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SPECIAL FEATURE

WHAT WE CAN LEARN FROM INSECTS



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EU RESEARCHERS
SAW BREXIT COMING**

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EDITORIAL

by the editorial team

INSECTS: AN ENDLESS SOURCE OF INSPIRATION FOR RESEARCH AND DEVELOPMENT

Known as entomology, the study of insects is a branch of science whose interest is often inversely proportional to the size of its subjects. Not only do insects make up over 50 % of species known on Earth, but they have a lot more in common with humans than we'd first think: some of the most known species work in unison, have hierarchical societies, divide labour based on classes, and even plan for more difficult days to come.

Insects can either wreak havoc or preserve life on Earth. An impressive number of answers to pending scientific questions or technological challenges can be found through a better knowledge of insects and their often mind-bending characteristics.

**'An impressive number
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Over the past years, scientist across the globe have been studying insects to test new treatments for humans, investigate the nature of ageing, draw inspiration for cooperation mechanisms in robots, study the effects of pollution and solve many other scientific challenges. EU funding — mostly provided in the form of Marie Skłodowska-Curie actions — has helped and continues to help these scientists in their quest for answers.

This issue of the *research*eu results magazine* is an ode to the entomologists' contribution to scientific advances in Europe. The special feature section covers eight recently-completed or close-to-completed projects, with topics as

fascinating as insect response to climate change, maggot-inspired robotics, beetle-inspired farming, fungus that can control ant behaviour, or genetic alterations that allow insects to walk on water.

This special feature is followed by the usual eight sections providing insights into biology and medicine, social sciences and humanities, energy and transport, environment, IT and telecommunications, industrial technologies, food and agriculture, and physics and mathematics, along with a list of upcoming events hosted by or involving EU-funded research projects.

We look forward to receiving your feedback. You can send questions or suggestions to:
editorial@cordis.europa.eu



Erratum

In issue 54 of the *research*eu results magazine*, our article dedicated to the FORMIT project (p.14) includes a typo that unfortunately went through our quality control process. The first name of Prof. Dr. Mohren, coordinator of FORMIT, is actually 'Frits' and not 'Fits'. We wish to apologise to Prof. Dr. Mohren for this mistake.



Focus on
Shaping the
future of
offshore wind

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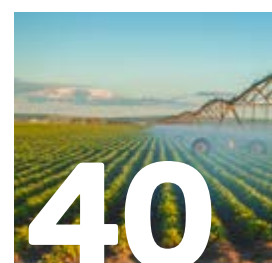
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SPECIAL FEATURE

WHAT WE CAN
LEARN FROM INSECTS

INTERVIEW

STUDYING INSECTS'
RESPONSE TO SHORT-TERM
CLIMATE EVENTS

Studying the response of living organisms to climate change is essential in the face of what increasingly looks like an irreversible trend. However, unlike other species which have gathered much scientific attention, insects seem to have been left behind. An EU project is seeking to bridge this knowledge gap while taking insects' specific features into account.

The CLIMINSECTS (The effect of expected climate change on insect performance: physiology, behaviour and life history) project was born from the observation that insects show very flexible responses to climate change.

Unlike mammals or birds, insects can see their performance being affected even by the most sudden and short-term changes in temperature, also known as variance of climate traits. This means that the annual or monthly changes other studies commonly refer to are mostly irrelevant in the case of insects.

Dr Inon Scharf, who coordinates the project at Tel Aviv University, discusses early results of his study of flour beetles, insects collected by the university over the past 100 years, and additional insect predator species, already investigated in the lab under other projects.

★ **Why is it so important to know more about the effects of environmental variance on insects?**

Dr Inon Scharf: Variance is highly important for different reasons. First, global warming is expressed not only as an increase in the annual average temperature, but also as an increase in the frequency of extreme events, such as heat waves. It is therefore important to study how a sudden change in temperature, even for a limited time period, affects insect performance.

Second, insects experience daily changes in temperature, sometimes over a very short time, so annual or even monthly temperatures, which are usually referred to in such studies, may be of lower relevance. Third, insects have a shorter lifespan than most vertebrates, and therefore even

relatively short extreme events may have significant consequences for the insect's performance and response.

Variance of the response traits are also important. Ecologists were long interested mainly in average responses to different factors, and treated variance in response variables as 'noise'. However, this variance is very important when seeking to understand the potential for evolutionary change. When individuals are tested several times, it is not trivial whether and to which extent individuals are repeatable in their response (for instance, always responding better or worse than average), whether females and males have similar responses, and how age and stressors experienced by groups of individuals induce such variance.

