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SPECIAL FEATURE

## CLEANING UP SPACE JUNK

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TELECOMMUNICATIONS  
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TO MOROCCO  
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**Editorial coordination**

Gyn Nilsson

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# EDITORIAL

*by the editorial team*

## IS THE KESSLER SYNDROME AT OUR DOORS?

Sometimes fiction can be closer to reality than we think. Though astronauts are unlikely to meet George Clooney and Sandra Bullock in outer space, the harrowing scenes from Alfonso Cuarón's 'Gravity' could soon happen above our heads.

In 1978, Kessler — a NASA scientist — came up with a scenario which would later be referred to as the 'Kessler syndrome': a chain reaction of collisions between orbital technologies. According to Kessler, the horrid scenes from Gravity are getting increasingly likely as time goes by. And although he says we have time to deal with it, the time between collisions — around 10 years at the moment — will be halved in 20 years' time.

Kessler's observations are widely accepted by the scientific community. A few weeks ago, the International Space Station was forced to change position after a swarm of debris skimmed past it — roughly 300 metres away from its position. This had already happened three weeks before, which is hardly surprising: experts say there are about 500 000 debris items floating in Earth's orbit.

Of course, there is ultimately no other way around Kessler's syndrome than to clean the Low Earth Orbit where most satellites gravitate. Clear guidelines need to be provided, new technologies need to be developed, stakeholders should be convinced of the greater good of expensive mitigation or re-entry processes, and

### 'There are about 500 000 debris items floating in Earth's orbit'

solutions need to be found for the smallest debris — which can be difficult to track and endanger even the most resistant satellites.

Governments are well aware of the problem. China, Russia, the United States and Europe have all listed space debris among their priorities. Technologies like sails, lasers, grapples or even robotic in-space recyclers are under development, some thanks to FP7 funding.

This issue covers eight FP7 projects directly related to space debris, most of them having been completed over the last three months. These include two interviews. One is with Dr Juan R. Sanmartín of UPM, coordinator of the BETS project which demonstrates how newly developed tethers could be the next big thing in satellite de-orbiting. The second is with Christophe Jacqueland from CILAS who coordinated the CLEANSPACE project. Thanks to the latter project, laser technology used to change the trajectory of small debris is now within reach.

The magazine also includes our usual seven sections, and closes with a list of upcoming events.

We look forward to receiving your feedback. You can send questions or suggestions to: [cordis-helpdesk@publications.europa.eu](mailto:cordis-helpdesk@publications.europa.eu)



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## INTERVIEW

## THIN AS A RAIL, STRONG AS A ROCK

Satellite de-orbiting and re-entry is essential to halting the continuous increase in orbital space debris. The BETS project, which ends this month, is making waves with a new tether solution that is faster and more resistant to damage than any other existing technology.

A clean Earth orbit could be considered as a finish line on the journey towards improved space asset safety. But to get there stakeholders still need to answer three questions: how do we stop waste from accumulating in space, how do we get rid of existing debris and, once this is all done, how do we keep space tidy?

'Post-mission disposal' (PMD), which aims to move space assets to a

disposal orbit or re-enter them into the atmosphere at end-of-life, will play a major role in answering the first and third questions. Though experts suggest that PMD alone will not prevent the debris population from growing uncontrolled — the so-called Kessler syndrome tells us that each collision generates a swarm of debris fragments, triggering a chain reaction — it will certainly prevent things from getting

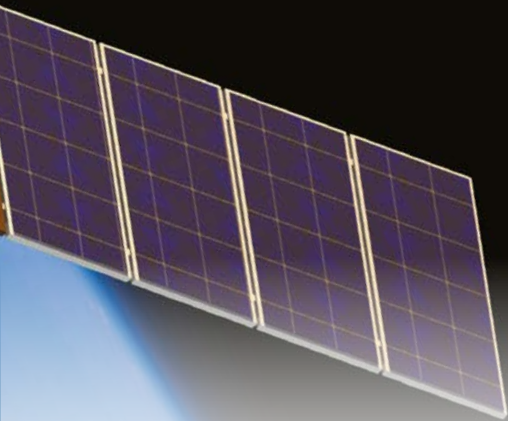
worse. But proving its efficiency will also build momentum for 'active debris removal' (ADR) by persuading businesses and governments that they are not investing in a lost cause.

Once limited to rockets, de-orbiting and re-entry technologies took a giant leap forward with the introduction of the bare tether concept in 1992. But until now these long conducting wires hanging from satellites have been highly vulnerable to





## SPECIAL FEATURE CLEANING UP SPACE JUNK



*"A de-orbit tether system of minimum complexity beats all other possible systems."*

damage from abundant small space debris.

The BETS (Bare Electrodynamic Tethers) project might have found the solution to this issue: replacing traditional round tethers with tape, they observed that the probability of the tether being damaged by debris during de-orbiting differed by several orders of magnitude — in other words, it is hundreds of times less likely.

Prof. Juan Sanmartin, who coordinated the project, told us how the team's findings make de-orbiting tether systems more efficient, faster and resistant than any other existing technology.

### ★ What are the main objectives of the project?

**Prof. Juan Sanmartin:** The BETS project is focused on a single but ambitious long-term objective: proving that a de-orbit tether system of minimum complexity beats all other possible systems, whether propulsive systems (chemical, electrical) or just dragging systems augmented by deploying a sail. We aim to demonstrate that such a solution has the lowest system-to-satellite mass ratio and makes de-orbiting faster with better manoeuvrability, but also that it has a high reliability level and a capacity to survive space debris throughout operation. The project was determined to develop its concept up to Technology Readiness Level 4-5 — that is, validation in laboratory and relevant environment.

### ★ How does a space tether work exactly?

A space tether is a thin, multi-kilometre-long, conductive wire bridging a satellite and some opposite end mass. The tether frame is in motion relative to the co-rotating plasma and Earth's magnetic field. As a result, the highly conductive ambient plasma, which is equipotential in its own frame, presents, in the tether frame, a motional electric field of an order of 100 V/km, which is the product of (near) orbital velocity and the geomagnetic field. This allows plasma contactor devices to collect electrons at one polarised-positive (anodic) end and eject electrons at the opposite end, setting up a current along a standard, fully insulated tether. Lorentz drag on the magnetically induced tape current produces orbital decay of the satellite.

### ★ What kind of technological advances does BETS bring to the table?

The bare tether concept had taken away the insulation and had electrons collected over the anodic segment for a much more effective current collection. Ten years ago tether technology might have been said to face three main difficulties. One was the re-entry issue that Design for Demise had resolved years ahead of BETS. Another was

the generally-acknowledged low probability of survival of round tethers when hit by small debris; which has given rise to the complex concept of multi-line 'tape' — we will call it 'fake tape' — made of thin round wires cross-connected to survive debris impacts. This concept also emerged before BETS was kicked off and has somehow been accepted as the solution to the tether survivability problem.

What we bring to the table is proof that a bare tape might withstand impact much more effectively than a bare round tether, due to both faster de-orbiting and the disparate character of width and thickness. This, along with the finding that real tape de-orbits much faster than 'fake tape', is a fundamental result in tether technology.

A third difficulty was the long de-orbit times high inclination orbits seemed to require. This was partly offset by detailed calculations under a detailed model of the geomagnetic field. It was further shown in BETS that the coupling of in-plane, off-plane oscillations, if bounded, helped de-orbiting by keeping the tether moderately away from the orbital plane.

### ★ You said this technology was much more efficient. How so?

Tethers use a dissipative mechanism quite different from air drag and can de-orbit in just a few months; also, tape tethers are much lighter than round tethers of equal length and perimeter, which can capture equal current. The three disparate tape dimensions allow easily scalable design to apply for arbitrary missions. Switching the cathodic contactor off-on allows manoeuvring to avoid catastrophic collisions with big tracked debris. Lorentz braking is as reliable as air drag. Tethers are still reasonably effective at high orbital inclinations, as mentioned above.

### ★ What are the next steps for the project, and follow-up plans after it ends?

We have multiple opportunities ahead of us. One of them is the fact that Horizon 2020 includes a topic for the in-orbit demonstration of

## SPECIAL FEATURE

de-orbiting a satellite at the end of its operational life.

Mr Gómez Molinero, CTO from Airbus Defence & Space Spain, manifested his interest in electrodynamic tethers at the 6<sup>th</sup> European Conference on Space Debris at ESOC/ESA (2012). Several contacts and meetings between BETS-UPM and Mr Gómez took place, where Mr Gómez was invited to make a presentation about a possible

collaboration in the next H2020 call. Airbus would be interested in the use of bare electrodynamic tethers for de-orbiting the Multiple Payload Dispensers in the VEGA or Soyuz-Fregat Arianespace launchers, dispensers that it does build. He contacted Arianespace for that purpose, and one of his collaborators at Airbus started the preliminary design of such a demonstration mission under UPM supervision. A meeting

with Arianespace is planned for this spring.

★ **Are you pleased with the results of your research?**

We are. An important result from BETS was the determination of design criteria for sizing the three disparate dimensions of a tape tether — affecting the mass, ohmic effects, current-collection regime, self-magnetic field and survivability against debris in space under varying ambient conditions and as the tether loses altitude. A specific, thorough full code named BETsMA is now a Registered Design.

Other important results are innovative manufacturing, as well as ground-testing of basic tether-system hardware: Plasma Contactor (Colorado State University), Power Control Module (small company emxys), Deployment Mechanism (DLR — Bremen), and crosswise / lengthwise structured tape (Fundación Tecnalia). Furthermore, fundamental research at the Università di Padova and ONERA-Toulouse improved current knowledge of the basic physics underlying tether technology.

★ **Have any governments shown interest in deploying the technology yet?**

There is indeed a potential impact at a political, international level. The increase in the number of countries with direct access to space makes the present approach to the debris problem not just European or national, but fully international. To guarantee an effective implementation of de-orbiting new satellites at end-of-life, international consensus is required, in effect resting on UN space governance. The project could certainly lead to exploitation of leading-edge technology by companies in Europe. Ultimately, however, it could have a political success comparable to its commercial one.

**PROF. JUAN SANMARTIN**



© Prof. Juan Sanmartin

**BETS**

★ Coordinated by the Technical University of Madrid in Spain.

★ Funded under FP7-SPACE.

★ Project website:

<http://www.thebetsproject.com>



# MICROPROPULSION FOR KAMIKAZE DEBRIS-REMOVAL MISSIONS

How do we make space exploration cheaper, facilitate satellite maintenance and remove debris from Earth's orbit? A European team of researchers led by the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland believes all answers lie in a single technology: a new, ultra-compact motor that will enable small satellites to journey beyond Earth's orbit.

Space exploration is an expensive pastime. And although it is still a high priority on political and scientific agendas, shrinking budgets are pushing engineers into a quest for more efficient technologies to enable low-cost missions. The price tag for small satellites, for instance, is around EUR 360 million. The bigger the satellite, the higher the cost. Nanosatellites could be an alternative, but until now they have lacked an efficient propulsion system.

MICROTHRUST (Microelectromechanical systems (MEMS)-based electric micropropulsion for small spacecraft to enable robotic space exploration and space science), a project supported under the EU's Seventh Framework Programme (FP7) to the tune of EUR 1.9 million, aimed to tackle this issue with a new propulsion technology. The latter will equip 'Clean Space One', a disposable space-cleaning satellite due to launch in 2018.

The MICROTHRUST technology is a small, high-performance electrical micropropulsion system of a few hundred grams which, combined with advanced nano- or micro-satellites weighing from 1 to 100 kilograms, gives birth to spacecrafts capable of flying to any location in the Earth-Moon system and beyond — in just a fraction of the time and at a fraction of the costs of existing technologies.

The system runs on an ionic chemical compound (EMI-BF4), using electricity to expel ions and generate thrust. But if it does indeed need fuel, consumption levels are ridiculously low. According to EPFL scientist Muriel Richard: 'We calculated that in order to reach lunar orbit, a 1-kg nanosatellite with our motor would travel for about six months and consume 100 millilitres of fuel.'

Combined with Clean Space One, the technology is expected to help clear Earth's orbit of targeted debris. Its first target will be none other than SwissCube, the first-ever Swiss satellite launched in 2009 to photograph 'air glow' — a photoluminescence phenomenon that occurs in the upper atmosphere and is caused by the

interaction between solar radiation and oxygen molecules.

Clean Space One, which will feature a gripping mechanism inspired from a plant or animal, will track down SwissCube at a speed of 28 000 km/h, grab it and head back to the atmosphere where both satellites will disintegrate. The kamikaze operation is expected to cost EUR 8 million. Its aim is to inspire other spacefaring nations to handle their satellites and other space debris in a responsible manner.

## MICROTHRUST

- ★ Coordinated by the Swiss Federal Institute of Technology in Lausanne, Switzerland.
- ★ Funded under FP7-SPACE.
- ★ Project website: <http://microthrust.eu>
- ★ <http://bit.ly/PNg8nd>



## INTERVIEW

## BIG LASER FOR SMALL DEBRIS

Remember how Imperial destroyers smashed asteroids in 'The Empire Strikes Back'? You can almost consider that old fashioned. Thanks to the CLEANSPACE project, space debris as small as 1 cm could soon be tracked down by Earth-based lasers.



© Dr Christophe Jacqueland

Dr Christophe Jacqueland

The protection of satellites is a pressing issue. If we were to replace the approximately 1 000 active satellites in orbit today, the estimated cost would be around EUR 100 billion. Many sectors of the economy would be impacted, and society as a whole would have to suffer the consequences.

*"We believe the ground-based laser station we envisioned can be up and running within 10 years."*

Various technologies have been considered to resolve this issue. From DARPA's scavenging robots and ESA's cargo freighters — both due to launch in 2015 — to Japan's fishing nets, scientists' brains teem with ideas. Laser technology is one of these. Proposed by NASA in 2011, the concept of a laser station used to modify the trajectory of space debris is increasingly looking like a suitable solution.

The CLEANSPACE (Small debris removal by laser illumination and

complementary technology) project, which has been running for three years and is due to end this month, looks into the role laser technology could play in the removal of small debris — the most problematic for orbiting satellites. Their main objective is to define a technology roadmap for surveillance, identification and tracking, to be used with a possible ground-based laser protection system.

Dr Christophe Jacqueland, who coordinates the project, agreed to discuss some of its main outcomes.

★ **What are the main objectives of the project?**

**Dr Christophe Jacqueland:** The CLEANSPACE study is an answer to FP7 Security research call SPA-2010-2.3.02 'Need to protect space assets from on orbit collision'. It aims to answer this need by defining the necessary requirements for the safe and routine removal of small space debris in Low Earth Orbit with a ground-based high-energy laser station. Such technology would protect valuable space assets from destructive on orbit collisions.

★ **What is new or innovative about the project?**

Using a laser to modify the trajectory of space debris is new and we defined a global architecture of such a ground-based system. But the more innovative part of the project is at the technical level: laser matter interaction in a vacuum has been studied, coherent coupling of laser beams of moderate energy has been demonstrated, and the suitability of ceramic technology to develop large-size samples with a complex shape and luminescent dopant repartition has been tested. In order to ensure lasting international support and a smooth debris removal process, an international organisation has been proposed and finally simulation tools have been developed to evaluate trajectory modification for single-pass or multiple-pass operation.

★ **How would your global architecture work exactly?**

Such a system can create, for each shot, a very small thrust on space debris by ablating a very thin layer of its surface. The repetition of thousands of shots of such lasers reduces the velocity of the space debris, pushing it into a lower orbit. This concept can allow both for changing the course of a piece of debris — thereby avoiding a predicted collision with valuable space infrastructure — and ultimately for removing the waste, as its new course leads to atmospheric re-entry.

★ **What were the main difficulties you faced and how did you resolve them?**

No major issue was faced during the project, thanks to a very competent team, a team of people with experience who got to know each other, who didn't change from the beginning to the end. I would like to take the opportunity of this article to say that it was a pleasure for me to work with all of them, and benefit from their various fields and nationalities.

Of course, we faced some important decisions during the course of the CLEANSPACE project, as we were constantly looking for optimisation. The more important one was when we merged the two initial laser concepts (one from each main laser partner and external activities) to define a third laser architecture using the best concepts of its predecessors, and especially the actively-coupled Nd:Yag ceramic amplifiers.

★ **What are the next steps for the project, and follow-up plans after it ends?**

When CLEANSPACE comes to an end, we believe the ground-based laser station we envisioned can be up and running within 10 years. The realisation of this system can be separated into two phases. Phase one will deal with necessary technology steps, primarily laser development,



integration of several technologies into a demonstrator, implementation of a first debris monitoring and cataloguing network and policy implementation.

The second phase can be started only upon commitment of the European Union and other major spacefaring nations to ground-based 'laser debris removal' (LDR) and an agreement to fund the construction of an LDR system. Within this phase, the LDR station will be constructed and the high-energy laser, the telescope and some additional optical components will be fabricated and integrated into the station. It seems feasible to complete this second phase within five years.

★ **Are you pleased with the results of your research?**

The project organised a demonstration day before the end of the project to disseminate the main

technical results and to show the four experiments we made: one named 'Debris tracking Mock-up', one which illustrates 'laser propulsion', a 'laser coupling demonstrator' and finally a 'disk laser demonstration'. Participants had the opportunity to find out more about the concept and to see how a laser can move an object in a vacuum environment (because the space debris environment is a vacuum).

★ **Have any businesses or governments shown interest in deploying the CLEANSPACE technology yet? When do you think it could materialise?**

The business model of such a system is still to be developed and it was not part of CLEANSPACE. However we developed a roadmap for a 10-year effort.

The amount of debris in Low Earth Orbit is rapidly increasing with, in the

short term, potential collisions between debris and space assets and a possible chain reaction. Removing five big pieces of debris per year with automatic missions is useful but we must also address the issue of reducing the population of small debris which will continue increasing for decades. The CLEANSPACE project is a solution for small debris, and this is what we emphasized when discussing with businesses.

**CLEANSPACE**

★ Coordinated by CILAS in France.

★ Funded under FP7-SPACE.

★ Project website:

<http://www.clean-space.eu/>

★  <http://bit.ly/1knlnEc>

*"The repetition of thousands of shots of such lasers reduces the velocity of the space debris, pushing it into a lower orbit."*

## SPENDING NOW FOR HIGHER LONG-TERM BENEFIT

Cleaning space is a costly endeavour, one where every euro needs to be spent wisely. But short-term financial predictions certainly won't help in the fight against space debris. New guidelines and recommendations defined under the ACCORD project should prove highly valuable in changing habits and switching priorities.

Is the money invested in space debris mitigation well spent? This question was at the heart of ACCORD (Alignment of Capability and Capacity for the Objective of Reducing Debris), an FP7 project which ended in February.

