmaceutical microbiology' will be held from 20 to 21 January 2014 in London, United Kingdom.

Building upon last year's event, 'Pharmaceutical microbiology 2014' will draw upon the experiences from knowledge experts and specialists around the globe to provide presentations and stimulating discussions.

The conference will focus on the regulatory aspects, with topics addressing preparations for auditing, what to expect during the inspection process, and how to rectify challenging situations. There will also be considerable attention given to novel rapid methods, case studies from the USA, their implementation, and the current regulatory view on methods. Among these hot topics, popular topics for debate will include sterility assessment, risk management and contamination control.

For further information, please visit:

<http://www.smi-online.co.uk/pharmaceuticals/uk/conference/pharmaceutical-microbiology>

Computers, privacy and data protection 2014: Reforming data protection — the global perspective

The seventh 'International conference on computers, privacy and data protection: Reforming data protection — the global perspective' will be held from 22 to 24 January 2014 in Brussels, Belgium.

Every year in Brussels, CPDP gathers policy-makers, academics, computer scientists, consultants, practitioners and activists from all over the world to exchange ideas and discuss emerging issues in information technology, privacy, data protection and law.

CPDP 2014 aims to stage more than 40 panels and workshops (with a stimulating mix of academics, practitioners, regulators and advocates), as well as multiple side events (such as open debates, Pecha Kucha performances and artistic interventions).

For further information, please visit:

<http://www.cdpconferences.org>

Systems thinking for a sustainable economy: Advancements in economic and managerial theory and practice

The second international symposium 'Systems thinking for a sustainable economy: Advancements in economic and managerial theory and practice' will be held from 23 to 24 January in Rome, Italy.

The symposium aims to address the global sustainability challenges from a systemic perspective.

Systems thinking sheds light on the several interactions between natural and social systems. Knowing these interactions gives a better understanding of the principles that can help solve some of today's most pressing environmental, social and economic issues.

The criticalities of and opportunities for sustainability will be discussed in light of cutting-edge research and practice in the various social science fields. This multi-disciplinary perspective includes economics, management, engineering and sociology.

For more information, please visit:

<http://bslab-symposium.net/2nd.International.Symposium.Rome.2014.htm>

CORDIS launches Top Stories service highlighting EU-funded research results

CORDIS is undergoing a significant revamp, starting with the new 'Top Stories' service which brings together success stories from across the many projects and domains of EU research. The Top Stories tab replaces the former Results tab on the CORDIS website's new top menu.

An enhanced Projects and Results service now integrates the former Technology Offers, which have been rebranded as 'Results in Brief', providing multilingual overviews of project outcomes to a broader public and supporting the exploitation of research results.

Project periodic or final reports are also available as 'Report Summaries' (formerly known as 'results') and complete the project information linked to each factsheet.

These changes reflect the role of CORDIS as the European Commission's primary public repository and portal to disseminate information on all EU-funded research projects and their results.



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