★ **What were the main types of effects you investigated and why?**

We asked ourselves three questions: How is the ability of insects to tolerate unfavourable warm or cold temperatures affected by other stress sources, such as starvation and old age? How does exposure to different temperatures as larvae and as adults affect insects' tolerance to extreme cold and heat shock, survival under starvation and reproduction, and how does repeated thermal stress affect insect performance? Does the body size of insects decrease as a possible response to ongoing global warming?

Answering the first question is important because insects live in complex environments and have to simultaneously cope with multiple stress sources. Studying how well they cope with thermal stress is important for better understanding the range of responses to unfavourable

climate conditions, which also depends on other environmental aspects. This is also important for understanding how animals trade off between different demands.

The second question arose as thermal exposure during different life stages can lead to different outcomes. Whilst mild exposure to unfavourable temperatures during the adult stage often leads to beneficial acclimation to harsher temperatures, exposure to unfavourable temperatures during the growth stage is less likely to have a beneficial effect. This question is important not only in the context of climate change but also to understand whether some life stages are more critical than others.

Regarding the third question, many researchers currently believe that body size decreases in response to global warming, while others doubt that the response is general and universal. While this decrease has been studied in mammals and birds, almost nothing is known for insects, in spite of the fact that most of earth's biomass and species are insects.

★ **How did you proceed to answer these questions?**

First, we established a system of flour beetles in the laboratory. These are common pests found in meal storage areas, mostly in the developing world, which are easy to grow and keep in the lab. Their short generation time allows relatively fast adaptation and response to environmental change and they are ectotherms: they are affected by climate more than endotherms, which regulate their body temperature. We raised the beetles under different thermal conditions, testing various behavioural, physiological and life-history responses, keeping them until old age, starving them and inducing repeated thermal stresses. The point was to study the effect of all of the above on thermal tolerance and other traits related to ecophysiological performance, such as activity, mating behaviour, reproduction and survival.

In addition to these lab experiments, we also gained access to the large insect collection of Tel Aviv University (a part of the Steinhardt Museum of Natural History), with a few million specimens collected over the past 100 years or so. This collection allowed us to study possible body size decrease in response to climate change.

Finally, we shifted ongoing projects in the laboratory, mainly on insect predators that use traps for hunting, such as pit-building antlions and wormlions, to include aspects of thermal ecology. We notably compared the behaviour (cannibalistic behaviour, for example) of insects originating from different climatic regions in Israel. We became interested in how climate generally affects behaviour.

★ **What would you say are the most notable results of the research so far?**

We could observe that the thermal tolerance of insects deteriorates with advanced age and starvation. The effect of starvation is nevertheless reversible. Then, we noticed that growth and adult temperatures have a different and sometimes contrasting effect on thermal tolerance.

A third finding is that repeated thermal stress in the laboratory leads insects to enter a sort of 'energy-saving', resilient mode, with lower activity and reproduction, but better tolerance for further stress. There is a carry-over effect to the offspring of parents exposed to repeated stress, and their offspring are somewhat smaller.

Finally, our analysis of specimens collected over 100 years, in contrast to mammals and birds, shows that body size probably does not decrease in response to ongoing climate change. We failed to show a decrease in body size in beetles, and concluded that this 'rule', even if valid for



DR INON SCHARF

mammals/birds, does not hold true for beetles and plausibly for other insects as well. It could be that insect phenotypic plasticity — meaning the ability to express different phenotypes by the same genotype and the contribution of the immediate environmental conditions — is too strong and fully mitigates potential effects of climate change.

★ **Based on this project, how do you think insects will evolve in the face of climate change and what could be the consequences?**

Hard to say. We mainly focused on immediate phenotypic responses to climate change. I think that our work mainly demonstrates how plastic insects are when coping with changes, and how short-term conditions can have significant and diverse effects. My guess is that insects are tougher than it seems, and due to their strong plasticity they will survive quite well. Other researchers even expect an increase in insect performance, because plants will be more stressed and produce fewer biochemical compounds to protect against insects that eat them. This may have worrying implications for pests and agriculture.

Generally speaking and without a direct link to our research, the effect of climate change on insects may be important concerning phenology, meaning the time link between plant flowering and their insect pollinators, with negative effects on both, and distribution ranges of different species. Needless to say, the ones most threatened are those with limited distribution range, those with poor dispersal ability, or those inhabiting very cold areas: they have nowhere to escape, while those in warm areas could migrate to places previously being too cold for them. Interestingly, insects grow faster under warmer conditions, and increasing temperatures will enable insects to invade habitats currently not populated by them.