'There could be more investment, but I think manufacturers and operators take an understandable 'cost versus benefit' approach to debris mitigation,' explains Dr Hugh G. Lewis, coordinator of the project. 'As our survey has found, some mitigation measures are more costly or technically challenging to implement and those are the measures that, typically, have the greatest long-term benefit for the environment but little apparent short-term benefit for the manufacturer or operator.'

ACCORD investigated the industry's capability to implement various debris mitigation measures, along with the latter's capacity to reduce debris creation. They then proceeded to combining capability and capacity indicators within an environmental impact ratings system to evaluate the effectiveness of mitigation practices and, last but not least, identified existing and future challenges for investors.

'GEO satellites are, arguably, the most expensive satellites to build and launch, and they are responsible for the major share of revenues from space infrastructure. Correspondingly, perhaps, compliance with GEO post-

*"A decade after the publication of the IADC Space Debris Mitigation Guidelines one might have expected compliance to be near 100%."*

mission disposal guidelines is very high. In contrast, satellites in LEO generate a much smaller share of the total revenues from space but they reside in

the worst debris environment. Compliance with LEO post-mission disposal guidelines is only one tenth of the compliance in GEO', Dr Lewis notes. This issue is even more obvious with most nano-satellites which, although relatively inexpensive to build and launch, generate very little revenue — making it unaffordable to comply with debris mitigation guidelines or standards.

'The inclusion of the 25-year post-mission de-orbit requirement in the CubeSat Standard is a step in the right direction. That being said, a decade after the publication of the IADC Space Debris Mitigation Guidelines one might have expected compliance to be near 100%.' Dr Lewis expects the project's results to improve the statistics.

To help stakeholders face the most common non-compliance scenarios, ACCORD provides suggestions for improvements to international debris mitigation guidelines and standards, options for better regulatory oversight and possibilities for future research and development. Some of these include



improved space situational awareness, spacecraft protection, de-orbit devices and design for demise.

Now that the project has come to an end, ACCORD partners want to build on the work that has been done over the last three years. 'We now have an understanding of the context in which spacecraft manufacturers and operators are working,' Dr Lewis notes. 'This understanding will be crucial as the consortium members work within organisations such as the IADC, the United Nations and ISO to monitor existing debris mitigation guidelines and standards, and to develop new measures to tackle the space debris problem. At the same time, those in the space industry are now able to perform their own simple assessments using the ACCORD Environmental Impact Rating System, and we are aiming to increase the awareness of this system. I am optimistic that the multi-faceted approach will promote improved compliance with debris mitigation guidelines'.

For future work, Dr Lewis already has hopes of tackling another issue: that of 'active debris removal' (ADR). Whilst there are currently no guidelines or standards addressing these future practices, a gap will quickly appear and ACCORD knowledge could prove priceless when it comes to closing it.

### ACCORD

- ★ Coordinated by the University of Southampton in the United Kingdom.
- ★ Funded under FP7-SPACE.
- ★ Project website: <http://www.fp7-accord.eu/>



# PROTECTING OUR SATELLITES FROM SMALL DEBRIS IMPACT

The volume of space debris will increase in the coming years, so the probability of damage to our satellites will simultaneously climb. Manufacturers of satellites in 'Low Earth Orbit' (LEO) will be forced to introduce new and more robust designs.

The EU-funded REVUS (Reducing the Vulnerability of Space Systems) project anticipated this trend and, for almost three years, worked to provide techniques and solutions at system level and at architecture level aimed at reducing the vulnerability of LEO satellites to small debris impact. Targeting debris from 0.1 mm to 5 cm, REVUS was led by France's Airbus Space systems and comprised nine other expert partners from five countries. The project consortium concluded its work in December 2013.

The project team began by embarking on a vulnerability analysis of the current satellites. The analysis allowed them to calculate the contribution of each range of debris size to the satellite risk of failure and propose different solutions at satellite architecture level. Claude Cougnet of Airbus Space systems, coordinator of REVUS, points to one of the vital conclusions from the project. 'REVUS has shown that the major contributors to the vulnerability of the satellite are the particles with a diameter in the range of 3 to 4 mm, and that protecting the satellite against this size of debris would see a

significant reduction in the probability of failure due to the debris.'

Following the vulnerability analysis, the selected solutions were assessed to see how well they would work in future satellites. The team conclusively agree that a combination of solutions, rather than a single solution, is the most attractive approach. In fact, the application of a set of solutions on two reference satellites showed that the risk of failure was reduced by at least 50%. Mr Cougnet was keen to emphasise this point. 'There is no generic solution applicable to all satellites: the set of solutions will be specific to each satellite design, depending on application, orbital parameters, satellite configuration and needs. REVUS brings a palette of solutions with their potential gains and impacts.'

REVUS also investigated and evaluated the characteristics and performances of shield building blocks, and succeeded in developing a set of enhanced spacecraft shielding configurations. The space community can now benefit from the REVUS's 67 design rules for future satellites that take into account protection against debris from the

early phases of development to minimise or avoid impacts.

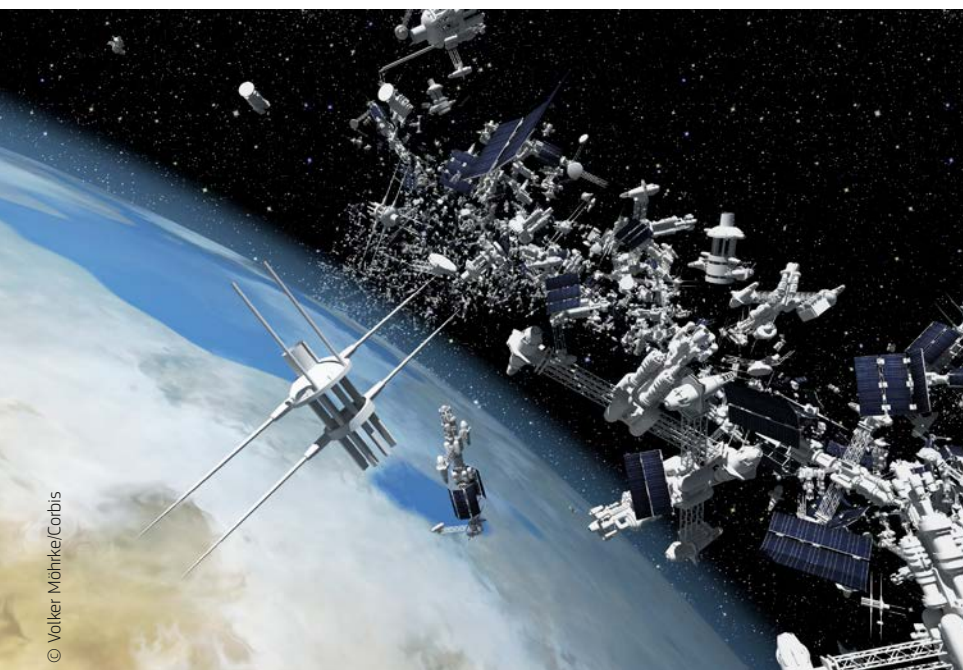
The REVUS team gathered together for a final workshop in Paris towards the end of 2013 where each partner had the opportunity to present and discuss results in front of representatives from agencies, industry, universities, etc. Mr Cougnet notes, 'The team is satisfied with the general results achieved together. But it was clear from the start of the project, that each partner also had its own objective such as improving an existing tool, increasing experience in shielding materials, developing solutions for future satellites, etc. I think that the team is also satisfied with the results with respect to the particular objective of each partner.'

Mr Cougnet is confident that these results will be of benefit to the space community — institutional, industrial as well as scientific. 'Research institutes and universities have used REVUS scientific findings and models to improve the design of space systems. They have also improved their models of environment for the evaluation of impacts of small debris on a satellite and have developed architectures to reduce the vulnerability of satellites. The advancements generated during the project will be used as a baseline for future research.'

Looking to the future, Mr Cougnet adds, 'The REVUS team is now drawing on lessons learned in order to identify where additional work would be necessary to improve or complete the results. For instance is it possible to consolidate by test the extrapolation of the ballistic limit equation of the tested shielding configuration above 7 km/s? Based on this analysis, we will probably propose a follow-up project for the appropriate Horizon 2020 call.'

## REVUS

- ★ Coordinated by Airbus Defence & Space/Space systems in France.
- ★ Funded under FP7-SPACE.
- ★ Project website:  
<http://www.revus-project.eu/>



## SAFER ORBITING FOR SATELLITES

With space junk travelling at speeds of up to 50 000 kilometres per hour, even the smallest bits can cause serious damage to our communication, Earth-observation and navigation satellites. P<sup>2</sup>-ROTECT is a European collaboration which sought to provide the space community with solutions to better deal with the space debris by developing a global vulnerability tool.



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P<sup>2</sup>-ROTECT (Prediction, Protection & Reduction of Orbital Exposure to Collision Threats), which ran for almost three years and concluded in December 2013, focused on quantifying, evaluating and reducing vulnerability to space debris by developing a definition of vulnerability and a way to calculate it via its innovative Savespace tool.

Thibault Lang, project coordinator for P<sup>2</sup>-ROTECT, is more than satisfied with the results: 'The method and the Savespace tool developed during this project represents a breakthrough in the domain of risk evaluation since it takes into account both types of debris (untrackable and trackable debris) and works at mission level (service availability) instead of spacecraft level,' he explains.

Space debris can be broken down into 'trackable' and 'untrackable' items. Currently our space surveillance equipment can track objects in 'Low Earth Orbit' (LEO) as small as a few centimetres in diameter, yet collisions with objects above 1 cm in diameter can also be fatal for the space assets. For the trackable debris population, satellites execute collision avoidance manoeuvres, requiring costly onboard propulsion systems and in many cases limiting the satellite lifetime. Smaller objects, meanwhile, simply cannot be tracked and collisions are unpredictable.

In its research efforts, P<sup>2</sup>-ROTECT took both untrackable and trackable debris into account. The team investigated three ways of reducing the mission vulnerability, in both the

short and long term, based on an integrated methodology developed during the project, namely: better satellite protection, better conjunction prediction, and a cleaner environment.

The Savespace tool developed by the P<sup>2</sup>-ROTECT team allows for the analysis of very innovative risk reduction solutions. Compared to traditional methods these avoid the overestimation of risks due to debris and allow trade-offs between solutions oriented towards avoidance of trackable debris and the collision effect of untrackable ones.

Mr Lang notes, 'Savespace succeeded in quantifying the current risks induced by the overall space debris population on three missions of interest for the EU: Sentinel-1 (S1) in LEO, GALILEO constellation in Medium Earth Orbit and 'meteosat third generation' (MTG), the weather observation constellation in Geostationary Orbit.' Analysing these three missions with extreme orbital regimes in terms of collision exposure gave a first distribution of the global risk in space.

In the S1 orbit where the risk induced by space debris is much higher with respect to the two other missions, P<sup>2</sup>-ROTECT found that in the long term full mitigation measures are sustainable and limit the natural increase of the mission vulnerability (induced by the Kessler syndrome) while better prediction can notably increase the safety in the short term. Mr Lang details P<sup>2</sup>-ROTECT's main findings, 'According to our assumptions, the S1 mission risk



evaluations in the long term (2093-2100) show that full compliance with the mitigation measures leads to a situation twice safer than that induced by an active debris removal of five objects per year in a MASTER2009 Business-As-Usual context. In the short term (2013-2020), a better prediction of the conjunctions is a global measure more efficient than protecting the satellite S1 itself.' The work of the P<sup>2</sup>-ROTECT team could have a concrete impact on the lifespan of our satellites and other space assets. By combining better prediction with enhanced satellite protection, it is estimated by P<sup>2</sup>-ROTECT that S1 could gain an extra mission lifetime of 4% of its nominal lifetime (7.25 years).

Savespace conveniently translates the risk at mission level into a 'cost' effective index which indicates the extra mission lifetime saved with respect to the current situation by implementing some risk reduction measures. The risk is also evaluated at function level, and gives valuable information on the most vulnerable functions contributing to the mission.

'This new way to apprehend the risk and to identify the most effective palliative measures is now adopted and used by Thales Alenia Space [a French-Italian aerospace partner] for its own studies. On MTG the risk reduction methodology and the proposed design recommendations will be enforced by the OHB System [a German space technology partner].' According to Mr Lang, the findings of P<sup>2</sup>-ROTECT also consolidate the European Space Agency (ESA) position through the European 'Space Situational Awareness' (SSA) Programme and demonstrate the significant role that lethal trackable debris plays in the global risk assessment.

A wide variety of other groups can benefit from the Savespace tool and the work of P<sup>2</sup>-ROTECT. The target communities of the project include the space industry, national and regional agencies and policy makers (such as the United Nations Office for Outer Space Affairs, European Commission, governments/space agencies, European Space Agency, European Space Council), insurance companies and the general public.

Other researchers and policy makers will also benefit from P<sup>2</sup>-ROTECT's efforts. 'The Savespace tool is expected to shed new light on the mission risk evaluation taking into account the global effect of the space debris. Therefore it can provide objective and factual results in a European decision-making process.' Mr Lang cautions, however, that further testing and research is necessary. 'More exhaustive mission risk assessments with the Savespace tool have to be conducted in order to draw a global map of the most successful risk reduction strategies for every orbital regime.'

The P<sup>2</sup>-ROTECT partners are currently working on a proposal under the Horizon 2020 programme to ensure that they can build on the impressive achievements of the first project phase.

#### P<sup>2</sup>-ROTECT

- ★ Coordinated by ONERA Aerospace Lab in France.
- ★ Funded under FP7-SPACE.
- ★ Project website: <http://www.p2roTECT-fp7.eu/>

## THE EU KEEPS AN EYE ON THE SKY

Satellites and space debris in space must be closely monitored to maintain security and ensure seamless communication technology.

Space around the Earth is much busier than it seems. There are satellites roaming the skies, hovering space debris, strange weather phenomena and high-tech communication airwaves all creating a congested space environment. The importance of space for communications, geospatial navigation, defence and the environment has prompted the EU to enhance its 'space situation awareness' (SSA). One of the ways it has done so is through the EU-funded project SPA (Support to Precursor SSA Services).

The project developed European SSA capabilities to better manage and exploit space assets in line with the European Space Policy, strengthening both security and the economy. It mapped knowledge on the topic to produce recommendations for advancing SSA, particularly as related to policy and governance issues.

SPA also established a forum on the topic and emphasised key issues to stakeholders through workshops and presentations. It conducted numerous

modelling scenarios and exercises involving orbit determination, in addition to analysing data from key SSA surveillance and tracking sensors.

Much of the project's work has helped advance the 'European Union Satellite Centre' (EUSC) by providing over-flight information on satellites to better plan image acquisition. Indeed, the main goals of the project have been to facilitate space surveillance as well as the tracking of man-made and near-Earth objects such as comets. SPA was also designed to enhance environmental monitoring, in addition to monitoring and forecasting space weather, which yields valuable information for space missions.

Balancing sensitive information that is both civil and military in nature, the project produced concrete findings on SSA requirements to support security and advance policymaking. It also studied the economic and strategic importance of space, as well as the legislative framework of SSA in Europe.



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All these findings, outcomes and recommendations will help enhance national security and sovereignty, supporting SSA activities and helping to introduce new services that promote the well-being of EU citizens. The project has underlined the importance of having 'security in space from space', safeguarding space assets and satellite-based services while ensuring the sustainability of space. This initiative will undoubtedly help secure the future of SSA in Europe.

#### SPA

- ★ Coordinated by the European Union Satellite Centre in Spain.
- ★ Funded under FP7-SPACE.
- ★ [http://cordis.europa.eu/result/brief/rcn/11091\\_en.html](http://cordis.europa.eu/result/brief/rcn/11091_en.html)

BIOLOGY AND MEDICINE

# FIGHTING CANCER BY ATTACKING ITS SUPPORT NETWORK

When we think of cancer we often think of rogue, villainous cells in an otherwise healthy organ. But research is increasingly showing that our bodies are complicit in the disease, providing cancer cells with hiding spaces. Scientists are trying to use this knowledge to create a more accurate laboratory model of one particular type of cancer — multiple myeloma — and thus to develop better drugs to treat it.

**M**ultiple myeloma affects a type of white blood cell. In Europe and the USA 50 000 people are diagnosed yearly with multiple myeloma. Drugs targeting the cancer have been marginally successful, but many have failed when they get to human testing.

Therefore the EU-funded OPTATIO (OPTimizing TArgets and Therapeutics In high risk and refractOry Multiple Myeloma) project is developing a new type of testing platform that incorporates both cancer cells and their surrounding 'micro-environment': tissue cells, bone marrow cells, blood vessel cells and immune cells. These support cells are in close contact with the cancer cells and are exchanging chemical signals with them as a tumour develops. In essence, they serve as the soil in which the seed of cancer grows.

Researchers have already created realistic 'co-culture' systems of both seed and soil, but what the OPTATIO project introduces is an entirely new level of verification of the results. Through partnerships with clinicians the team has

collected cells from hundreds of myeloma patients across Europe. Since clinical data also exist on these patients — including information about which drugs they responded to and how — the results between cell culture and real-life patient can be compared to get as close a replica as possible.

In addition, co-culture systems could allow researchers to test a new approach to drug therapy: perturbing the cancer's 'soil' rather than attacking the cancer cells directly. This is a promising improvement since drugs that target the cancer cells often do not kill all of them, and can thus encourage drug resistance. 'Drugs will always target only a proportion of the disease, and so there is a lot of selective pressure on these cells,' says Project Coordinator Wolfgang Willenbacher at Innsbruck Medical University in Austria. 'We feel the environment might be a much more constant variable,' he adds.

The industrial partners involved in the project initially provided thousands of compounds that were tested in the

co-culture systems. Two primary categories of potential drugs tested were kinase inhibitors, which block enzymes crucial for cancer cells to multiply, and natural marine substances, which contain chemical weapons produced by marine organisms.

From that original testing, the researchers identified several promising candidate compounds to bring to the next stage of drug testing, in mice. That part of the project is underway now. Depending on how the tests go, the team expects to have at least one, and maybe more, drugs ready for phase I clinical trials by the end of 2014.

## OPTATIO

- ★ Coordinated by Innsbruck Medical University in Austria.
- ★ Funded under FP7-HEALTH.
- ★ [http://ec.europa.eu/research/headlines/news/article\\_14\\_03\\_24\\_en.html](http://ec.europa.eu/research/headlines/news/article_14_03_24_en.html)
- ★ Project website: <http://www.optatio.eu>



## WORKPLACE EXPOSURE TO NANOPARTICLES

Engineered nanoparticles (ENPs) are ubiquitous, advancing the state-of-the-art in applications ranging from medical technology to aerospace. EU-funded scientists developed 17 portable devices to monitor workplace exposure for enhanced public safety.

ENPs have unique electromagnetic and other properties in comparison to bulk quantities of the same compounds, with functionalities that were not previously possible. These miniature materials with at least one dimension on the scale of 100 nanometres or less have very high surface areas compared to their volumes. The resulting high surface reactivity leads to interesting interactions.