CLIMINSECTS

★ Coordinated by Tel Aviv University in Israel.

★ Funded under FP7-PEOPLE.

★ <http://cordis.europa.eu/project/rcn/107308>



HOW MAGGOTS ARE INFLUENCING THE FUTURE OF ROBOTICS

What can software designers and ICT specialists learn from maggots? Quite a lot, it would appear. Through understanding how complex learning processes in simple organisms work, EU-funded scientists hope to usher in an era of self-learning robots and predictive computing.

Animals — no matter how simple or complex — display a remarkable capacity for learning. Even with limited brain power, an organism can choose the right thing to do in response to external stimuli, which is something that current computational learning theory cannot fully account for.

Learning from maggots

The EU-funded MINIMAL (Miniature Insect Model for Active Learning) project, launched in 2014, has focused on the learning processes in a relatively simple animal, the fruit fly larva (maggots). Despite having fewer than 10000 neurons, this creature is capable of learning quickly and flexibly certain cues that lead them towards good things and away from bad things.

‘Understanding the specific mechanisms behind this learning process could have important applications for technology, such as the development of self-learning small robotic devices,’ explains MINIMAL project coordinator Professor Barbara Webb from the School of Informatics at Edinburgh University in the UK.

‘This could mean, for example, being able to develop small, cheap robots for use in precision agriculture, which are able to learn which plants need fertiliser or irrigation. This can then be delivered only where and when needed. Our key idea is that small but active systems can, like

animals, locally discriminate and remember only the effective cues needed for the ongoing task.’

The humble maggot was selected by Webb and her team because they were able to closely monitor and control both the animal’s behaviour and brain processes in remarkable detail. They were able to track the entire process by which these animals are capable of learning new odours that lead them to good food (such as sugar) and away from bad food (such as quinine).

‘We discovered that some specific single brain cells are sufficient, when activated, to make the larva learn that a particular odour is good,’ says Webb. ‘We plan to explore this further using a new method developed through the MINIMAL project, which shows the activity of specific brain cells lighting up, which we can track even when the larva moves around freely. We really did not expect this last method to work so it is perhaps one of the most satisfying elements of the project so far.’

Information opportunities

The project team’s work on the learning process of the maggot could benefit other fields as well. ‘Although our main aim has been to demonstrate such capabilities in real world robot systems, there may be parallels in the information environment,’ says Webb.

For example, whilst current trends in computing often rely on big data, it is

notable that in nature, animals often learn with very little data to predict associations (such as the maggot’s ability to detect good food). Understanding how this works could have ramifications for the development of software and computer interfaces that anticipate a user’s next action.

Looking even further into the future, it might one day even be possible that the larvae themselves could become engineered computational devices, capable of performing critical signal processing tasks.

‘The next step is to consolidate our findings into a model of the neural learning mechanism of the larva and test this out on a robot,’ says Webb. ‘We have also developed a soft robot maggot, but it has been difficult to control its movement. Biologically-based learning could be the answer, and we firmly believe that such robots have potential for a range of applications.’

The MINIMAL project is due for completion at the end of December 2016.

MINIMAL

- ★ Coordinated by Edinburgh University in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/110523>
- ★ Project website: <http://blog.inf.ed.ac.uk/minimal/contact/>



LEARNING FROM BEETLES, NATURE'S MASTER FARMERS

The sustainable production of pathogen-free crops is one of mankind's most pressing concerns, given projected population growth and the threat posed by climate change to arable land. Incredibly, the study of a species of unassuming tree-dwelling beetles could hold some answers.

Certain species of beetles have been successfully farming and harvesting fungi for at least 40 million years, keeping destructive bacteria at bay and developing a lasting and sustainable relationship with both their crop and environment. The success of the tree-dwelling ambrosia beetles could therefore hold lessons for humans who have been cultivating crops for a mere 10000 years.

A lesson in sustainable farming

The ambrosia beetles, which live in social groups inside trees, transport fungi spores from their natal nest when they settle new trees. The spores are then 'planted', and once the fungus has developed fruiting bodies, these are harvested. Just like humans, the beetles must deal with pathogens that can harm their crops and ensure a sustainable, healthy environment for crop growing.

'My ultimate goal in this project has been to identify possible solutions that can be taken up by scientists and researchers in forestry and agriculture,' explains project coordinator for the EU-funded FARMING IN BEETLES (Mechanisms of Fungiculture in Ambrosia Beetles) project, Dr Peter Biedermann from the Max Planck Institute for Chemical Ecology in Germany. 'Just like in the beetle nests I am studying, fungal pathogens pose a huge threat to human agriculture, so understanding the beetles' success might provide insights that are relevant for our agriculture as well.'

Launched in March 2015, the two-year project, funded through a Marie Curie Intra-European Fellowship grant, has already uncovered new findings. The relationship between the beetle and the fungus involves not just one but several fungus species, which are likely planted within the nest in order, i.e. in a crop

rotation scheme that would be familiar to human farmers. Most remarkably several bacteria play a major role both in inducing fruiting bodies and in fighting pathogens.

'It was also really surprising to find out that in the fruit-tree

pinhole borer, the ambrosia beetle species that I mainly study, the major fungus crop consists of a single strain that can be found across the whole of Europe,' says Biedermann. 'Humans also grow a few very successful cultivars of their crops. Another fascinating result was that fungi are only found in beetles that colonise dead trees. Beetles that dwell in trees that are still alive do not carry fungi as they would probably kill their host tree.'



The project also built on the discovery that plant growth can be enhanced through certain microorganisms (endophytes) that live within the plant tissue and can help to repel herbivores. 'Uncovering the role of bacteria in the beetles' gardens might help us to understand the role of endophytes associated with our crops as well,' says Biedermann. 'Finally, antibiotics produced by bacteria also seem to play a major role within the beetles' nests, so there is the potential to perhaps transfer knowledge for medical applications or even detect novel antibiotic substances.'

Applying new techniques

After confirming the complexity of the beetle-fungus system, the remainder of the project, due for completion in February 2017, will be focused on unravelling these interactions in more detail. 'For example, what chemical substances are involved, which of them are produced by the bacteria and which by the fungi themselves?' asks Biedermann. 'Which bacterial species occur within the nests; are they always the same or is there variation across the geographic range of ambrosia beetles?'

Biedermann also wants to explore in depth the parallels between beetle and human agriculture, to see what these two — traditionally distinct — research fields can learn from each other. 'I want to bring researchers that study insect farming and agronomists together, with the aim of stimulating each other's research,' he says. 'For example, it would be very interesting if we could apply bacteria to our crops in order to produce antibiotics against crop pests. This is exactly what the farming beetles seem to do.'

FARMING IN BEETLES

★ Coordinated by the Max Planck Institute in Germany.

★ Funded under FP7-PEOPLE.

★ <http://cordis.europa.eu/project/rcn/188001>

"Biedermann also wants to explore in depth the parallels between beetle and human agriculture, to see what these two — traditionally distinct — research fields can learn from each other"



THE BUZZ ON HOW CLIMATE CHANGE IMPACTS NATURE'S MIMICRY SYSTEM

EU-funded researchers are studying how a changing climate affects hoverflies, which mimic bees and wasps, and the evolutionary consequences of these changes.

In some form or fashion, all animals and plants interact with other animals and plants. For example, sometimes they eat or are eaten by other organisms. Other times they compete with one another over access to food and water, such as when birds scramble over a bird feeder. And sometimes animals or plants work together for everyone's mutual benefit, like the fungi and algae found in lichens.

Of course none of these associations happen overnight, but are the result of a long history of co-existence, during which a degree of balance is struck that allows animals and plants to cooperate in a stable manner. However, these historic couplings are under immediate threat, the result of the rapid, human-induced climate change that has the potential to 'decouple' these interacting species.

Introducing the hoverfly

As the threat of decoupling is a new phenomenon, little is known about its effects on species and what its potential long-term consequences are. The EU-funded ECOEVOMIMIC (The Ecology and Evolution of Mimicry in a Changing World) project is working to fill this knowledge gap by being the first to study the impact that climate change has on a mimicry system. For this particular study, the mimics of choice are hoverflies, a

group of species that mimic stinging bees and wasps. Like the bees and wasps they mimic, hoverflies are economically important pollinators that are seeing their overall population decrease.

'I'm interested in the evolutionary consequences of changes in the timing of animal activity', says project researcher Dr Christopher Hassall. 'More specifically, the project has aimed to determine the ecological responses to climate change in these animals, and the evolutionary consequences of these responses, as well as provide novel experimental tests for hypotheses that explain the evolution of mimicry across a range of other animal groups.'