This particular property also raises safety concerns about workplace exposure to ENPs as reactivity with biological tissue could be problematic. The EU-funded project NANODEVICE (Novel concepts, methods, and technologies for the production of portable, easy-to-use devices for the measurement and analysis of airborne engineered nanoparticles in workplace air) developed 17 easy-to-use, portable pre-prototype devices and measuring instruments to characterise and assess the levels of ENPs in the workplace, both online and offline. At the time of project initiation, no similar devices were in existence. The few in existence measured only size distribution, number concentrations or effective surface area. However, most did not allow

online measurements, were expensive and difficult to use, and had limited sensitivity.

Scientists produced a nano metal oxide reactor and ENP aerosol synthesis reactors. These were used to manufacture and characterise the physicochemical properties and metrics of 23 reference airborne ENPs. Importantly, researchers identified the relationship between certain physicochemical properties and toxicity, providing increased understanding of ENP behaviour in organisms and corresponding biological responses. Such knowledge is fundamental in determining safe 'Occupational exposure limits' (OELs).

NANODEVICE also worked toward standardisation of ENP safety protocols and regulations. However, this broad-sweeping area will require major support from governments, industries and research centres at national, regional and international levels. The team put together a report summarising standardisation needs and outlining an implementation strategy.

Small and medium-sized enterprises (SMEs) often dominate ENP research but budgetary constraints mandate

the use of only cost-effective solutions. The numerous prototype devices produced by NANODEVICE promise to significantly enhance workplace safety and increase the competitiveness of participating SMEs. Moreover, these devices will

*"The numerous prototype devices produced by NANODEVICE promise to significantly enhance workplace safety."*

provide the foundations for evidence-based decision-making for policy-makers and lead to effective setting of OELs. Safe production of ENPs and enhanced public support will have important benefits for EU competitiveness as well as public health.

### NANODEVICE

- ★ Coordinated by the Finnish Institute of Occupational Health in Finland.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/result/brief/rcn/10695\\_en.html](http://cordis.europa.eu/result/brief/rcn/10695_en.html)
- ★ Project website: <http://www.nano-device.eu>



## INTEGRATING HOMECARE FOR OLDER, FRAIL PATIENTS

European researchers investigated problem areas related to the health services continuum. Issues often arise following discharge from hospital, due to fragmented care systems. The focus was on integrated homecare for older, physically frail patients.

Aiming to carry out a comprehensive evidence-based assessment of 'integrated homecare' (IHC) in terms of a 'Health technology assessment' (HTA), the HOMECARE (Clinical continuity by integrated care) project focused on patients having suffered a stroke, heart failure and chronic obstructive pulmonary disease. The HTA, based on practical guides for each of the selected chronic conditions, was developed by international expert groups representing each condition. The EU-funded initiative included clinical trials and pilot experiments with tele-facilities.


Project partners developed and documented new discharge pathways for elderly, frail somatic patients, for each of the three chronic conditions studied. Researchers propose that these pathways be followed alongside the coordination carried out by general practitioners.

The HOMECARE project identified a number of conditions that are crucial to IHC implementation. First, patient psychological values and the home setting are at the core of IHC organisational efficacy. Second, IHC should be delivered by a multidisciplinary outreach team. Third, organisation and finance must be adapted to the local health system. Lastly, integrated clinical patient-centrism should be balanced with the economics of IHC.

Comparing IHC with usual hospital care, the EU-funded study first reviewed the existing knowledge base on IHC for patients having suffered a stroke, heart failure and chronic obstructive pulmonary disease. Researchers added to that knowledge through new project surveys and trials. They then worked to develop practical guides on IHC services relevant to the three chronic conditions under study. The practical guides serve as guiding material for local healthcare teams planning to implement IHC services, and contributed to generating key input to the final HTA.

With studies conducted in countries across Europe, including Poland, Portugal, Sweden, Denmark and the Netherlands, HOMECARE project results point to the effectiveness and potential of IHC for stroke, heart failure and chronic obstructive pulmonary disease patients. This is supported in terms of clinical effectiveness, health economic evaluation, patient and caregiver perspectives, and organisational perspectives. IHC thus represents a sound alternative to usual hospital care, for patients and healthcare providers, and given the net savings for society.

### HOMECARE

- ★ Coordinated by the University of Southern Denmark in Denmark.
- ★ Funded under FP7-HEALTH.
- ★ [http://cordis.europa.eu/result/brief/rcn/12902\\_en.html](http://cordis.europa.eu/result/brief/rcn/12902_en.html)
- ★ Project website:  
<http://www.integratedhomecare.eu>
- ★  <http://bit.ly/1ikios0>



## NEW BIOMARKERS FOR PROSTATE CANCER

Prostate cancer is the most common cancer type for men in Europe. New tumour-stage biomarkers could greatly facilitate early diagnosis and treatment of the disease.

The greatest challenge in the medical management of prostate cancer is the development of markers that can distinguish between early-stage, non-aggressive tumours and those that will progress to an invasive form of the disease. The major objective of the PROMARK (Genetic prostate cancer variants as biomarkers of disease progression) project was to test if inherited genetic variants can serve as biomarkers for disease prognosis. The EU-funded

project integrated the efforts of 18 research groups.

During the course of the project, samples and clinical information from 5 500 prostate cancer cases and over 7 000 controls from different parts of Europe were collected. Genetic studies of the collected samples led to the discovery of six sequence variants that affect the risk of prostate cancer. Only one of the variants showed a stronger association with the

aggressive form of the disease. In addition, six sequence variants that associate with levels of 'Prostate-specific antigen' (PSA) in blood were identified. A risk model that included both the prostate cancer risk variants and PSA variants outperformed risk models that included only the cancer risk variants.

Functional studies of the role of the transcription factor HNF-1Beta in normal and malignant prostate cells were



conducted. Expression analysis showed that higher levels of HNF-1Beta are associated with improved prognosis. Over expression of HNF-1Beta in prostate cancer (PC3) cells demonstrated that HNF-1Beta has a measurable effect on the expression of a large number of genes.

*"The results of the PROMARK project have been presented in 10 scientific publications."*

Pathway analyses indicated that the largest effect is on genes that play a role in cell death and survival, movement and proliferation. Over expression of HNF-1Beta in PC3 cells reduced proliferation, adhesion, migration and colony formation in soft agar. Methylation studies showed that the HNF-1Beta promoter is differentially methylated in paired tumour and benign patient samples with a higher level of methylation in tumour cells.



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The results of the PROMARK project have been presented in 10 scientific publications. Patent applications have been filed for all prostate cancer and PSA sequence variants discovered in the project. The results from the functional analysis of HNF-1Beta may be used for the improved diagnosis and treatment of prostate cancer.

#### PROMARK

- ★ Coordinated by deCODE genetics in Iceland.
- ★ Funded under FP7-HEALTH.
- ★ [http://cordis.europa.eu/result/brief/rcn/6367\\_en.html](http://cordis.europa.eu/result/brief/rcn/6367_en.html)
- ★ Project website: <http://www.promark-fp7.eu>

## MODELLING ANTIBIOTIC RESISTANCE IN MICROBES

The intensive use and misuse of antibiotics has built up resistance in most human pathogens against antibiotics. An EU-funded project has generated the knowledge to predict the rate and future path of resistance evolution to mitigate this worrying phenomenon.

The PAR (Predicting antibiotic resistance) project has developed quantitative models to capture the complex dynamics of microbial resistance. The relevant values were then validated using in vitro and in vivo models.

Key issues addressed by PAR were the formation and emergence of resistant bacteria, and the mechanism of pathogen survival and persistence as well as their transmission.

PAR researchers identified the resistance genes, the resistome, in *Pseudomonas aeruginosa*. The effects of these mutations were studied in several species of *Mycobacterium tuberculosis* to assess the different phenotypic changes.

Project work also demonstrated that many antibiotics, including  $\beta$ -lactam antibiotics, can promote mutagenesis in *Escherichia coli*, for example. Of particular concern is the fact that some antibiotics may affect bacterial resistance generation at 'sub-minimum inhibitory concentration' (sub-MIC). Findings from a dabbling duck model using *E. coli* suggest that extremely low antibiotic concentrations in the environment can maintain the resistant bacteria.

Results of particular interest concern a highly problematic resistance gene, NDM-1, that has recently spread globally at an alarming rate. PAR investigations show that this gene has a high expression and recombination rate as well as associations with certain plasmids. This is a community-acquired infection closely

linked to poor sanitation in East Asia and often spread by tourism and medical tourism. One important political impact was that these studies led the Indian government to draw up an antibiotic prescription and control policy for the first time.

PAR researchers demonstrated that for commercially available antibiotics (e.g. fusidic acid and mecillinam), resistance development and compensatory evolution is generally slower for drugs with multiple targets.

Dissemination initiatives included four major research planning meetings, 135 peer-reviewed publications, and over 200 conference presentations and book chapters. In addition, results have been presented and discussed in several other forums — the EU, European Medicines Agency (EMA) and within the industry.

The results produced in the project have generated great interest from the public health sector, physicians, environmental agencies, agricultural organisations and media. Project outcomes also have significant implications for improving our understanding of molecular evolution, bacterial physiology and preventing antibiotic resistance.

*"Extremely low antibiotic concentrations in the environment can maintain the resistant bacteria."*

#### PAR

- ★ Coordinated by Uppsala University in Sweden.
- ★ Funded under FP7-HEALTH.
- ★ [http://cordis.europa.eu/result/brief/rcn/11539\\_en.html](http://cordis.europa.eu/result/brief/rcn/11539_en.html)

## DEVICE FOR DIABETIC FOOT ULCERS

Over 55 million Europeans suffer from diabetes, and 8 million of these patients are at risk of developing a 'Diabetic foot ulcer' (DFU). Each year, as a result of unsuccessful DFU treatment, up to 450 000 lower limb amputations cost health authorities around EUR 2-2.5 billion.

The EU-funded PREVENTDFU (Device for prophylaxis and treatment of diabetic foot ulcers for hospital and home use) project is undergoing research to remedy this situation. A prophylactic device proto-

*"The FlowOx™ device will improve the quality of life of diabetic patients."*

type called FlowOx™ will be developed to prevent or treat DFUs for use in homes or nursing homes. This device will modify existing pulsating negative pressure technology and use it to increase blood flow and prevent wound formation or stimulate healing at the ulcer site.

Scientists have also worked on determining the optimal means of restoring blood flow in the lower extremities or limbs of diabetic patients using pulsating negative pressure. For this purpose, the prospective patient group will include diabetic or non-diabetic patients with peripheral arterial occlusive disease along with healthy subjects. Requisite ethical approvals for the study were obtained successfully and pilot experiments have already

started. Study outcomes will help determine optimal treatment protocols and negative pressure settings.

PREVENTDFU scientists completed a comprehensive literature review encompassing the medical and biomechanical aspects of the device. Also, user trials were conducted to gain their perspective on DFU treatment requirements and issues with orthoses, externally applied devices used to modify the structural characteristics of the neuromuscular and skeletal system.

Based on those for ankles, foot design specifications were incorporated into the principal design and a preliminary risk analysis carried out. This resulted in the manufacture and testing of wearable leg-and-foot chamber prototypes to further optimise design. In parallel, work is ongoing to develop and optimise the other device components such as the control system, pump, valves, user interface, power supply, pressure sensor, data logging system and housing.

Ultimately, the FlowOx™ device will improve the quality of life of diabetic patients by reducing their risk of DFU-related toe, foot and leg amputations. This will also result in substantial



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healthcare savings and boost the European medical device manufacturing, nursing and assisted living sectors.

### PREVENTDFU

- ★ Coordinated by Otivio AS in Norway.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/result/brief/rcn/12892\\_en.html](http://cordis.europa.eu/result/brief/rcn/12892_en.html)
- ★ Project website: <https://sites.google.com/site/preventdfu/home>

## THE MAGNETIC GUIDING OF TISSUE RECONSTRUCTION

The main aim of the MAGISTER project was the creation of a new type of 'magnetic scaffolds' (MagSs) for the manipulation of tissue regeneration in an organism. This initiative generated scaffolds for possible multiple use and multipurpose delivery for the repair of large bone defects.

Tissue regenerative medicine offers new possibilities for the functional and structural restoration of damaged tissue. One of the approaches involves seeding cells into a 3D scaffold, to which the cells can attach and grow. The addition of 'growth factors' (GFs) enhances the proliferation and differentiation of the cells in the scaffold.

MagSs provide unique properties not available with other methods and materials. They also offer the possibility of

controlled release or redosing of GFs, of mechanical stimulation of the seeded cells, and of assembling a scaffold in the desired configuration.

The EU provided funding for the four-year MAGISTER (Magnetic scaffolds for in vivo tissue engineering) project. The project successfully developed innovative practical MagS applications for tissue engineering and regeneration.

Researchers developed and fabricated a number of biocompatible magnetic materials for scaffolds. Hydroxyapatite, gelatine, coral polymers were impregnated with 'magnetic nanoparticles' (MNPs) either produced by the project consortium or already commercially available. Utilisation of a humic acid-magnetite combination produced novel fully bioresorbable and biocompatible materials.



New MNP 'Bio-agents aggregates' (BIOAGs) for the controlled delivery of both 'Vascular endothelial growth factor' (VEGF) and stem cells were also developed. The technology combined MNP manufacturing with an innovative surface

In an in vitro model, researchers demonstrated a distinct side-by-side magnetically guided colonisation of a scaffold fibre by two different types of cells. In vivo results also showed that magnetic guiding of bio-agents inside the MagS leads to excellent tissue reconstruction with clear vascularisation effects.

Project results were presented in 14 publications. The work of MAGISTER means that a MagS can be used as a fixture that offers long-living assistance to tissue engineering. This provides the unique possibility of adjusting the scaffold activity to the personal needs of a patient.

*"The project successfully developed innovative practical MagS applications for tissue engineering and regeneration."*

functionalisation method based on novel biocompetent hyperbranched peptides (dendrons). The dendrons were designed to functionalise the surface of MNPs and to control the exposure of functional groups capable of binding VEGFs. This approach improved angiogenesis through increased magnetisation of stem and endothelial cells.

#### MAGISTER

- ★ Coordinated by the National Research Council in Italy.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/result/brief/rcn/12924\\_en.html](http://cordis.europa.eu/result/brief/rcn/12924_en.html)
- ★ Project website: <http://www.magister-project.eu/>

## APPLYING THE NON-CODING RNA LINKS WITH CANCER

The importance of 'microRNAs' (miRNAs) for normal development and related cellular processes can no longer be under appreciated. EU research has revealed that incorporation of these molecules into disease models will lead to an increased understanding of cancer development.

Recent discoveries show that miRNAs regulate gene expression at the post-transcriptional level, between transcription and translation of the gene. They do not code for proteins but exert their regulatory function by binding onto the messenger RNA (mRNA) transcript.

'Non-coding RNAs' (ncRNAs), such as miRNAs and long ncRNAs, have a key role in the aetiology and/or progression of human cancer. The specificity and potency of some miRNAs could also be exploited in therapy.

The ONCOMIRS (MicroRNAs and cancer: From bench to bedside) project worked on the identification of novel key components of the miRNA-processing machine and their role in carcinogenesis. Another important objective was the identification of novel putative cancer-causing ncRNAs.

Through protein-complex purification and mass spectrometry analyses, many factors involved in the process of the miRNA-processing machine have been identified. In particular, those linked with cancer development have been reported.

Truncating mutations in the TARBP2 gene shorten the Dicer-binding protein TRBP, which affects miRNA processing and Dicer function, thus promoting tumour development. Dicer and other miRNA-processing enzymes may therefore be important in cancer prognosis. ONCOMIRS researchers showed that while a decrease in Dicer expression increases the transforming potential of cancer cell lines, complete silencing is not tolerated by most cancer cells.

The scientists generated new microarray platforms based on 'Locked nucleic acid' (LNA) technology. Attempts were made to validate single miRNA-mRNA interactions using

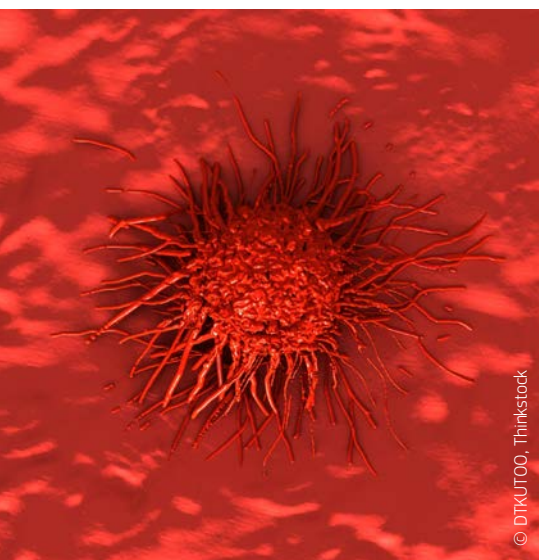
LNA oligonucleotides that bind specifically to sequences encompassing miRNA target sites within mRNAs. These so-called target site blockers have given very promising results and are now commercially available.

A new generation of miRNA mimics and antisense therapeutics has also been developed. The researchers tested and optimised their biostability, cytotoxicity and electropulsion-based delivery in vivo. Electrotransfer of miRNA inhibitors offers a new avenue for anti-cancer (retinoblastoma and glioblastoma) therapy.

The results of the efforts of this consortium unveiled novel functions of ncRNAs in normal and pathological processes. Scientifically, the research in the consortium is of utmost importance for understanding the roles of ncRNAs in pathological processes such as cancer.

#### ONCOMIRS

- ★ Coordinated by Flanders Interuniversity Institute for Biotechnology in Belgium.
- ★ Funded under FP7-HEALTH.
- ★ [http://cordis.europa.eu/result/brief/rcn/10117\\_en.html](http://cordis.europa.eu/result/brief/rcn/10117_en.html)



SOCIAL SCIENCES AND HUMANITIES

# E-PARTICIPATION: THE FUTURE OF CITIZEN ENGAGEMENT IN THE EU

With the elections to the European Parliament in just a few weeks, the issue of citizen engagement in policy has never been more pressing. But if you wanted to get involved in politics, share ideas and engage in debates, would you know where to get started? Thanks to several EU projects, the tools and services required for e-Participation are beginning to emerge and EU citizens are making their voices heard in new and more interactive ways.

The EU is funding several research projects that are trying to determine what makes an effective way of engaging citizens online. Three of those projects — PUZZLED BY POLICY, OURSPACE and PARTERRE — have delivered tools that aim to make participation in politics open to every citizen.

'Policy making can be very complex — the documents have a lot of jargon in them,' says Deirdre Lee, the coordinator of e-Participation project PUZZLED BY POLICY. 'What we do is try to bridge that gap and bring policy to citizens.'