Field experiments and human psychology

In the first phase of the project, Dr Hassall and his team successfully demonstrated that hoverflies are actively advancing their phenology in response to climate change. Based on this finding, the project is exploring what the consequences are for these animals and their relationship to other species. 'Hoverflies, which are harmless and do not sting, imitate the appearance, behaviour and sounds of bees and wasps in order to deter a predator', explains Dr Hassall. 'This mimicry, however, relies on predators being able to learn to avoid wasps and

bees and then avoid the hoverflies that resemble these stinging insects.'

Thus, the second phase of the project is focused on exploring how changes in the timing of hoverfly activity relative to bees and wasps might interfere with predators' ability to learn. To accomplish this, the project uses a combination of field experiments and ongoing human psychological experiments as a method for exploring how predators perceive shifting patterns of occurrence.

The experimental design used by the ECOEVOMIMIC project is based around a continuum of experimental control. Although the field experiments had very little control and were subject to a large number of uncertainties, they also provided the most relevant insights into biological questions. Working with human participants as 'predators' in computer games, on the other hand, offers a great deal more control, but clearly humans are not hoverfly predators. However, it is assumed that the general cognitive machinery employed by humans is sufficiently similar to that of birds as to be useful in making biological inferences.

Diversity and distribution

The significance of the ECOEVOMIMIC project is that it examines the consequences of climate change for a neglected but important group of insects. 'These animals are important pollinators and many also help control such pests as aphids', says Dr Hassall. 'As a result, these findings contribute both to an understanding of how ecosystems will be affected by the changing climate and to our knowledge about the diversity and distribution of an important pollinator group.'



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ECOEVOMIMIC

- ★ Coordinated by the University of Leeds in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/186250>



HOW A FUNGUS CAN CONTROL ANT BEHAVIOUR

One of the most graphic examples of parasites controlling behaviour is the manipulation of carpenter ants infected by the fungus *Orphiocordyceps unilateralis*. The parasite, which has recently been the subject of an EU-funded study, causes its host to bite into vegetation before dying; a trait that is essential to the fungi's lifecycle.

The HETEROGENIUS (Heterogeneous activity underlying the control of animal behaviour by a fungus) project examined the process from the fungal genome point of view. This was in contrast to earlier studies of this phenomenon, which focused on the ants' behaviour.

The aim of the project was to understand the complex genetic mechanisms behind adaptive parasite manipulation of host behaviour. Researchers therefore developed protocols for isolating the fungus found in ant cadavers collected in the field and for growing and maintaining fungal cultures. Infection protocols were then developed to reconstruct *O. unilateralis* infections and behavioural manipulation under laboratory conditions.

Ant tissues were cultured and combined with a metabolomics study to determine the fungal metabolites secreted in different parts of the host. This led to the discovery of novel cyclic depsipeptides, a group of mycotoxins.

The technique also revealed different secretomes (secreted proteins) for ant brain and muscle tissue and reacted heterogeneously to brains of different ant species. Furthermore, the study led to the discovery of the first candidate compounds that are likely involved in brain manipulation.

RNA from the heads of infected ants (taken while alive and after death following biting) were compared to RNA from the heads of healthy ants. Results indicated that the majority of the fungal genes up-regulated during manipulated behaviour were unique to *O. unilateralis*. They also revealed that the fungal parasite might be regulating neuronal stress responses in the host during manipulated biting.

The fungus was also found to impair the host's chemosensory communication and cause apoptosis. In addition, scientists found genes up-regulated during manipulation that may encode for proteins with reported effects on



behaviour, neuropathologies and the biosynthesis of secondary metabolites, such as alkaloids.

The fungal circadian clock was investigated, with field studies showing that manipulated biting behaviour is synchronised at noon. This indicated that external synchronisers, such as light and temperature, might have a significant influence on the parasitic behaviour.

HETEROGENIUS has provided valuable insights into parasite-host interactions, especially those concerned with behavioural manipulation. The discovery of genes and metabolites involved in this phenomenon will generate new opportunities for applied research in the fields of drug discovery and biological control of insect pests.

HETEROGENIUS

- ★ Coordinated by LMU Munich in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/104565>

INTERVIEW

HOW TO WALK ON WATER: LIFTING THE VEIL ON EVOLUTION FROM TERRESTRIAL TO WATER WALKING INSECT

Anyone who has seen a lake or a small pond will have witnessed the evolutionary marvel of those curious insects that run over water with no trouble whatsoever, as if it were solid ground. An EU project is allowing ENS de Lyon to investigate the genetics behind this capacity.

Heteroptera and Gerromorpha, two species of semi-aquatic insects, are dominating water surfaces worldwide and have become somewhat of a scientific curiosity. To understand this adaptation — these insects are none other than evolutions of their terrestrial counterparts — integrative studies combining evolutionary developmental

biology and evolutionary ecology are needed.

The WATER WALKING (Developmental genetics and adaptive bases of a major ecological transition - How to walk on water!) project is trying to achieve just that. Abderrahman Khila, group leader at ENS de Lyon, has been



SPECIAL FEATURE

developing a multi-level approach to study how the interplay between developmental genetic pathways and the ecological environment can drive morphological evolution such as that observed in semi-aquatic insects.

★ **Why is it so difficult to integrate evolutionary developmental biology with evolutionary ecology?**

Abderrahman Khila: We need tools and we need a good ecological context at the same time. Current standard models (*Drosophila*, mice, zebrafish, etc.) offer great tools but lack the ecological context. Natural models, which are usually chosen because of a specific ecological context, have not been established for a routine use of sophisticated tools, such as transgenesis or genetics.

★ **How can the study of semi-aquatic insects help overcome these problems?**

Semi-aquatic insects pose a particularly interesting set of biological problems that enables us to address questions related to species adaptation and diversification. Moreover, these insects have proven quite amenable in terms of the transfer of certain genetic tools: It makes it possible to address these questions in a detailed and integrative manner, that is, combining developmental genetics with ecology and evolution.

One striking aspect of the biology of this group of insects is their capacity to occupy water surface as a new habitat (their ancestors were terrestrial) and therefore acquire new

ecological opportunities. Accompanying this transition is a large set of conspicuous phenotypes such as increased leg length, reversal of relative leg length plan (second legs are the longest in water striders, whereas in most insects third legs are the longest) as well as the way they generate movement on the fluid substrate. They also exhibit an array of sexually relevant phenomena such as spectacular dimorphisms and phenotypic plasticity often driven by conflict between genres.

This, along with the tools we were able to establish, made a big difference in integrating ecology, evolution, and developmental genetics.

★ **How did you proceed to study these insects?**

I was invited to join an effort to study the genetic basis of sexual conflict in the water strider by Prof. Locke Rowe (University of Toronto) in collaboration with Prof. Ehab Abouheif (McGill University, Montreal). My first condition then was that we try to test some basic techniques, which worked very well. It worked so well that I decided to build the rest of my career on this system.

★ **What are the main things you have learnt so far?**

Water striders generate movement on water using a highly efficient trick: they have evolved elongated second legs with a paddle shape that act as oars. The right and left second legs move in a simultaneous sculling motion through the water just like oars on a rowing boat.

The first question we asked ourselves is, how do such morphological and function modifications evolve? We found that a *Hox* gene called *Ultrabithorax* (*Ubx*; conserved from invertebrates to humans) changed its spatial and temporal expression and that these changes shape the second legs into the way they look. What was really surprising is that this gene makes second legs long but makes the third legs short, which results in the characteristic morphology of water striders. We found that these opposing roles of the gene are mediated through differences in the amount of *Ubx* protein that each leg has. More specifically, at low dose — the case of the second legs — *Ubx* promotes growth, but at high dose — the case of third legs — *Ubx* suppresses growth.

As we wondered how it is that differences in dose can result in opposing effects on the growth of the legs, we

found that genes that are regulated by *Ubx* responded differently to its levels. We discovered, for the first time, that an ancient immune system protein (important for antigen processing and presentation in humans) called *gilt* is now controlled by *Ubx*. At a low dose of *Ubx* (second legs) *gilt* is expressed and contributes to lengthening the leg. At a high dose of *Ubx* (third leg) *gilt* expression is entirely shut down contributing to keeping that leg shorter.

In addition to locomotion on fluid, we found that the shape of water striders' legs is under selection from predators striking from underneath the fluid, such as fish. This work allows us to understand how selection (requirement for locomotion on fluid substrates as well as predation) can shape animal

“Water striders generate movement on water using a highly efficient trick: they have evolved elongated second legs with a paddle shape that act as oars.”

morphology through changes in a pre-existing developmental programme and also through the emergence of new genetic interactions.

★ **What do you still need to do before the end of the project?**

There are several projects that are still in motion. The first tries to understand how these animals acquired the ability to maintain their body weight on water whilst most others would drown. Small hairs on their legs allow for the trapping of air and thus forming a cushion between the leg and the water surface. We would like to understand how the shape and the density of these hairs are established during development.