One of the keys to the success of these new initiatives is that they use existing social media platforms. 'Sometimes what happens with e-Participation projects, is that governments build platforms or websites and then expect citizens to come there to give their point of view. When they don't come, they're disappointed,' says Ms Lee, who is based at Insight-NUI Galway, Ireland. 'We use

existing networks like Facebook, LinkedIn and Twitter to get the message out to the communities that are interested in policy.'

The PUZZLED BY POLICY pilots showed that people may not understand how their own views fit in with existing or new policy. With this in mind, the PUZZLED BY POLICY Policy Profiler tool shows the user where they are positioned in terms of policy directions, as well as with respect to other people, NGOs, political parties and other stakeholders. The users are then encouraged to join online discussions — as a result they get to see a range of opinions and can contribute their own.

Tamara Jonjic from the European University Institute and a partner in PUZZLED BY POLICY says that this process helps EU citizens understand their own views better, and allows them to share those views with policy makers.

'Citizens are empowered to critically analyse existing policies and also to suggest policy improvements and policy alternatives,' she added.

PUZZLED BY POLICY also shares summaries and reports of these discussions with policy makers. As a result, policy makers can make better-informed decisions that reflect the views of their constituents and this starts a virtuous cycle of engagement.

## OURSPACE — helping young people take an interest in policy

The policy consultation platform developed by OURSPACE is getting younger EU citizens involved in the process of policy making. The platform brings together EU policy makers and future voters, and has already been adopted by youth organisations that include the British Youth Council, Model European Union (MEU) and Cafebabel.

The OURSPACE platform allows young people to join in debates and challenge policy makers via an iPhone App, Facebook, iGoogle gadget and standalone website.

'Kudos to the OURSPACE project as well as all those who have made a contribution,' says Austrian MEP Ulrike Lunacek. 'Seeing the large number of topics and young panellists which can be found on the page, one cannot say that young people would not be interested in politics.'

## Creating a dialogue with voters

The PARTERRE project helped to promote e-Participation by offering a set of tools to local government agencies, most of which have now become successful products and services. A self-assessment tool enables public sector organisations to determine whether they are ready to introduce an e-Participatory model of local democracy. PARTERRE also offers a 'Town Hall' style meeting service that allows users to debate policy initiatives in small groups, with five of these events being rolled out in Palermo, Italy, from November 2013 to June 2014, commissioned by the Municipality.



These meetings can also be fully migrated online by using a collaborative town planning tool, Demos Plan, which has been

*“People may not understand how their own views fit in with existing or new policy.”*

very successful in Germany, where policy makers and citizens actively co-work on maps, drawings and other documents. Citizens can make comments and suggest changes to plans in real time, and policy makers can incorporate their feedback seamlessly, rather than going through iterations of planning meetings and exchanges of heavy and costly printed files.

Finally, on the occasion of the upcoming elections of the European Parliament, and with the support of an Italian media

company, another project has now just been launched by members from the PARTERRE team. The project called Blasting News consists of creating 28 websites across all EU Member States where citizens can post articles detailing what they expect from the next European Parliament and what Europe actually means to them. The first version of this new ‘blasting’ initiative is online and will be fully operational very soon.

### The importance of e-Participation

EU-funded ICT research projects create a set of tools that make e-Participation a reality. The projects develop and promote effective means for the involvement of stakeholders in the policy process.

‘You should not forget that your voice has power,’ says Ira Giannakoudaki

of the City of Athens IT Company (DAEM SA), a partner in the PUZZLED BY POLICY project. ‘You can participate now to benefit all citizens.’

#### PUZZLED BY POLICY

★ Coordinated by the National University of Ireland, Galway in Ireland.

#### OURSPLACE

★ Coordinated by Athens Technology Center in Greece.

#### PARTERRE

★ Coordinated by Regione Toscana in Italy.

★ Funded under ICT Policy Support Programme (ICT-PSP) as part of the Competitiveness and Innovation Framework Programme (CIP).

★ [http://cordis.europa.eu/result/brief/rcn/12448\\_en.html](http://cordis.europa.eu/result/brief/rcn/12448_en.html)

★ Project websites:  
<http://www.puzzledbypolicy.eu>  
<http://www.ep-ourspace.eu>  
<http://www.parterre-project.eu>

## SEYLE IDENTIFIES ‘INVISIBLE’ ADOLESCENT GROUP AT RISK OF DEPRESSION

There is no health without mental health, and the foundation for good mental health is laid in the early and adolescent years of our lives. Mental health issues developed in younger years often increase with age and impact not only on the individual, but also on their family and society as a whole.

While the majority of young people in the EU are said to enjoy good mental health, 20% of children and adolescents suffer from developmental, emotional or behavioural problems and approximately 12% have a clinically diagnosed mental disorder. These are only the young people that have been diagnosed, beyond them there are many more young people who are considered ‘at risk’.

Most of us are familiar with the obvious risk factors traditionally associated with depression. Behavioural problems or alcohol and drug use trigger immediate alarm bells in our heads. However, a recent study led by researchers at the Karolinska Institute in Sweden as part of the SEYLE (Saving and Empowering Young Lives in Europe) project, has revealed more subtle risk factors that should also be considered. According to the study, adolescents who demonstrate a combination of low physical activity, high media use and reduced sleep comprise an ‘invisible-risk’ group that displays a high prevalence of depression and psychiatric symptoms. The study found that 58% of respondents comprised the ‘low-risk’ group, 13% of individuals were clustered in the ‘high-risk’ group and the remainder occupied this ‘invisible’ group. It may be easy to dismiss these warning signs simply as ‘typical teenage behaviour’ but this ‘invisible’ risk group was found to have a similar prevalence of suicidal thoughts, anxiety, sub-threshold depression and depression to the ‘high’ risk group whose behaviour was more extreme and explicit.

Vladimir Carli, lead author of the study from the National Centre for Suicide Research and Prevention of Mental Ill-Health (NASP) at the Karolinska Institute, noted, ‘As many as nearly 30% of the adolescents clustered in the ‘invisible’ group had a high level of



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psychopathological symptoms. While the ‘high’ risk group is easily identified by behaviour such as alcohol and drug use, parents and teachers are probably not aware that adolescents in the ‘invisible’ risk group are at risk’.

The study is the first to estimate the overall prevalence of a wider range of risk behaviours and lifestyles and their association with symptoms of mental ill-health among European adolescents. Its findings, which were published in the February 2014 issue of World Psychiatry, contribute to the work of SEYLE to promote health among adolescents through the prevention of risk-taking and self-destructive behaviours. The SEYLE project has also succeeded in developing and implementing interventions in the field of child psychiatry, anthropology and suicidology in eight countries and produced baseline data on nearly 9000 school-based adolescents.

#### SEYLE

★ Coordinated by the Karolinska Institute in Sweden.

★ Funded under FP7-HEALTH.

★ [http://cordis.europa.eu/news/rcn/36460\\_en.html](http://cordis.europa.eu/news/rcn/36460_en.html)

★ Project website:  
<http://www.seyle.eu>

## REDUCED TRUANCY, IMPROVED MENTAL HEALTH

With studies showing that many high school students skip at least one day of school within the academic year, truancy is viewed as a serious public health problem. An EU-funded research team set out to enhance our understanding of the phenomenon and its parameters, and to propose prevention strategies.



*“Pupils across the entire sample showed a significant decrease in school refusal drives.”*

truant students had become non-truant. For all pupils, the highest rates of non-truancy at follow-up were observed in the ‘Mechanistic’ intervention. However, considering only truant pupils at baseline, the highest rates of non-truancy at follow-up were seen in the ‘Combined’ intervention. As such, a combination of interventions was shown to be able to significantly help truant pupils.

Project members then recommended best practices and effective, culturally adjusted models for preventing truancy and promoting adolescent mental health in different European countries.

WE-STAY outcomes thus underline the benefits of introducing approaches to promoting mental health that make school safe and offer interventions for pupils at risk. This not only serves to reduce truancy rates, but also has an impact on mental health, a key determinant of general health, both in the short and long term.

**M**echanistic and law-enforcement interventions aimed at preventing truancy do not account for the social and psychological issues associated with the phenomenon. In fact, the approach may even negatively impact adolescents’ well-being and mental health.

Funded by the EU, the project WE-STAY (Work together to stop truancy among youth) explored the relationship between truancy and mental health. Researchers collected relevant epidemiological data, with lifestyle, family attitudes and coping strategies among the comprehensive range of topics under investigation. Just over 11 000 adolescents were recruited from study sites in Estonia, Germany, Israel, Italy, Romania and Spain.

Three school-based intervention programmes were implemented.

Adolescents were randomised across four intervention arms: professional screening (TRUANCY-SCREEN), awareness of truancy and mental health problems (TRUANCY-AWARE), combination of the professional screening and awareness interventions (TRUANCY-COMBINE), and a mechanistic control arm for truancy (TRUANCY-MIC).

The outcomes of all interventions were evaluated from a multidisciplinary perspective that also took into account social and psychological aspects. After one month of interventions, pupils across the entire sample showed a significant decrease in school refusal drives and significant improvements were observed with regard to well-being.

Follow-up at 12 months showed that 52.2 % of the originally identified

### WE-STAY

- ★ Coordinated by the Karolinska Institute in Sweden.
- ★ Funded under FP7-HEALTH.
- ★ [http://cordis.europa.eu/result/brief/rcn/11454\\_en.html](http://cordis.europa.eu/result/brief/rcn/11454_en.html)
- ★ Project website: <http://www.we-stay.eu>



ENERGY AND TRANSPORT

# THROWING LIGHT ON TO NANOWIRES



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At the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, Professor Anna Fontcuberta i Morral's ERC-funded UPCON project is investigating new concepts and technologies that point the way to the next generation of photovoltaic systems. Prof. Fontcuberta i Morral is a speaker at this year's American Association for the Advancement of Science (AAAS) conference in Chicago, where she will give a talk entitled 'Nanowires have the power to revolutionize solar energy'.

Over the past 20 years, the growth of research into photovoltaic cells has been driven by the rising economic and environmental costs of fossil fuels. Even so, the unit-energy costs of using photovoltaic sources remain relatively high. Therefore, innovative concepts and technologies are urgently needed to increase the overall efficiency of photovoltaic systems and reduce the costs of the energy they produce.

'Early photovoltaic cells used thick silicon semiconductor technologies which are limited to an energy-conversion efficiency of around 30-40%,' explains Prof. Fontcuberta i Morral, 'the second-generation devices use less material and rely on micron-scale thin-film silicon technologies. However, the theoretical energy-conversion limit — the efficiency of turning the sunlight falling on the surface into electrical energy — remains unchanged. Our aim is to use nanoscale technologies to

overcome this limit and demonstrate devices that can provide a step change in the performance of photovoltaic devices.'

## Of growing importance

Prof. Fontcuberta i Morral and her team are investigating nanowire solar cells within the framework of the UPCON (Ultra-pure nanowire heterostructures and energy conversion) project. Using molecular beam epitaxy, a technique used in making microchips and other electronic devices, they grow nanowires which are typically 50-300 nm in diameter and up to 30 microns long. These are grown vertically on a silicon substrate and are made of gallium arsenide layers which form 'p-n junctions' that convert incident light to electrical energy. The p-n junctions — interfaces between two types of semiconductor materials

that form the basis of most electronic devices — can be either horizontal to the wire, or radial along its length.

Eventually, the intention is to grow two-dimensional arrays of nanowires, each separated from its neighbour, to produce ‘forests’ of individual solar cells. A vital aspect of this next-generation technology is scale, as the professor explains: ‘Moving solar-cell devices to the nanoscale brings eventual manufacturing cost savings, for example in the use of expensive materials. In addition, as the devices get smaller and the dimensions of the nanowires are smaller than the wavelength of the incident sunlight (400–700 nm), new physical phenomena come into play which can help break through the energy-conversion barriers that limit larger-scale devices.’

### Lighting the way

In 2013, together with researchers from the Niels Bohr Institute in Denmark, Prof. Fontcuberta i Morral and her UPCON colleagues at the EPFL, Martin Heiss and Olivier Demichel, published their latest research results that demonstrate just how important the element of scale is.

The research involved depositing a single, two-micron-long nanowire

solar cell on to a silicon substrate and then measuring the light absorption and electrical current generated when it is illuminated. They found that, remarkably, light absorption in the vertical nanowire is much higher than in an equivalent thin-film solar cell, and the nanowire generates the electrical power several times. In fact, the nanowire absorbs light from an area that is larger than its physical cross-section — confirming that it has built-in light concentration properties. In effect, nanowire solar cells work as if they had small-scale lenses collecting light from a larger area. Solar cells become more efficient when working under such light-concentration conditions. Thus, this is a route to further increasing solar cell efficiency.

‘This research shows that nanowire arrays offer a path for more efficient solar cells, and the increase in absorption cross-section means that they can be more widely spaced, thus greatly reducing material costs,’ says Prof. Fontcuberta i Morral. As well as the experimental results, the team modelled the nanowires to understand how the efficiency boost arises as a function of wavelength and nanowire diameter. They found that, theoretically, absorption could be boosted by a factor of up to 70 times.

These recent and unexpected results are receiving much interest from the scientific community, partly due to the potential for future photovoltaic energy sources. However, as the professor points out, the implications are wider: ‘Our research concerns more than renewable energies. Small nanowire arrays could act as tiny power sources integrated into the nano-machines and devices of the future, such as health sensors for diseases like diabetes. They could be used as almost-free energy sources to produce hydrogen fuels from water, an expensive process at the moment. And equally, this is about doing more with less. It is increasingly important for material scientists to factor in the growing scarcity of strategic metals and minerals from the earth’s crust, so nanowire-based devices have the potential to raise overall efficiency, both in converting light to energy and in using less valuable resources to do so.’

#### UPCON

- ★ Coordinated by the Swiss Federal Institute of Technology in Lausanne in Switzerland.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://erc.europa.eu/erc-stories/throwing-light-nanowires>

## CONNECTING WAVE POWER TO THE ELECTRICITY GRID



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One of the main obstacles to integrating wave energy into the power grid and its commercial exploitation is the variability and intermittency of the generated power and the need for energy storage. An EU-funded initiative addressed this problem by conducting an investigation into storage alternatives using ‘Wave energy converters’ (WECs).

The SEA2GRID (Grid connection of wave energy converters: Investigation on storage requirements and solutions) project used sea wave power to produce electricity. Sea waves are a very intermittent source of power. Therefore, SEA2GRID employed storage to connect the WECs to the grid and ensure that the power delivered was conveniently smoothed to meet strict Grid Code requirements.



Project partners studied the state-of-the-art of storage technologies and developed analytical models for the entire sea-to-grid process to evaluate the best options for the grid connection of WECs with regard to

*“Suitable storage technologies could include lead-acid batteries, flywheels and potentially nickel-cadmium.”*

storage elements and compensation provisions. Case studies demonstrated that integration of a single WEC/wave farm into a strong grid did not present special concerns and specific energy

storage provisions were not required. However, energy storage is more critical in the case of weak grids and is fundamental to solving power quality issues and ensuring grid code compliance.

SEA2GRID researchers studied the short-term energy storage needed to resolve this issue. They found that a power rating of the storage in the range of the wave farm installation and an energy rating in the order of magnitude of a few hundred KWh would be required. Based on this information, suitable storage technologies could include lead-acid batteries, flywheels and potentially nickel-cadmium (Ni-Cd) batteries. However, other factors such as storage lifetime and efficiency should also be considered before a final decision can be made.

The SEA2GRID project investigated the application of long-term energy storage for energy management and demonstrated the potential for a combined wind and wave energy farm. This would further stabilise its power output by jointly deploying a centralised energy storage device. A test case on the grid integration of a wave farm to serve the needs of an isolated community showed that matching power generation and consumption is a clear priority. Their correlation is also crucial to determining energy storage requirements.

#### SEA2GRID

- ★ Coordinated by Tecnalia Research & Innovation in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/result/brief/rcn/12934\\_en.html](http://cordis.europa.eu/result/brief/rcn/12934_en.html)

## POWERING VEHICLES FROM WASTE HEAT

Combustion of fuel currently provides power for electrical components in cars and trucks. Scientists working on EU-funded projects are using novel materials that harvest waste heat from exhaust gases to provide electricity and reduce emissions.

Motor vehicles rely on combustion of fossil fuels for motion and an alternator (converts mechanical energy into electrical energy) for electrical supply to on-board components. EU-funded scientists are working on technology exploiting ‘thermoelectric’ (TE) materials to harvest waste heat from exhaust gases and convert it into electricity. This should mitigate to some extent the effects of rising fuel prices and increasing electrical demands of cars.

The project HEATRECAR (Reduced energy consumption by massive thermoelectric waste heat recovery in light-duty trucks) is developing thermoelements to provide electricity, to either on-board components or the power train of hybrid electric vehicles. Reduced fuel consumption for these purposes translates into major emission reductions.

TE materials have been employed previously in automotive applications but have not achieved reasonable conversion efficiencies. Scientists tackled this issue in two ways. They selected bismuth telluride (Bi<sub>2</sub>Te<sub>3</sub>) suitable for lower operating temperatures in a diesel engine. They also optimised the geometry of heat transfer surfaces to maximise the temperature difference

available to the TE modules. The technology was implemented in a prototype ‘TE generator’ (TEG) for a diesel ‘Light-duty truck’ (LDT) in common use in the EU.

Performance of TE materials was increased by over 20 % through ball milling and subsequent spark plasma sintering. Driving cycle tests demonstrated that the TEG system decreased fuel consumption by about 2.2 % on the ‘New European driving cycle’ (NEDC) and by 3.9 % on the more heavily loaded ‘Worldwide harmonised Light vehicles Test Procedures’ (WLTP) cycle. Increases in TEG electric output corresponded to the same decrease in alternator demand.

The technical feasibility of a Bi<sub>2</sub>Te<sub>3</sub>-based TEG for application to a diesel LDT has been successfully demonstrated. In order to enhance marketability, further work should be focused on decreasing the cost together with several recommendations regarding engine type, driving conditions and



material properties. HEATRECAR technology has the potential to significantly decrease fuel consumption and associated carbon dioxide emissions, resulting in significant socioeconomic impacts.

#### HEATRECAR

- ★ Coordinated by Fiat Research Centre SCPA in Italy.
- ★ Funded under FP7-TRANSPORT.
- ★ [http://cordis.europa.eu/result/brief/rcn/7541\\_en.html](http://cordis.europa.eu/result/brief/rcn/7541_en.html)
- ★ Project website: <http://www.heatrecar.com>

## SELF-MONITORING VEHICLES

Vehicles will soon be able to warn us when there is need for servicing or when there is a likelihood of breakdown. The EU-developed system making this possible will optimise maintenance and reduce downtime for business vehicles.