Another important project addresses the question of how evolutionary novelties emerge. Some species specialise in fast running water and have evolved a propeller on the tip of their second legs; a sort of fan. We found that this novelty emerged through the emergence of a new gene by duplication. This is exciting because the general agreement is that novelties can emerge by re-using pre-existing genes.

A final project deals with sexual selection. A species of water-walking insects exhibits a spectacular



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ABDERRAHMAN KHILA



polymorphism in the males in terms of leg length; some males have short legs (females too) but others have extremely long legs. We now know that leg length is important for male combat to acquire females and that males with longer legs often win. We are trying to understand how such spectacular phenotypic plasticity can evolve from a both ecological and developmental perspective.

★ **Besides the integration of two disciplines, what do you think could be the main benefits of your research?**

The integration per se is not the main goal. The goal is to understand how diversity comes to be and what factors contribute to it. The answers to this important question have been scattered and truncated because fields of study (such as developmental biology, ecology,

population genetics etc.) are not sufficiently cross fertilising. By integrating them, we hope to bring a more comprehensive understanding of diversity in general.

WATER WALKING

★ Coordinated by ENS de Lyon in France.

★ Funded under FP7-PEOPLE.

★ <http://cordis.europa.eu/project/rcn/189963>



© WATER WALKING

A STEP IN THE RIGHT DIRECTION FOR NAVIGATIONAL UNDERSTANDING

With fresh insights into navigational behavioural, the EU-funded ANT NAVIGATION project brings us a step closer to the next generation of neuroscience breakthroughs.

Most animal species, including humans, rely on the ability to navigate through their environment. Indeed, survival often depends on it, such as when foraging for food.

Being able to navigate effectively requires the combination of information from different sources (multimodal integration). For this reason, it has often been regarded as an indicator of high-level cognitive functioning, as it infers skills of analysis, comparison and judgement to come up with the best strategies, along with the ability to learn and remember.

However, research indicates that complex navigational behaviour may not require the brain power previously thought. The EU-funded ANT NAVIGATION (Multimodal navigation in insects: Use of olfactory, visual and idiothetic cues in ants) project investigated this hypothesis through the close study of ants. According to Dr Paul Graham, the research coordinator, the value of studying ants was precisely that, 'as insects have evolved with limited neuronal

resources, they demonstrate economical strategies by which problems might be solved.' The implication being that a more accurate comprehension of how insect navigation works also offers an insight into the economical ways in which brains process and use information generally, including in humans.

Multi-modal integration in desert forager ant navigation

Dr Graham and his team closely investigated the behaviour of desert ant foragers in southern Spain and Tunisia. Firstly, because as he puts it foragers 'do very little in their life, except navigation.' Secondly, these ants are solitary and so don't rely on social cues such as chemical trails. Combined with the fact the desert landscape offers little in the way of visual cues to begin with, both traits afford a unique opportunity to study navigational techniques.

As desert ants forage for food, it was traditionally presumed that the principle navigational strategy enabling



them to return successfully to their starting point, usually their nest, was that of Path Integration. This has been likened to the maritime technique of continually updating distance from a starting point, with direction of travel, to provide orientation. This technique has been demonstrated through past experiments that manipulate the appearance of the sun to alter perception of direction, or by elongating the length of ants' legs, resulting in them overshooting their return target (e.g. their nest).

One of the contributions of the ANT NAVIGATION project was in the careful tracking of ant movements. 'We were one of the first groups to record not just ant paths but also the speed of the ants when they were guided by Path Integration and in the

early stages of learning about other environmental cues. This was a simple task, but it hadn't been done previously,' explains Dr Graham.

By tracking ant speed, the project

was able to suggest that ants follow an inbuilt rule. That rule correlates their speed to the significance of a location, therefore ants give themselves the time necessary to assimilate higher quality visual information at key locations. As Dr Graham asserts, 'This is exciting because it shows how ants balance the relative merits of different sources of information without having to "think" about the value of this information.'

"We work closely with engineers so that the insights of our biological studies can be translated into robotics."

Shared knowledge for a great leap forward

When asked about the impact of the ANT NAVIGATION project, Dr Graham highlights how a richer understanding of the computation involved in the navigational strategies of insects, can better inform the design of small autonomous robots that might one day match insects' behavioural performance. 'We work closely with engineers so that the insights of our biological studies can be translated into robotics,' he explains.