Vehicle breakdowns usually come as unwelcome surprises. A worst case scenario would be long delays waiting for roadside mechanics, followed by a tow and further delays when the right parts are unavailable. For commercial operators, downtime means lost business.

The MODE (Maintenance on demand) project proposed a better model. With EUR 3.7 million in EU funding, the 10-member consortium ran from September 2009 to December 2012. The project's concept was that vehicle systems should monitor themselves. A vehicle would notify its owner when it needed either routine or unscheduled maintenance. The alert would include specific information

about the problem, allowing the required parts to be assembled in advance of a maintenance stop.

Such a maintenance concept would greatly minimise maintenance downtime, ensuring more uptime of commercial vehicles than currently possible. The concept would also pre-empt most unplanned breakdowns, while allowing an optimal part replacement schedule with reduced long-term costs. Maintenance service providers could also offer tailored service contracts that optimise maintenance schedules for individual vehicles.

The MODE project's main goals were to develop the technologies necessary to facilitate vehicular self-monitoring. The technologies included wireless sensor networks, algorithms for condition monitoring and remaining-life assessment, and telematic systems to communicate the system report to a central system.

MODE's on-board data management system was successfully completed using the existing Volvo Telematics Gateway and was validated by field testing as fully functional. The project also completed the data transfer system, which it demonstrated when using vehicle data for monitoring and scheduling maintenance. The project completed its database platform.

High-level integration tests demonstrated the database's ability to acquire, process and retrieve both vehicle-reported and computed data. MODE abandoned its initial proposal for a web interface following unsatisfactory testing. Instead, the project embedded third-party computerisation units into MODE-compliant software modules. Finally, the project integrated and validated its systems via realistic test cases.

MODE's work will help to avoid breakdowns and minimise vehicle downtime, improving the competitiveness of vehicle-dependent businesses. In addition, MODE's maintenance concept will keep more vehicles in better condition, resulting in environmental and safety benefits.

### MODE

- ★ Coordinated by Volvo Technology AB in Sweden.
- ★ Funded under FP7-TRANSPORT.
- ★ [http://cordis.europa.eu/result/brief/rcn/9925\\_en.html](http://cordis.europa.eu/result/brief/rcn/9925_en.html)
- ★ Project website: <http://fp7-mode.eu>

## ENHANCING SOLAR CELL EFFICIENCY TO LOWER OVERALL ENERGY COST

EU-funded scientists developed novel organic polymer solar cell materials that promise to significantly increase energy conversion efficiency. Overcoming the efficiency barrier could lead to low-cost solar energy for all.

The Sun is a virtually 100 % renewable source of energy that can be exploited by 'photovoltaics' (PV) or solar cells to produce electricity. Relevant technology has advanced tremendously over the past few decades and current research is focused on ways to increase energy conversion efficiency while decreasing

costs. The majority of such work is devoted to the development of innovative materials with tuneable optoelectronic properties.

While polymer solar cells have drawn widespread attention in recent years, one promising class of materials that has been neglected is aniline-based

ones. The aniline monomer can be oxidised to produce a variety of different aniline-based polymers with very interesting micro- and nanostructures. The EU-funded project SOLICOAPS (Self-organising liquid-crystalline oligoanilines for photovoltaic applications) applied newly developed synthetic techniques to novel



aniline-based self-assembled organic semiconductors.

Liquid crystals have unique optical properties and their self-organisation into ordered states between liquid and crystal opens the door to a number of applications. Self-assembled 'liquid crystalline' (LC) semiconductors can

SOLICOAPS provided a new route to the design of LC TANIs as a novel class of electron donors for the well known C60 electron acceptors. Highly efficient charge transfer should lead to the development of cost-effective PV technology and widespread market uptake. This will reduce dependence on combustion of fossil fuels and

thereby the associated environmental impact.

#### SOLICOAPS

- ★ Coordinated by the University of Bristol in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/result/brief/rcn/12927\\_en.html](http://cordis.europa.eu/result/brief/rcn/12927_en.html)

*"Liquid crystals have unique optical properties."*

yield stacked and aligned architectures that increase charge carrier mobility and are of great interest to the PV community.

Scientists focused on LC tetra(aniline) (TANI) compounds. They designed and synthesised novel TANIs and blended them with the photoactive (electron acceptor) materials PC60BM and IC60BA. The first ever LC TANI in a half-oxidised ('emeraldine base' (EB)) state with novel chemical and electrochemical properties was obtained through characterisation of materials. Moreover, photoluminescence quenching (an indication of how fast charge transfer occurs) of the C60 electron acceptors by TANI EB derivatives makes these promising for PV applications.



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## OPTIMISING SHIP MAINTENANCE

Traditionally, it can be difficult to know when a ship needs maintenance. A new combination method gives justifiable maintenance schedules and offers superior defect detection.

**S**hips are structures of mainly steel, operating in a highly corrosive environment that also causes metal flexing. Thus, ships need considerable inspection, which is generally done according to average guidelines and without consideration for the circumstances of any particular ship.

As a result, certain ships may receive less attention than warranted, increasing the risk of structural failure. Helping to fix this problem was the RISPECT (Risk-based expert system for through-life ship structural inspection and maintenance and new-build ship structural design) project. Consisting of 11 partners from six EU countries, the consortium-led project ran from October 2008 to March 2013 and aimed to provide a better methodology for ship assessment.

Traditionally, ship inspections would be scheduled in a standard way based on average needs for a given ship class. Alternatively, individual ship parts considered at risk may be inspected as needed. Both methods are unsatisfactory in some ways. The project's new method combines the best features of both, incorporating statistical analysis of

long-term experience from many ships with risk-based methods. The result is a process that gives justifiable risk-based inspection schedules, meaning a superior rate of defect detection.

The project delivered all 14 of the outputs initially agreed on. These include a methodology uniting the two main kinds of ship inspection protocols. RISPECT's process specifies codes for various kinds of ship damage such as corrosion, cracks and coating breakdowns. RISPECT also devised tools for assessing such damage.

By including results of structural, reliability and risk analyses, the project's process enables acquisition, storage and more effective use of inspection data. A major component of the work was a large database, the structure and reports of which the project defined. The result is a justifiable decision-making

*"RISPECT's process specifies codes for various kinds of ship damage such as corrosion, cracks and coating breakdowns."*

process for the structural management of ships throughout their working lives.

One outcome of the RISPECT project will be an accepted methodology for scheduling inspections for ship damage. This will mean safer ships and fewer shipping accidents, potentially avoiding environmental or other disasters, and financial losses.

#### RISPECT

- ★ Coordinated by the University of Strathclyde in the United Kingdom.
- ★ Funded under FP7-TRANSPORT.
- ★ [http://cordis.europa.eu/result/brief/rcn/7284\\_en.html](http://cordis.europa.eu/result/brief/rcn/7284_en.html)
- ★ Project website:  
<http://www.rispect.eu>



## RENEWABLE ELECTRICITY GENERATION CLOSER TO HOME

EU-funded scientists have developed the advanced controllers required to implement 'fuel cell' (FC) technology in modular and local electricity generation systems. Dealing with inherent non-linearities will increase reliability and efficiency.



The EU is committed to relieving dependence on fossil fuels for energy in order to increase energy security and reduce emissions that affect global climate change. Developing alternative renewable forms of energy is a priority and, increasingly, experts are promoting their exploitation in 'Decentralised electrical generation systems' (DEGS).

DEGS are modular power-generating plants close to the end user with the potential to significantly reduce transmission losses and unrecovered waste heat. DEGS using hydrogen as the energy carrier in combination with FC technologies have great potential, but FCs exhibit highly non-linear behaviours requiring sophisticated controllers.

The EU-funded project ACRES (Advanced control of renewable energy generation systems based on fuel cells/wind power) developed such technology by exploiting advanced non-linear controllers in various stages of development. The controllers were adapted for five different applications in order to enhance reliability, performance and efficiency.

*"The demonstrators should encourage interested companies to invest in DEGS."*

ACRES scientists validated their advanced control systems for FC-based DEGS and manufactured several demonstrators of the technology within the one year of funding. The demonstrators should encourage interested companies to invest in DEGS with major impacts on the EU economy, energy security and the environment.

#### ACRES

- ★ Coordinated by the State Agency Research Council in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/result/brief/rcn/12546\\_en.html](http://cordis.europa.eu/result/brief/rcn/12546_en.html)





ENVIRONMENT AND SOCIETY

# THE 'TRIPLE-WIN' WAY TO REDUCE CARBON IN THE ATMOSPHERE

Reducing the amount of carbon in the atmosphere is a key priority facing the world today as it attempts to mitigate the scale and effects of climate change. EUROCHAR is developing a technique which not only promises to help tackle this priority, but also offers additional benefits in the form of environmentally-friendly energy production and enhanced soil fertility.

The idea behind this 'triple-win' solution involves turning organic material (biomass) into a form of charcoal through a process of pyrolysis, or high temperature heating in a closed, oxygen-free environment. The resulting charcoal, or 'biochar' as it is known, in effect 'locks in' the carbon that was contained in the original

biomass. The carbon is prevented from escaping into the atmosphere, as would happen if the biomass were left to biodegrade naturally.

'The stability offered by the biochar — the extent to which it locks in, or 'sequesters', the carbon — is central to the technique,' says EUROCHAR's (Biochar for Carbon sequestration and

large-scale removal of greenhouse gases (GHG) from the atmosphere) Project Coordinator, Dr Franco Miglietta of Italy's Consiglio Nazionale delle Ricerche, because it means the biochar can safely be buried in soil. 'The end result of this stabilisation process would be coal, which is completely undecomposable,' explains Dr Miglietta.

While biochar is not as stable as coal, it does allow carbon that was originally in the atmosphere, and which would otherwise have been released back into it, to be safely sequestered in the soil.'

As well as sequestering the carbon, pyrolysis has a second advantage: it produces 'syngas', or synthesis gas, a combustible hydrocarbon which can be used as a fuel. The third aspect of the biochar 'triple-win' is that the soil is not just a place of storage for the

*"Biochar 'locks in' the carbon that was contained in the original biomass."*

biochar. It actually benefits from it. Adding biochar improves the physical structure of the soil, making it lighter, able to contain more water, and increasing its fertility.

'This completes the loop,' says Dr Miglietta. 'If we have better soil we can produce more biomass. With more biomass we can produce more energy, and that means we can produce more biochar.'

One key part of the EUROCHAR research was an investigation to establish exactly how stable biochar actually is. This was done by examining ancient pits containing biochar thousands of years old. 'Although the final, detailed analysis has yet to be completed,' says Dr Miglietta, 'the results clearly indicate that biochar provides an option for carbon sequestration which could last for centuries.'

A separate strand within the project, based on field experiments at sites around Europe, established that, when added to soil, biochar protects the carbon still in the soil from degradation and decomposition, in addition to its function of sequestering the carbon in the original biomass. It therefore has a dual impact when it comes to reducing carbon in the atmosphere.

The EUROCHAR team also worked on methods for creating biochar, and conducted a full life cycle analysis of the entire concept. Allowing for factors such as the energy input required for pyrolysis, this analysis showed that the creation and use of biochar resulted in a sequestration of around

20 % of the carbon contained in the original biomass.

Another important strand of the EUROCHAR project involved testing biochar for any potentially damaging impact, including whether its use over a long period might have a toxic effect on plants or animals. A second risk the research team looked into was the effect that mixing large quantities of biochar into the soil might have.

'The results of these risk assessments are still being analysed, but given favourable outcomes the work of EUROCHAR's research team could be put to practical use without too much delay,' concludes Dr Miglietta.

#### EUROCHAR

- ★ Coordinated by the National Research Council in Italy.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://ec.europa.eu/research/infocentre/article\\_en.cfm?artid=31836](http://ec.europa.eu/research/infocentre/article_en.cfm?artid=31836)
- ★ Project website: <http://www.eurochar.org/>

## ADDRESSING CLIMATE CHANGE BEGINS WITH THE CONSUMER

An efficiently constructed hybrid tool involving reconvened and reflective citizen discussion groups was used to support policy makers in understanding consumer behaviour and promoting consumption practices that favour sustainability.

Climate change often seems like a distant threat that is not directly connected to our daily lives. However, everyday consumer behaviour is an important determinant of sustainability. The EU-funded project PACHELBEL (Policy addressing climate change and learning about consumer behaviour and everyday life) worked on assisting policymaking to understand and facilitate consumer behaviour that favours sustainability.

Looking closely at citizen engagement as a policy tool to support governance, trust and legitimacy, the project team engaged with policy makers and lay citizens to study the linkages between them. The project worked rigorously on developing the new policymaking support tool and guiding policy makers on how to use it. Such a tool would be capable of revealing citizens' culturally shaped behaviours related to sustainability, and highlighting how citizens rationalised these behaviours.



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Through extensive active research efforts and reconvened and reflective discussion groups with citizens, the project team designed a prototype for the tool and tested it in different real-world situations to find the best ways of providing suitable policymaking support. In addition to the design, development and operationalisation of the policymaking support tool, the project team produced valuable guidance on how best to use the tool across a range of policy environments.



In each country within the project's scope, the team cooperated with policy makers to identify a current policy issue of interest or to validate knowledge about citizens' sustainability-related behaviours. These specific policy issues were investigated with specially recruited groups of citizens using the methodology developed within the project. A key policy issue explored, for example, was related to energy use, including electricity consumption and the use of smart meters.

The resulting 'Systematic tool for behavioral assumption validation and exploration' (STAVE) can reveal the nature of practical barriers preventing the adoption of environment-friendly consumer behaviours. The tool offers a means to allow policy makers to design and communicate their sustainability policies much more effectively. The feedback received from the collaborating policy organisations was overwhelmingly positive.

Overall, the project has created a user-friendly support tool that rapidly generates accurate data about everyday citizen behaviour, thus yielding information that can be used in a wide range of policy contexts. Trials have been

conducted in six European countries, demonstrating the tool's viability. Dissemination of PACHELBEL results has

*"The project has created a user-friendly support tool that rapidly generates accurate data about everyday citizen behaviour."*

been supported by the project website, publications and conference presentations. This tool could well play a pivotal role in promoting sustainability and mitigating the effects of climate change.

#### PACHELBEL

- ★ Coordinated by CIEMAT in Spain.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://cordis.europa.eu/result/brief/rcn/9948\\_en.html](http://cordis.europa.eu/result/brief/rcn/9948_en.html)
- ★ Project website: <http://www.pachelbel.eu>

## MARINE INVERTEBRATES — EFFECTS OF OCEAN ACIDIFICATION

Corals and pteropods play a major role in marine ecosystems and it is crucial that we understand the impact of ocean acidification on them. EU-funded scientists investigated the mechanisms behind calcification in corals and pteropods and how the process is affected by environmental changes.

Calcification takes place when calcium salts accumulate in body tissue. The AMICAL (Effect of ocean Acidification on Marine Invertebrates CALcification in sensitive ecosystems) project investigated the effect of rising partial 'Pressure of carbon dioxide' ( $p\text{CO}_2$ ) levels on model marine organisms. Tropical coral juveniles (*Acropora millepora*) and two species of Mediterranean pteropods (*Limacina inflata* and *Cavolina inflata*) were used. Pteropods are a type of sea snail commonly known as sea butterflies.



These organisms construct their skeletons and shells from aragonite, a form of calcium carbonate ( $\text{CaCO}_3$ ). Aragonite is less stable and dissolves more readily under high  $p\text{CO}_2$  levels than another form of carbonate known as calcite. The latter is the primary constituent in the shells of many types of marine organisms.

Researchers investigated the chronic and acute effects of elevated levels of  $p\text{CO}_2$ , as well as the effect of increased temperature combined with higher  $p\text{CO}_2$  levels on coral juveniles. The *A. millepora* larvae were kept under conditions that simulated different environmental scenarios for the 21<sup>st</sup> century. Molecular responses in corals were measured using high-throughput

RNA sequencing. The calcification and respiration rates of pteropods were measured under low- and controlled pH conditions to determine the physiological impact of raised  $p\text{CO}_2$  levels.

The molecular approach revealed that in *A. millepora*, elevated  $p\text{CO}_2$  levels strongly suppressed metabolism but enhanced extracellular organic matrix synthesis. Targeted analyses showed complex effects on genes implicated in calcification. In addition, scientists uncovered a number of novel candidate genes for a role in calcification, providing a basis for future studies. According to the pteropod study, the animals demonstrated a significant decrease in the calcification rate

under low-pH (elevated  $p\text{CO}_2$ ) conditions.

AMICAL efforts have provided the first assessments on the physiological and molecular responses of two very sensitive marine invertebrates to rising  $p\text{CO}_2$  levels. Project outcomes will be of great interest to biologists working in the field of comparative genomics, as well as those involved in studying climate change.

#### AMICAL

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/result/brief/rcn/12903\\_en.html](http://cordis.europa.eu/result/brief/rcn/12903_en.html)

## UNTANGLING THE CAUSES OF COLONY COLLAPSE DISORDER

Colony collapse disorder threatens the health of beehives worldwide, but scientists still struggle to identify specific causes. A research network has made a thorough investigation of the different factors responsible, and developed some diagnostic tools.



**P**arasites, viruses and pesticides are the three factors most widely accepted as being responsible for colony collapse and honeybee decline. No one factor can be singled out though, meaning it is most likely a combination of threats.

The EU-funded BEE DOC (Bees in Europe and the decline of honeybee colonies) project aimed to improve colony health, fill knowledge gaps, and understand the interaction between viruses, parasites and pesticides in bees. Chemists, geneticists and apiculturalists combined their expertise for this research study.

A strong link was found between the presence of Varroa mites and several viruses in bee colonies: it was confirmed that these mites carry the viruses. Combined with pesticides, this resulted in higher deaths in larvae and pupae.

Two diagnostic tests were developed in response. One, called BeeClinic, is a research-grade diagnostic for the identification of a wide range of viruses, pesticides and other stressors. The other, BeeDoctor, is a detection method used to screen a hive for viruses.

Researchers also showed that feeding bees probiotics as well as certain essential oils resulted in improved survival rates.

BEE DOC has taken a comprehensive look at possible causes of honeybee mortality, and successfully developed new tools for farmers and scientists to use. All the project results have been made available to the public.

### BEE DOC

- ★ Coordinated by Martin Luther University of Halle-Wittenberg in Germany.
- ★ Funded under FP7-KBBE.
- ★ [http://cordis.europa.eu/result/brief/rcn/9968\\_en.html](http://cordis.europa.eu/result/brief/rcn/9968_en.html)
- ★ Project website: <http://www.bee-doc.eu>

## EUROPE'S CHANGING MARINE ENVIRONMENT

Marine ecosystems are undergoing dynamic changes with increasing pressure from human activities and climate change. An EU-funded initiative investigated Europe's marine ecosystems and developed new tools for assessing them.

**T**he MEECE (Marine ecosystem evolution in a changing environment) project was initiated to improve knowledge of marine ecosystems and assess 'Good environmental status' (GES) in Europe's seas. The information gained was fed into the 'Marine strategy framework directive' (MSFD), which requires EU Member States to develop strategies for achieving a healthy marine environment.

Project partners collected data on key processes, conducted experiments, developed computer models and explored a range of scenarios. Researchers also collated a large dataset on the discharge of European and non-European rivers and integrated the information with other European and global projects. The meta-database for ecosystem drivers held information on climate and ocean acidification, pollution, fishing, invasive species and the metabolic rates of plankton.

Researchers found that ocean systems are increasingly stressed by human-induced changes to their physical, chemical and biological environments, resulting in changes to phytoplankton productivity. Other challenges include ocean acidification, pollution, harmful algal blooms from excessive nutrient supply (called eutrophication) and the effect of invasive species on biodiversity.

Commercial fishing can affect the marine environment by disrupting and damaging habitats and the selective removal of species, resulting in the restructuring of food webs. Scientists

therefore used a range of models to study fish stocks. These combined hydrodynamics, nutrient-phytoplankton-zooplankton and higher-trophic-level organisms into a single modelling framework. Models are currently being developed to further explore the top-down effects of fishing, including its impact on the bottom of the food chain.

The project developed a number of online tools to help disseminate its findings. The model Atlas provides interested users and site visitors with the results of models and simulations produced by the MEECE scientific community. The IndiSeas initiative is a multi-institute collaborative effort linked to the MEECE project, which provides online indicators of the status of 34 marine ecosystems around the globe.

Thanks to MEECE, scientists now have a clearer understanding of how marine ecosystems will evolve in the face of climate change and human activities. This knowledge will aid in the protection of the marine environment.

### MEECE

- ★ Coordinated by Plymouth Marine Laboratory in the United Kingdom.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://cordis.europa.eu/result/brief/rcn/6304\\_en.html](http://cordis.europa.eu/result/brief/rcn/6304_en.html)
- ★ Project website: <http://www.meece.eu>



## DETECTION OF WATER CONTAMINATION

Scientists have developed a novel system that uses light to rapidly measure contaminants in water.

**A**quaphotomics is a relatively new discipline that uses the interaction of light and water to provide a rapid and comprehensive analysis of water. It also makes the real-time analysis of water quality a possibility for the first time.

The EU-funded AQUASENSE (Development of novel sensors for contaminant detection in water using near infrared light and aquaphotomics) project combined aquaphotomics with near-infrared imaging techniques to create a real-time, multi-contaminant detection system for rapid water monitoring and analysis. After comprehensive training in water quality monitoring and other relevant techniques, several common contaminants were chosen for testing. Baseline measurements were performed for several types of water, and

at different temperatures, in order to establish the variation in pure water. Temperature and humidity were identified as confounding factors that needed to be characterised and then corrected.

Researchers also developed algorithms that would allow for the identification of specific contaminants, and these were tested against known contaminants under various conditions. They found that the contaminant concentrations in drinking water were too low for detection with this new system, but it could be effective for screening wastewater.

AQUASENSE represents a first attempt to use light to measure water contamination in real time. The expertise and technical information gained during the project has thus laid the groundwork for future research in this field.



### AQUASENSE

- ★ Coordinated by University College Dublin in Ireland.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/result/brief/rcn/12909\\_en.html](http://cordis.europa.eu/result/brief/rcn/12909_en.html)

## SEA ANEMONE REVEALS SECRETS OF NERVE DEVELOPMENT



The sea anemone belongs to an ancient group of animals and has only a simple diffuse net of nerves. Genetic analysis of this marine creature's nerve development may be the key to understanding nerve regeneration in the complex human nervous system.

**M**embers of the Cnidaria, including corals, jellyfish and sea anemones, have non-centralised nervous systems. The EU-funded ANTAN (Analysis of the neural transcriptome of the sea anemone *Nematostella vectensis*) project on neural development is hinged on this simplicity of organisation.

ANTAN aimed to identify the gene expression profile of *Nematostella* neurons, and then select genes from this dataset for further functional analysis. However, technical difficulties surrounding RNA collection from isolated neurons steered the research towards two important molecules, a promoter and an inhibitor of neurogenesis: *NvSoxB(2)* and Notch signalling,

respectively. The project team used gene knockdown with morpholino, transgenics and drug treatments to examine the interplay between these two regulators.

*NvSoxB(2)* was found to play a key role in early neurodevelopment. It is expressed in nerve progenitor cells that go on to form the nerve cells in the ectoderm and endoderm. The interplay between *NvSoxB(2)* and other regulators was also investigated, but overall the focus lay on its interaction with the Notch pathway, due to its importance in regulating proneural factors.

Successful results from cellular and molecular events in the neurogenesis of *N. vectensis* are the subject of papers to be submitted to the high-profile journals *Current Biology* and *Development*. The work of ANTAN is set to continue after the project ends, with comparative microarray analysis of sea anemone larvae with knocked down and fully developed nervous systems.

ANTAN data has focussed on the genetic control of neurogenesis to shed light on the evolution of simple nervous systems. This has important implications in the biomedical field for nerve regeneration and therapy as sea anemones can regrow nerve cells at any life stage. Successful outcomes could result in the development of therapeutic options for nerve regrowth after human neuronal disease and injury.

### ANTAN

- ★ Coordinated by UNI Research in Norway.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/result/brief/rcn/12544\\_en.html](http://cordis.europa.eu/result/brief/rcn/12544_en.html)

IT AND TELECOMMUNICATIONS

# TAKING E-AGRI TO MOROCCO AND CHINA

‘Information and communication technologies’ (ICT) can be applied in truly innovative ways in agriculture to boost sustainable development in developing economies. With more than 50 % of the population living in rural areas in many developing countries, the successful uptake and transfer of so-called E-Agriculture technologies can have a huge knock-on effect for the rural population and society as a whole.

The E-AGRI (Crop Monitoring as an E-agriculture tool in developing countries) project, which concluded in January 2014, worked to provide agrometeorological services to farmers and decisions makers. It contributed to establishing and adapting advanced crop monitoring technologies developed by European institutions in China and Morocco. Ultimately, this technology will help local producers and governments to make early decisions on their agricultural production planning.

Project coordinator Dr Qinghan Dong of the Flemish Institute for Technological Research points to the excellent progress made by country partners over the three-year project phase. ‘We achieved the successful transfer of the European agricultural monitoring system to China and Morocco. This was a huge technical advance for Morocco in particular in terms of the infrastructure built up and the final capability of analysis,

thus far beyond the original project planning. This achievement is the result of strong commitment and synergy delivered by local partners during implementation.’

The progress in China was made on a more technical level but it is important, as Dr Dong explains, ‘We achieved a couple of things, particularly in terms of using a multi-model approach for crop monitoring and crop yield prediction using remote sensing. The multi-modal approach allows us to take into account simultaneously multiple yield drivers such as climate change or disease impact. We can use several models to perform a yield simulation including all of these drivers.’

Probably the most impressive outcome for the project team was successfully adapting the European ‘Crop growth monitoring system’ (CGMS) to the local context in Morocco. This process also offered the European Commission useful feedback on its

technology. ‘Our consortium teamed up, even with different institutes outside the project, to achieve the adaptation. Now, MARSOP, the crop monitoring operation run by the European Commission even takes some inspiration from what we have set up in Morocco. So the learning and benefits work both ways. In some sense, the return on investment for the European Union is also important.’

Dr Dong explains, however, that the process was not without problems. ‘The first year was difficult. The first simulation outcome did not agree with the ground observations. There was a bottleneck but we couldn’t see where and didn’t understand why it was performing so poorly in North Africa. After a deep analysis of all important driving factors in the system and involvement of local experts, we came up with a new calibration or parameterisation of the system, adapted to



the cropping pattern in North Africa, with a better result.'

*"The technology helps local producers and governments to make early decisions on their agricultural production planning."*

In China, the use of the BioMA platform with a multi-model approach is another example of positive feedback for the European institutions. Now the agricultural monitoring used by the Commission is also gradually integrating this approach into their daily operation. The E-AGRI project was also able to demonstrate that the use of remote sensing for yield forecasting is the most efficient and highly accurate

way to forecast crop yield in arid or semi-arid regions.

Dr Dong points to the benefits that this technology will have 'on the ground' for farmers and policy makers, as CGMS is already the core system used for the implementation of an innovative index-based insurance for farmers in Morocco. This kind of insurance is more transparent, more objective and more appealing for farmers. (There is no chance for cheating as the payout is based on the index).

'More generally speaking,' Dr Dong adds, 'the technology helps local producers and governments to make early decisions on their agricultural production planning. As a result they can strike the balance between supply and demand and ultimately prevent low prices from hurting farmers'

incomes, and manage agricultural commodity trading.'

Based on the results from E-AGRI, some partners of the Consortium have succeeded in teaming up for two new FP7 grants which began in 2013. They are called MODEXTREME (MODElling vegetation response to EXTREMe Events) and ERMES (Earth obseRvation Model based ricE information Service). The team has also applied the outcome of the E-AGRI project to agricultural insurance with two new projects focused on this domain.

#### E-AGRI

- ★ Coordinated by VITO in Belgium.
- ★ Funded under FP7-ICT.
- ★ Project website:  
<http://www.e-agri.info>

## ADVANCED DEVICES USING SPINTRONICS OSCILLATORS

Conventional oscillators are important components of electronic devices but pose a barrier to downsizing. Scientists used novel nano-oscillators instead to overcome the increasing functional and size limitations of electronic circuits.

Wireless communications systems typically employ oscillators created by inductors and capacitors (L-C oscillators). As the industry seeks ever-increasing function in ever-smaller packages, the inductor has become a bottleneck to certain advances in wireless communications devices.

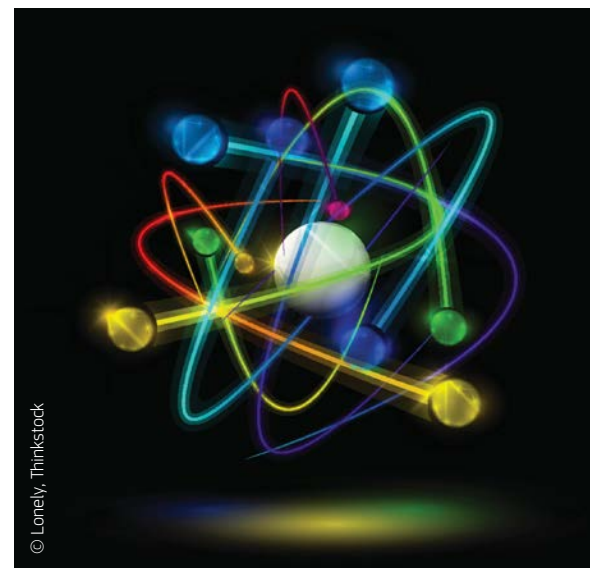
Spintronics, a field that exploits the spin of electrons as well as their charge, is providing novel devices that overcome the increasing limitations of conventional electronics. Of particular interest to wireless communications are 'spin-torque oscillators' (STOs), also called spin-transfer nano-oscillators. Scientists initiated the EU-funded project SPINAPPS (Spin torque oscillators for wireless and radar applications) to address existing challenges related to output power, frequency stability and frequency control.

A few STOs can cover the full frequency range of all communication standards. This is due to properties such as sustained microwave-frequency magnetic oscillations and high tunability by both electric and

magnetic fields. In addition, STOs are highly compact, easy to fabricate and compatible with conventional silicon 'Complementary metal-oxide semiconductor' (CMOS) technology. Their minimal power consumption and significant cost savings compared to conventional systems make them particularly attractive in wireless devices. Moreover, they can also be used in higher frequency applications such as new communications protocols and radar systems.

Investigators developed simulation software based on commercially available Cadence products to test the function of STO circuits in any semiconductor technology supported by Cadence. The simulation environment thus enables assessment of semiconductor noise and temperature dependence on STO performance as well as investigating novel circuit architectures.

Experimental work led to the optimisation of a highly effective process to integrate 'Nano-contact STOs' (NC-STOs) on four-inch silicon wafers. As a result, the team produced two different demonstrators, one based on



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'Magnetic tunnel junction STOs' (MTJ-STOs) on a printed circuit board and one based on 'Giant magnetoresistance STOs' (GMR-STOs) in an electromagnet.

The SPINAPPS consortium demonstrated the use of spin-torque oscillators in novel devices. Simulation software will certainly inspire innovation beyond the scope of the project to partners and scientists outside the consortium.

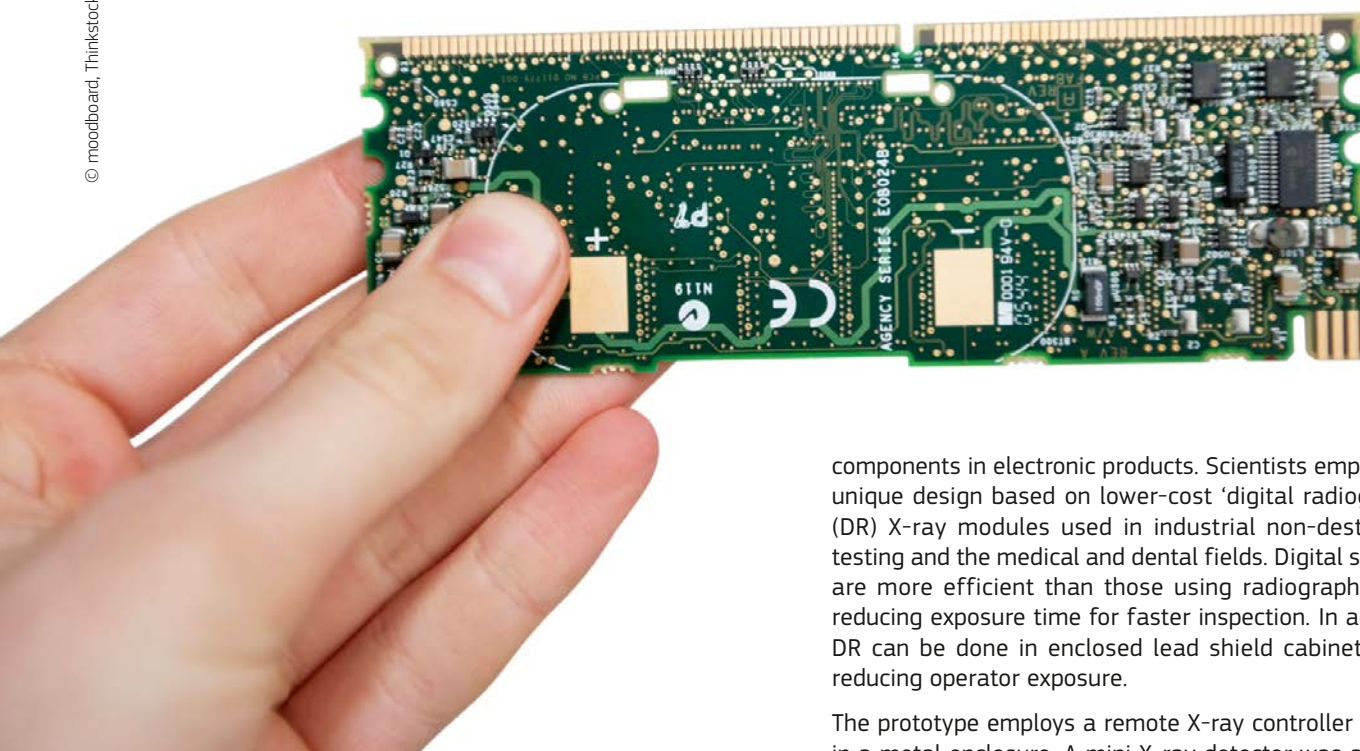
#### SPINAPPS

- ★ Coordinated by KTH in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/result/brief/rcn/6798\\_en.html](http://cordis.europa.eu/result/brief/rcn/6798_en.html)

## SEEING THROUGH CIRCUIT BOARD COUNTERFEIT DECEPTION

Counterfeit components are a growing concern to the electronics industry. An innovative, low-cost X-ray inspection system will enable visualisation of all pieces received by manufacturers to ensure final product quality and safety.

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Electronics manufacturers that inadvertently use components whose performance or materials are misrepresented can face lower yields, device failures and product recalls. Inferior counterfeits can even cause malfunctions of safety-critical devices that lead to loss of life or environmental disaster.

It is currently not possible to check each piece individually. Surface-mount components are packaged in reels or tubes of 1 000 to 20 000 pieces for automated feed.

*"The CHIPCHECK system is capable of inspecting individual components in less than one second."*

Removal from the original package followed by visual inspection and in-circuit testing is too costly and time intensive. Despite heightened precautions regarding the sourcing of safety-

critical components, counterfeits have entered the supply chain in both the aerospace and defence industries.

The innovative EU-funded CHIPCHECK (Development of Novel X-ray Inspection System for Fast Automated Detection of Counterfeit PCB Components) project set out to deliver a low-cost X-ray inspection system to evaluate each individual component and significantly reduce the introduction of counterfeit 'Printed circuit board' (PCB)

components in electronic products. Scientists employed a unique design based on lower-cost 'digital radiography' (DR) X-ray modules used in industrial non-destructive testing and the medical and dental fields. Digital systems are more efficient than those using radiographic film, reducing exposure time for faster inspection. In addition, DR can be done in enclosed lead shield cabinets, thus reducing operator exposure.

The prototype employs a remote X-ray controller housed in a metal enclosure. A mini X-ray detector was adapted from the dentistry sector to image small areas with very high resolution. An X-ray cabinet houses and integrates all parts to shield the operator from radiation. The CHIPCHECK system is capable of inspecting individual components on tape reels and other types of automated feeding systems in less than one second.

The increasing influx of counterfeit electronics components from countries with minimal cultural sensitivity or legislation to protect intellectual property rights is increasing the probability of failure of safety-critical systems. CHIPCHECK will enable inexpensive and reliable detection of counterfeit PCB components to increase safety and enhance the competitiveness of EU electronics manufacturers. With potential to become an electronics safety standard, the inspection system could have an important impact on the EU economy with sales expected at manufacturing sites around the globe.

### CHIPCHECK

- ★ Coordinated by TWI in the United Kingdom.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/result/brief/rcn/12550\\_en.html](http://cordis.europa.eu/result/brief/rcn/12550_en.html)
- ★ Project website: <http://www.chipcheck.eu>
- ★ <http://bit.ly/1f3QuHb>



## A HOT TOPIC FOR MERMAIDS

To study something in detail you need to look at it from all directions, whether it is the Venus de Milo statue in the Louvre Museum, a car you are thinking of buying, or when using a CAT-scanner to image inside the human body.

In the ERC-funded GLOBALSEIS (New goals and directions for observational global seismology) project, Professor Guust Nolet is doing this on a truly global scale, by developing a worldwide network of marine-based seismic-wave sensors that can give a much better picture of deep-earth structures and resolve a major paradox in geoscience.

Across the world's oceans the GLOBALSEIS research team is scattering a few 'mermaid' prototypes — not the fishtailed variety of mythology, but rather autonomous floating devices equipped with hydrophones that listen carefully to the seismic tremors coming from deep in the earth. These mermaids are launched from ships and descend to depths of up to 2000 metres where they drift along with the deep-ocean currents — recording the seismic waves that signal earthquake events originating in the Earth's mantle.

When enough data has been collected, they rise to the ocean surface and transmit this information through the global Iridium satellite network to the project team at the Géoazur Research Centre in the south of France.

'Simply put, through the mermaids, we are trying to understand why the Earth's interior is so hot,' explains Guust Nolet. 'When the Earth formed some 4.5 billion years ago it was very hot and with time it cooled by radiation. However, at some point in the geological past cooling slowed and the interior today is much hotter than theory tells us it should be. We do not know why.'

'On the one hand, geophysicists suggest there must be high concentrations of radioactive materials in the Earth's mantle, which decay and release heat. On the other hand, geochemists say that such high concentrations are not possible. This is a paradox. In the GLOBALSEIS project we are seeking a solution by investigating how mass and heat are being exchanged between the Earth's solid mantle and the surface, in particular by advection — the physical movement of material deep in the Earth.'

### Rise and fall of plumes and slabs

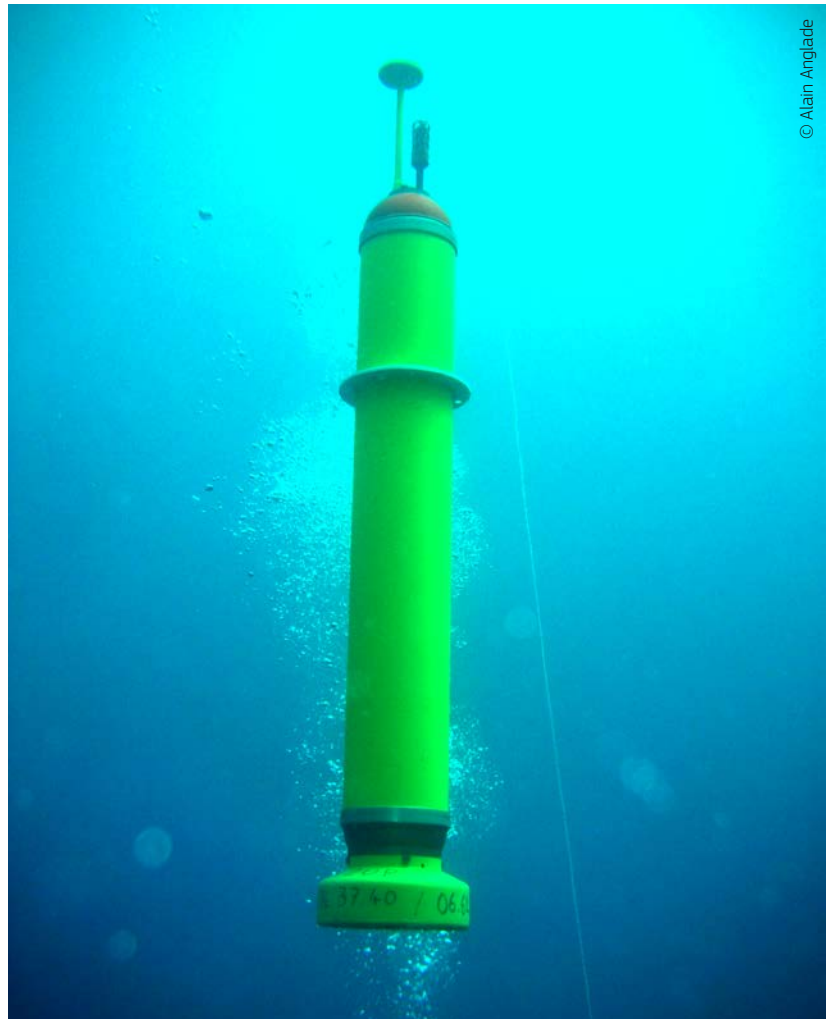
The project is studying 'plumes' and 'slabs': plumes are massive volumes of hotter rock which rise through the mantle and eventually reach the Earth's surface as volcanic activity. Slabs are the layers of colder rock which sink deep into the mantle from the Earth's surface at 'subduction zones'. Such movements involve the exchange of mass, and particularly heat, and thus could form an important element in explaining the temperatures observed in the Earth's interior.

Prof. Nolet and his team are using seismic waves from earthquakes to search for plumes and slabs and

image them by studying the waves' properties and using advanced mathematical methods of seismic tomography. This can be done because the temperature differences between warmer plumes, colder slabs and the surrounding rock affect the properties of seismic waves (such as their velocity) in ways that can be used to produce images.

'We are particularly interested in where plumes arise and how far slabs sink,' he says, 'so we are looking closely at the boundary between the upper and lower mantle at a depth of 660 kilometres. If we see that plumes and slabs cross this boundary then this would confirm a strong advective element in the Earth's cooling, a way of getting heat out of the interior.'

However, to date, seismic tomography has not been able to produce good enough images to investigate the depth and size of these features. This is because most plumes and slabs are found under the oceans, while most seismometers are on land, which means that high-resolution imaging has proved impossible. Ocean-bottom seismic arrays do exist, but are too



© Alain Anglade

expensive to implement on the scale that higher-resolution seismic tomography demands.

But technical developments over the last decades now offer a solution, as Prof. Nolet explains. 'I first had the

prototype as part of an earlier Marie Skłodowska-Curie grant, and the results were very hopeful.'

### Multiple mermaids

'Once dropped from a ship, mermaids are quite autonomous. They sink to a programmed depth and can stay there for months, listening for seismic events. When sufficient data has been collected, they rise to the surface and transmit the data back to us. We are hoping to mount a global, multi-disciplinary monitoring effort — a new project called MARISCOPE. By scattering mermaids around the oceans, especially in the southern hemisphere, we will be able to collect better, higher-resolution data to build 3D images of structures deep in the earth.'

The mermaids have already exceeded expectations and have enabled the research team to record earthquakes with magnitudes as low as 6 on the Richter scale, of which there are on average two every week. The next step is a fleet of 10 mermaids that will be launched around the Galapagos Islands to investigate an underlying mantle plume. However, the innovative technologies developed for mermaids are raising interest in potential commercial applications, according to

Prof. Nolet. The project received an ERC Proof of Concept grant to investigate these. Together with OSEAN, a company specialising in underwater technologies, the GLOBALSEIS team is developing a more powerful mermaid.

'The new 'Multimermaid' will be able to carry multiple scientific instruments covering a range of research areas, such as biology and meteorology, as well as seismology. It incorporates more powerful sensors, can go deeper and can last for up to five years on a single battery charge,' explains Prof. Nolet. 'In addition, it could be used for a range of non-scientific applications, such as locating groups of whales that can be a danger to shipping, or even locating black-box transponders from lost aircraft.'

#### GLOBALSEIS

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://erc.europa.eu/erc-stories/hot-topic-mermaids>
- ★ Project website: <https://www.geoazur.fr/GLOBALSEIS>
- ★  <http://www.euronews.com/2014/01/20/fishing-for-earthquakes-a-new-wave-in-seismology/>

*"We are trying to understand why the Earth's interior is so hot."*

idea for mermaids when I saw the oceanographers launching floats equipped with scientific instruments on to the oceans to collect data. Then, when the Iridium network of low-orbit communications satellites arrived it offered clear possibilities for locating and communicating with floating platforms over great distances.'

'The next challenge was to build a mermaid with enough artificial intelligence to recognise seismic events among all the noise of the ocean depths. It's not quiet down there — whales, ships, oil platforms and storms create a very high noise level, especially for highly sensitive seismic sensors. We built and tested the first

## NEW CHIP FOR TELE-HEALTHCARE

A complete 'System-on-a-chip' (SoC) has been developed for processing signals and algorithms associated with cardiac monitoring. The new technology targets a valuable market by developing novel cardio-monitoring products for use in home and professional environments.

Developing personalised cardio-monitoring tools requires a major technological breakthrough in the area of integrated sensing/processing solutions on a single chip platform. The goal of the EU-funded 21-month ICYHEART (Highly integrated ultra-low-power SoC solution for unobtrusive and energy-efficient wireless cardiac monitoring) project was to deliver a miniature microelectronics SoC with an embedded signal processing suite to enable low-power wireless electrocardiogram monitoring.

At the outset, user requirements were outlined and potential market areas identified such as chronic primary and secondary care, occupational healthcare, sports medicine and maternity services. Then the partners of ICYHEART successfully designed and developed a low-power integrated sensor interface test chip. Software for the embedded processor was developed to acquire and transmit the monitored data to a computer where they can be graphically displayed. In parallel, software enabling wireless communication with the monitoring device was also developed. This early software development and its incorporation in

the chip enabled the partners to optimise usage of computing and memory resources.

In the second year of the project, partners carried out the testing of the ICYHEART prototype with the intention of enabling the collection and initial analysis of physiological data from body-worn sensors as well as wireless data transfer to a monitoring device. On completion of the ICYHEART project the goal of delivering a miniature integrated microelectronics SoC, and its assorted embedded signal processing suite, that will enable wireless electrocardiogram monitoring in tele-healthcare had been achieved.

*"ICYHEART successfully designed and developed a low-power integrated sensor interface test chip."*

#### ICYHEART

- ★ Coordinated by RTD Talos in Cyprus.
- ★ Funded under FP7-SME.
- ★ Project website: <http://www.icyheart-project.eu>
- ★  <http://bit.ly/1rkNxtU>



INDUSTRIAL TECHNOLOGIES

# CROSSING BORDERS TO FIND AN ALTERNATIVE RUBBER SUPPLY

Natural rubber is a unique raw material with a whole range of applications. To reduce the current dependence on the rubber tree which mainly grows in Asia, a European substitute is vital.

**E**U-PEARLS (EU-based production and exploitation of alternative rubber and latex sources) was a joint project between several European research organisations and industrial partners which focused on research into two types of plants: the Russian dandelion and the desert plant known as guayule. The ultimate goal of the project was to make it possible to

produce natural rubber in Europe and reduce the commercial dependence on the Asian market. This will ensure security of supply as well as the optimal use of the raw material in finished products such as tyres and latex gloves.

Research under the project has shown that both the Russian dandelion and the guayule are an excellent

alternative to the rubber tree. In fact, the first ever prototype tyres from guayule and Russian dandelion plants, grown in Europe, have already been produced, giving a clear indication of the technical performance and economic potential of the rubber extracted. In addition, the French partners in the project have produced glove prototypes made from European guayule-based latex.

Specifically, the research has focused on making the Russian dandelion grow faster in order to increase the content of natural rubber available for extraction. To guarantee the sustainable exploitation of both crops, the project also involved research into genetics, breeding, agronomy and processing of the rubber and its by-products such as inulin — a sugary substance present in the roots.

Asked about the benefits of using these new alternative rubber sources, EU-PEARLS project coordinator Dr Hans Mooibroek of Wageningen University & Research Centre (UR) says: 'The traditional rubber tree is facing a number of threats including diseases such as leaf blight,

## INDUSTRIAL TECHNOLOGIES

which despite many efforts, has not been eradicated. Another fundamental problem with the rubber from this tree is the allergic reaction it can cause. This would be avoided with latex from guayule or the Russian dandelion,' explains Dr Mooibroek.

*"Guayule can now be successfully grown in the Mediterranean area."*

As a result of the research, experts say that guayule can now be successfully grown in the Mediterranean area of Europe while the Russian dandelion is better suited for eastern and northern European countries. One such country is Kazakhstan which is home to the original species of Russian dandelion called 'Taraxacum koksaghyz' (TKS) which

is used in the production of high quality rubber.

Dr Kamila Magzieva, Director of Independent Experts Consulting Board to Promote Scientific Research Activity in Kazakhstan and FP7 National Coordinator, has been very active in promoting both the EU-PEARLS project and TKSs' domestic production to the Kazakh Government.

Her efforts have certainly come to fruition as EU-PEARLS has become the first real example of technology transfer from the FP7 programme to Kazakhstan. KZ-PEARLS, as the new project is called, involves a team from Wageningen University and KeyGene Agro Business Park and will base its activities on the key achievements of the EU-PEARLS project.

At the first 'EU-KZ innovation through cooperation' exhibition and conference at the Astana Economic

Forum in May 2013, KZ-PEARLS signed a grant agreement with the National Agency for Technology Development. 'This means that the first stage of KZ-PEARLS has started in Kazakhstan,' confirms Magzieva. 'We are planning to cultivate TKS and guayule in Kazakhstan, transfer technologies for rubber extraction and eventually produce new rubber products here,' she adds.

#### EU-PEARLS

- ★ Coordinated by DLO in the Netherlands.
- ★ Funded under FP7-KBBE.
- ★ [http://ec.europa.eu/research/infocentre/article\\_en.cfm?artid=31739](http://ec.europa.eu/research/infocentre/article_en.cfm?artid=31739)
- ★ Project website: <http://www.wageningenur.nl/en/Research-Results/Projects-and-programmes/eu-pearls-projects.htm>
- ★  <http://bit.ly/1jFyiiT>

## NEW WAY TO PREVENT CORK TAIN

Cork stoppers are sometimes contaminated with a chemical that can spoil the sensory characteristics of wine. A novel decontamination approach that can be easily integrated into any existing wine bottling line has recently emerged.

A compound known as 2,4,6-trichloroanisole, or TCA, causes a wine fault known as cork taint in as much as 5% of European bottled wines. Cork stoppers are usually treated during their production, but environmental factors, like the presence of various chemical compounds converted by fungi, can result in re-contamination.

The EU-funded NEATCORK (Novel method to remove chloroanisoles present in cork stoppers) project applied atmospheric pressure plasma to decontaminate cork stoppers. This treatment technology, which had already been validated at laboratory-scale, can be applied immediately before wine bottle sealing, virtually eliminating the risk of re-contamination.

Commercially available cork stoppers were contaminated with enough TCA to represent worst-case scenarios. Six different atmospheric pressure plasma sources were set up and modified to treat the cork stoppers.

Researchers found that the treatment reduced TCA to amounts low enough to prevent cork taint. Advantageously, the treatment also did not affect the physical properties of the corks or of the wine.

Project partners, including a bottling line manufacturer, a plasma sources manufacturer and two winemakers, will industrialise and commercialise this technology. The move is set to benefit thousands of small and medium-sized European wineries in terms of customer satisfaction.



© michalzak, Thinkstock

#### NEATCORK

- ★ Coordinated by the University of Stuttgart.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/result/brief/rcn/12885\\_en.html](http://cordis.europa.eu/result/brief/rcn/12885_en.html)



## LOW-COST CUSTOM-MADE GOODS

Groups of people with special needs like the elderly, diabetics and the obese often need custom-made footwear and clothes, which are usually expensive and unstylish. An EU project helped European businesses to design and produce low-cost customised goods.

**D**iabetic, elderly and obese people as well as people with disabilities often have trouble finding garments, shoes and other goods that can be tailored to their needs at a reasonable price. European small and medium-sized enterprises (SMEs) should service the sizeable market for customisable goods.

To deliver small quantities of goods in a cost-effective and eco-friendly way, European SMEs need new processes, technologies and other tools. Developing these was the goal of the CORENET (Customer-oriented and eco-friendly networks for healthy fashionable goods) project. The 14-member EU-funded consortium ran for 36 months to May 2013, receiving EUR 3.5 million. Its aim was to develop new manufacturing methods, tools and technologies that allow profitable small-scale design and production of customised goods for consumers with health problems.

The project's results include software and hardware, and four business development areas. The most important is the reference model, intended to help SMEs form and dynamically operate collaborative networks of suppliers that can serve these new target groups and enter the market. The processes devised were the cornerstone for the project's later

successful development of numerous advanced software and other tools.

The reference model provided the necessary framework for developing solutions to support different processes. They included market analysis for clustering target customers, searching for partners and developing collaborative planning tools, laser marking machines and digital printing.

Project results were combined in four different business case studies where they were tested and validated. Product categories for study were footwear, sewed garments, knitted garments and textile production. Each focused on specific business processes addressing particular target groups, such as designing special shoes for diabetic or otherwise disabled individuals. The project's dissemination activities focused on certain target consumer and business groups. The latter included businesses in the textile, clothing and footwear industry, the manufacturing and engineering industry, and the enterprise software industry. Additionally, the project targeted relevant academic communities.

CORENET successfully introduced new concepts and solutions to the SMEs in the target sector. These enabled participating SMEs to effectively address the needs of the various market



niches that are expected to grow in the future, providing opportunities for small European businesses to enter new markets and to maintain a competitive position in the global arena.

### CORENET

- ★ Coordinated by TXT e-solutions in Italy.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/result/brief/rcn/12811\\_en.html](http://cordis.europa.eu/result/brief/rcn/12811_en.html)
- ★ Project website: <http://www.corenet-project.eu>
- ★ <http://bit.ly/PKvhFL>

## ENSURING THE SAFETY OF NANO-BASED PAINT

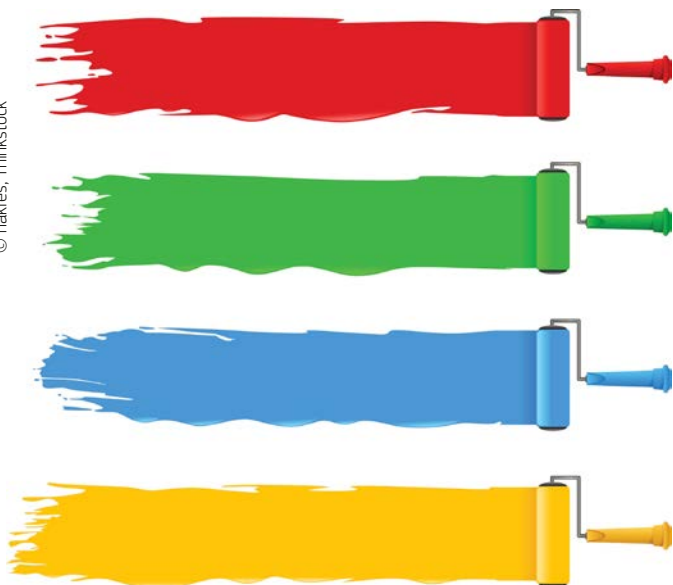
EU-funded scientists evaluated the release of 'engineered nanoparticles' (ENPs) from house paint, and its human and environmental impacts throughout the product's life cycle. Results should guide future design and certification of nano-based paints.

**N**anomaterials have revolutionised the functionalities attainable by numerous products across many industries. Within the housing sector, paints and coatings incorporate an increasingly high amount of ENPs. These increase resistance to ageing and add properties related to biocidal activity, air purification, thermal insulation and self-cleaning.

People are exposed to such materials in large quantities and on large surfaces within their homes. Scientifically identifying potential exposure levels and hazards is therefore critical to human and environmental safety. Scientists working on the EU-funded project NANOHOUSE (Life cycle

of nanoparticle-based products used in house coating) filled in data gaps.

Researchers investigated some of the most commonly used ENPs in indoor and outdoor coatings and paints consisting of silver (Ag), titanium dioxide (TiO<sub>2</sub>) and silicon dioxide (SiO<sub>2</sub>). Experiments showed that very few single ENPs are released from paints even when subjected to hard abrasion and leaching. Under harsh conditions, they are primarily released still embedded in the paint matrix or in agglomerate form. Weathering results in the release of only a small amount of ENPs. ENP release is influenced by the binder used, meaning that new formulations could reduce release throughout the life cycle, including in a landfill scenario. Furthermore, there was no significant release of ENPs into the environment under landfill conditions. This is because geomembrane lining systems in landfills effectively block release and there was no evidence of ENP release in fumes during incineration.



The team employed cell cultures and in vivo testing to investigate toxicity following acute and repeated exposure. Although pristine ENPs show some toxicity, after ageing, ENPs released embedded in a paint matrix did not induce significant toxic effects.

NANOHOUSE outcomes are expected to have an important positive impact on sustainable building with solutions to enhance competitiveness while decreasing the potential release of ENPs. Data will no doubt be an important input to the development of standardised testing and the certification of new products.

#### NANOHOUSE

- ★ Coordinated by the Atomic Energy and Alternative Energies Commission in France.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/result/brief/rcn/9950\\_en.html](http://cordis.europa.eu/result/brief/rcn/9950_en.html)
- ★ Project website: <http://www-nanohouse cea.fr>

## ANIMAL WASTE TRANSFORMED INTO PLASTICS

It is undisputed nowadays that traditional plastic materials should be replaced by biocompatible and biodegradable alternatives. To this end, a European study set out to utilise waste material from animal slaughterhouses to synthesise novel plastics.

Plastics such as 'polypropylene' (PP) or 'polyethylene' (PE) pose an environmental hazard as they elevate the atmospheric 'carbon dioxide' (CO<sub>2</sub>) concentration during incineration. Ecological considerations therefore necessitate the replacement of these materials with bio-based alternatives like 'polyhydroxyalkanoates' (PHAs).

PHAs constitute a family of biodegradable and biocompatible polyesters with a wide spectrum of potential applications ranging from simple packaging to medical and pharmaceutical materials. Investigators of the EU-funded ANIMPOL (Biotechnological conversion of carbon containing wastes for eco-efficient production of high added value products) project wished to synthesise PHAs from animal waste derived from slaughterhouses.

ANIMPOL had to consider the high cost of PHA production compared to petrochemically produced plastics while avoiding the use of nutritional materials important to mankind. Given the limitations of current technologies, the consortium selected saturated fat of porcine, bovine and avian origin. These would be exploited to produce 'Fatty acid methyl esters' (FAMES) that can be used as liquid fuel (biodiesel).



A variety of animal waste materials was also used as a carbon source for various microbial PHA producers. The fermentation reaction conditions were extensively investigated to maximise production yield.

Experiments were converted into mathematical models to predict the different types of fermentation carried out by the two bacterial species chosen (*Cupriavidus necator* and *Pseudomonas chlororaphis*) on different substrates. Significant optimisation was also carried out with respect to the PHA recovery techniques.

The overall streamline process of PHA production from slaughterhouse animal waste was verified to be cost effective, environmentally safe and efficient. Given the public demand for the plastics market to turn to 'green' alternatives, the ANIMPOL approach constitutes a viable strategy for producing biodegradable polymers.

#### ANIMPOL

- ★ Coordinated by the Graz University of Technology in Austria.
- ★ Funded under FP7-KBBE.
- ★ [http://cordis.europa.eu/result/brief/rcn/9651\\_en.html](http://cordis.europa.eu/result/brief/rcn/9651_en.html)



## ‘PIEZO-PAIR’ EAR-PROTECTIVE DEVICES

‘Noise-induced hearing loss’ (NIHL) in the work place is a growing problem, particularly in the manufacturing and transport sectors, causing losses from reduced productivity. Despite EU legislation making use of ear protection devices mandatory, worker compliance is low due to concerns about impaired hearing capability and incompatibility with safety equipment.



Combining two piezo materials in a pair obviates the need for an external power source as well as sound filters. This is because one material acts as a receiver and harvests energy at the speech and warning signal frequencies. The other uses the energy harvested by the receiver to generate a signal that allows the wearer to hear incoming speech and warning signals.

*“About 572 000 people suffer from occupational hearing loss.”*

Within the first nine months of the project, scientists completed a review of existing ear defender technologies and generated a comprehensive computerised ear model. PIEZOSELEX also focused efforts on device specifications by taking into account energy requirements, harvestable energy power in various environments and characteristics of piezoelectric materials.

Various device solutions were modelled in detail to optimise design specifications for prototype systems and a system was developed for their testing. In parallel, scientists worked on testing different piezo materials to characterise properties and behaviour.

To assess device ergonomics and requirements, PIEZOSELEX designed and completed up to 200 questionnaires along with four focus groups consisting of European workers. Scientists obtained data about ear dimensions for about 200 workers in Europe that will aid in designing the proof-of-concept for the in-ear device prototype.

The annual losses from NIHL to businesses in the manufacturing and transport sectors are about EUR 345 million and about 572 000 people suffer from occupational hearing loss. Successful project outcomes will result in the development of low-cost hearing protection technology that will encourage worker compliance, productivity and safety in the workplace.

The EU-funded PIEZOSELEX (Piezo pair materials for the selective exclusion of workplace noise) project aimed to devise low-cost in-ear protection devices using piezo materials. The device specifications took into account all factors such as selective hearing capability for speech and alarms, user comfort and safety.

PIEZOSELEX consortium members were organisations with expertise in fields such as piezo material manufacture and medical device development as well as organisations from the hearing loss industry. They came up with the innovative idea of using piezo pairs to self-power the device and filter noise above 75 decibel amplitude.

### PIEZOSELEX

- ★ Coordinated by GBA Services in the United Kingdom.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/result/brief/rcn/12829\\_en.html](http://cordis.europa.eu/result/brief/rcn/12829_en.html)
- ★ Project website: <http://www.piezoselex.eu>

## EFFICIENT COMPOST MONITORING IN A BALL

Composting is a sustainable way of treating organic waste. Researchers have made composting more profitable by improving the monitoring of the final product's quality.

The EU-funded COMPO-BALL (Novel on-line composting monitoring system) project set out to develop a wireless system to measure

temperature and humidity at various points in the composting process. The proposed solution consists of a set of sensors that are encapsulated in a protective ball, termed a SensoBall.

In the first work phase, COMPO-BALL developed the new sensors and the protective ball material that would be used. Researchers also conducted

market research to determine the composting industry's needs and requirements.

Based on these results, a prototype, consisting of five sensor nodes and a central hub, was developed. The prototype system could successfully measure and send out humidity and temperature data, across a newly



developed communication protocol. A second system with 30 encapsulated sensor nodes has been tested and refined in field trials in Spain and the Netherlands. A ball recovery system has also been developed and demonstrated.

COMPO-BALL offers a simple but comprehensive monitoring solution that is also novel — the industry has not seen this solution before. Not only

will the data improve profitability in the composting industry, they will also allow stakeholders to comply with new and more stringent composting regulations.

#### COMPO-BALL

- ★ Coordinated by Iris in Spain.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/result/brief/rcn/12826\\_en.html](http://cordis.europa.eu/result/brief/rcn/12826_en.html)

## AIRCRAFT COMPOSITES PRODUCED CHEAPER

EU-funded scientists developed cost-effective manufacturing technology for widely used composite aircraft structures. Reducing the cost of production will have significant impact on the competitiveness of the EU aerospace industry.

Carbon fibre-reinforced plastics (CFRPs) are increasingly employed in the production of aircraft structures. CFRPs have high strength-to-weight ratios resulting in high mechanical performance with reduced fuel consumption and emissions. Current long-range aircraft have utilised CFRP structures produced primarily with costly state-of-the-art manufacturing processes.

*“FPP has more potential for high-volume production due to faster production speeds.”*

The EU-funded project IMAC-PRO (Industrialization of manufacturing technologies for composite profiles for aerospace applications) developed cost-effective CFRP stiffener production chains. Their focus was on two types of aircraft structures: the stringers (longitudinal stiffening elements) of the fuselage, and frames and beams.

Three different technologies were developed for stringer pre-forming. A discontinuous ‘hot pressing’ (HP) process was employed to form non-crimped fabric material. Scientists also developed a ‘Fibre patch pre-forming’ (FPP) production route for an integrated pre-form tape made from single patches cut from ‘unidirectional’ (UD) glass tapes to be formed into a T-stringer. Finally, they developed a pre-form for curved stringers consisting of stringers made from tubular braided sleeves. Pultrusion and infusion technologies were investigated for curing of stringers. Although HP technology is quite



mature, FPP has more potential for high-volume production due to faster production speeds.

Two heavy profiles, a JF-frame and a C-beam, were selected for development of pre-forming appropriate for frame and beam manufacture. UD braiding technology for the manufacture of textile-based composites is the preferred pre-forming technique used to avoid the limitations of prepreg (pre-impregnated fibres for which a matrix is already present). UD-braided pre-forms are produced from dry carbon fibre. The pre-forms are then resin-infused, cured and finished. New curing tools were produced for each profile using novel technology enabling a very short infusion time before closing the mould for wetting and curing. The UD technology was shown to

be highly effective at producing complex curved pre-forms cost-effectively with minimal scrap.

Frames, stringers and floor beams are important lightweight structures with high stiffness and strength that are largely responsible for the aerodynamic shape of an aircraft. Optimised design and cost-effective manufacturing of such components as demonstrated within the IMAC-PRO project will have a major impact on the competitiveness of the EU aerospace industry.

#### IMAC-PRO

- ★ Coordinated by Airbus in Germany.
- ★ Funded under FP7-TRANSPORT.
- ★ [http://cordis.europa.eu/result/brief/rcn/5758\\_en.html](http://cordis.europa.eu/result/brief/rcn/5758_en.html)





SPACE

# INSPIRING THE FUTURE OF SPACE EXPLORATION

There are many ways to pique the interest of young Europeans in space exploration. The ODYSSEUS project was initiated to engage and inspire students through a pan-European scientific contest focusing on three major themes: our solar system, spaceship global cooperation, and co-evolution of life.

**ODYSSEUS** (Engage and inspire the European youth in the space exploration through a scientific contest) is a project that used innovative and interactive teaching approaches to promote scientific orientation for high-school students. Using a hands-on science approach, the contest showed students aged 14 to 18 that space and science can be fun and relevant for everyone. The organisation of the contest, in each EU country as well as at a pan-European level, involved a community of volunteer teachers and space experts.

A web portal featuring project information and facilitating the registration and submission of entries was launched to reach out to potential contestants. The website also served as a teachers' resource for novel experiments and projects.

In total, 621 students and 207 teachers/coaches registered for the contest: 105 teams from 15 EU countries and 13 teams from three non-EU countries were selected. Participating teams were responsible for the design, development and submission of their entries, for one of the three themes. Entries had to be creative and innovative in approach and to seek out answers to scientific issues. The winning teams — made up of 22 pupils and five teachers — were invited to the

European Astronaut Centre in Cologne, Germany. They presented their projects at the award ceremony held at Space Expo in the Netherlands.

ODYSSEUS activities raised interest in science career paths and helped to strengthen science education in school curricula. They also enhanced public understanding of the three selected themes. Other outcomes include the publication of good teaching practices, and the production of resources and applications that can help boost scientific literacy and support teachers in assessing students' efforts in scientific fields.

By offering a novel way of directly interacting with science, the ODYSSEUS scientific contest contributed to improving science education, reducing gender stereotypes and inspiring students to appreciate science.

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## ODYSSEUS

- ★ Coordinated by Signosis in Belgium.
- ★ Funded under FP7-SPACE.
- ★ [http://cordis.europa.eu/result/brief/rcn/10643\\_en.html](http://cordis.europa.eu/result/brief/rcn/10643_en.html)
- ★ Project website:  
<http://www.odysseus-contest.eu/>

## ROBUST AND DURABLE NETWORKS FOR SPACE DATA

EU and Russian researchers have further developed an on-board networking technology for spacecraft applications. It will underpin many future space and 'Earth observation' (EO) missions, including those helping to protect our environment.



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Spacecraft need an on-board communication network with many demanding requirements. The technology has to support both avionics and payload data-handling applications.

In order to fulfil this need, the EU-funded SPWRT (Spacewire RT) project was established. Based on Spacewire, the existing standard for high-speed data links and

networks for use on-board spacecraft, the project conceived and created a new communications network technology.

A highly experienced team of European and Russian academic and industrial organisations worked on the SPWRT project. Initially, the researchers produced a set of user requirements and case studies for networking on-board spacecraft.

In addition, the scientists decided to base their network research on SpaceFibre technology. This high-performance network technology is currently being designed by the University of Dundee in Scotland on behalf of the European Space Agency (ESA).

Enhancing this high-speed serial data link, the project designed a technology capable of ensuring high-quality performance for critical applications. The SPWRT team researched quality of service and automatic fault detection, isolation and recovery capabilities.

By creating and developing this new technology, SPWRT has substantially strengthened the collaborative bonds between the European and Russian organisations involved. The technology is expected to be adopted widely with implementations by European, Japanese and Russian organisations already under way.

The enhanced SpaceFibre technology resulting from the now completed SPWRT project is designed primarily for spacecraft applications. However, its key characteristics of high performance and implementation simplicity are likely to make it attractive for terrestrial applications such as robotic applications too.

### Spacewire RT

- ★ Coordinated by the University of Dundee in the United Kingdom.
- ★ Funded under FP7-SPACE.
- ★ [http://cordis.europa.eu/result/brief/rcn/10486\\_en.html](http://cordis.europa.eu/result/brief/rcn/10486_en.html)
- ★ Project website: <http://spacewire-rt.org>

## SLOW AND STEADY WINS THE SPACE RACE

Soft and safe landings are critical to exploration of planetary surfaces as well as to re-entry of manned and robotic space vehicles. EU-funded scientists are developing the required technology and a unique soft landing test bed.

The success of future space exploration missions, whether robotic or manned, requires the capability of soft and precise landings on the surfaces of destinations such as the Moon, Mars and even Jupiter's moon Europa. Throttleable propulsion technology could be a key enabler.

EU-funded scientists working on the project SPARTAN (Space exploration research for throttleable advanced engine) are

*"They completed the engine design and tested it in static mode."*

developing that technology. This hybrid engine design will have the ability to increase or decrease engine power with advanced

safety, minimal environmental impact and lower life cycle costs. A major effort is being expended to develop the low-cost test bench and procedures to enable ground testing, including a landing test.

The hybrid propulsion system consists of the engine itself that houses the fuel together with the oxidiser injection system. During the second year of the project, scientists finalised the

throttling device and oxidiser system design, and delivered the throttling device performance validation report. They completed the engine design and tested it in static mode. Results pointed to minor modifications now underway, mainly in the catalyst components. The thrust control algorithm is under development as is the definition of the guidance, navigation and control architecture.

With its completion, SPARTAN will have demonstrated the first European soft landing drop test using a throttleable engine and an autonomously guided lander module. This will pave the way for future research, enabling soft landings on moon and planetary surfaces as well as re-entry of a crew space transportation vehicle. Reduced dependence on imported technologies for space access and transportation is an important driver of European space research programmes. Project success will demonstrate EU capability and ambition on the international space scene with a major impact on future space missions.

### SPARTAN

- ★ Coordinated by Thales Alenia Space in Italy.
- ★ Funded under FP7-SPACE.
- ★ Project website: <http://www.spartanproject.eu>
- ★  <http://bit.ly/1mCJhxx>



# EVENTS

JUNE  
19►20

Rome, ITALY

WORKSHOP

## FUNCTIONAL DNA NANOTECHNOLOGY WORKSHOP

The Functional DNA Nanotechnology Workshop will take place from 19 to 20 June 2014 in Rome, Italy.

The workshop will bring together stakeholders to share knowledge and ideas in an informal environment on such issues as nanotechnology, DNA-based sensing and DNA-based synthetic biology. The conference is being funded by the ERC (European Research Council) and will be organised by Francesco Ricci from the University of Rome, together with academics from Ludwig-Maximilians University in Germany and Bar Ilan University in Israel.

For more information, please visit:  
<http://www.fdn2014.com/>

JULY  
07►08

Paris, FRANCE

CONFERENCE

## SECOND INTERNATIONAL CONFERENCE ON ADVANCES IN COMPUTER, ELECTRICAL AND ELECTRONIC ENGINEERING

The Second International Conference on Advances in Computer, Electrical and Electronic Engineering (ICACEEE 2014) will take place from 7 to 8 July 2014 in Paris, France.

The aim of the conference is to provide an international forum for exchange of ideas and best practices among interested researchers, students, developers and practitioners in the areas of computing, communications and informatics. The programme will consist of tutorials, regular technical sessions, symposium, workshops, special sessions, demos and plenary/keynote speeches.

For more information, please visit:  
<http://www.icaceee.com/>

JULY  
18►19

Madrid, SPAIN

CONFERENCE

## 2014 INTERNATIONAL CONFERENCE ON ENERGY AND ENVIRONMENT RESEARCH

The 2014 International Conference on Energy and Environment Research will be held from 18 to 19 July 2014 in Madrid, Spain.

The event will focus on state-of-the-art technologies in the fields of energy and environment research, with the latest theoretical and technological advances to be presented and discussed. More specifically, participants will have a chance to look at how energy and environment research impact such domains as astronomy, biology, education, geosciences, security and healthcare.

For more information, please visit:  
<http://www.iceer.net>

## EVENTS

For more forthcoming events:  
<http://cordis.europa.eu/events>

JULY  
24►27

Brighton, United Kingdom

CONFERENCE

## INAUGURAL EUROPEAN CONFERENCE ON PSYCHOLOGY AND THE BEHAVIORAL SCIENCES 2014

The 'Inaugural European Conference on Psychology and the Behavioral Sciences 2014' will take place from 24 to 27 July 2014, in Brighton, United Kingdom.

The international and interdisciplinary conference will bring together a range of psychologists, medical doctors and social scientists to discuss the traditional confines of narrow fields of specialism, and new directions of research and discovery in psychology and the behavioral sciences. The theme of this year's event will be 'Individual, Community and Society: Conflict, Resolution and Synergy'.

For more information, please visit:  
<http://iafor.org/iafor/conferences/the-european-conference-on-psychology-and-the-behavioral-sciences-2014/>



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