The biological sciences have learned a lot about how organisms function through the study of so called 'model systems', such as flies and mice. Additionally, some animals have been studied intensely for specialist functional ability such as desert ants for visual navigation.

To take the science to the next level Dr Graham points to the need for a synthesis of behavioural science with neuroscientific knowledge. He expounds that, 'We hope soon to be able to manipulate the neural circuits of navigating ants and relate our findings to the detailed knowledge of key neural circuits in flies. This will be a great leap forward in neuroscience and will provide hope for truly autonomous small robots that could be useful for applications such as post-disaster surveillance and agricultural monitoring.'

ANT NAVIGATION

- ★ Coordinated by the University of Sussex in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/187878>

TASTE NEURONS WITH A SENSE OF ODOUR

Taste and smell are sensory mechanisms that act as gate-keepers to ensure that only good, safe food is consumed. EU-funded researchers have provided novel insight into these mechanisms using *Drosophila melanogaster* as an insect model.

Until recently, it was believed that gustatory or taste neurons detect only sapid molecules with flavour such as sugars, whereas olfactory neurons can sense only volatile molecules. The TASTEVOL (The taste of volatiles: perception of odours

through taste organs in *Drosophila melanogaster*) team proved otherwise using different electrophysiology techniques on their insect model.

The researchers used a two-electrode configuration rather than the commonly used tip-recording method where the electrode contains the stimulus and the electrolyte. As most odorant molecules are not water-soluble, uncoupling the stimulation from the recording enabled the scientists to record from the taste sensilla as well as the neurons. They stimulated the sensillum tip with tastants as well as vapours of volatile odorants such as acetic acid, acetone, 1-octanol, 1-octen 3-ol, and isoamyl propionate.

Some of the gustatory neurons proved to be sensitive to the volatile vapours, demonstrating the sensitivity of taste neurons in insects to some odorants. These findings were complemented by the results from behavioural experiments where flies with removed olfactory organs avoided acetic acid just like wild-type flies. Moreover, mutant

flies lacking taste sensilla did not avoid acetic acid vapours after ablation of olfactory organs.

An interesting finding was the impact of chemo-aversive chemicals on the appetite of flies. Results demonstrated that odorants such as acetic acid vapours prevented flies with no sense of smell from detecting the tastant sucrose in solution.

Project outcomes have significant implications for understanding and predicting insect behaviour in the natural environment, with applications notably in pest management. Furthermore, these results challenge the current hypothesis regarding the divergence of information coding in the taste and olfactory system. This also indicates that scientists need to rethink the currently held beliefs on the evolution of chemosensory systems.

TASTEVOL

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/107899>



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BIOLOGY AND MEDICINE

PRENATAL FAMINE EXPOSURE HAS SEX-SPECIFIC EFFECTS ON BRAIN SIZE

A new study, focused on the Dutch famine of 1944-45, has highlighted how prenatal famine exposure has sex-specific effects on brain size.

As part of the EU-funded BRAINAGE (Impact of Prenatal Stress on BRAIN AGEing) project, researchers from the University of Amsterdam and Jena University Hospital, Germany, studied prenatal exposure during the five-month Dutch famine that took place in the densely populated Western provinces, towards the end of the Second World War. The study has highlighted how men, but not women, who were exposed to famine in early gestation have smaller brain volumes than unexposed controlled participants at the age of 68 years.

The research team performed MRI scans on individuals who were born in Amsterdam around the time of the Dutch famine. During the famine, official daily rations varied between 400 and 800 calories, only around a quarter of the daily calorie needs of an adult. An estimated 30 000 people starved to death but despite the harsh circumstances, women still conceived and gave birth.

Conducting the study

It has already been documented that prenatal exposure in the Dutch famine during the first trimester posed a serious threat to brain development and increased the risk of

'Central nervous system' (CNS) anomalies, such as spina bifida and hydrocephalus. However, there was until this study little known about the effects on brain size in older age. In order to explore this further, the research team recruited a cohort of 2 414 men and women who were born in the same hospital in Amsterdam (the Wilhelmina Gasthuis) from 1 November 1943 to 28 February 1947. They were divided into exposed and unexposed groups based on their date of birth.

The team considered a person to be prenatally exposed to the Dutch famine if the average daily ration was less than 1 000 calories during a 13-week period in pregnancy or if the person endured a 16-week period of general exposure in early, mid or late gestation. People born before the famine or who were conceived and born after the famine were considered to be unexposed and acted as a control group.

Differences between men and women

In previous studies of this cohort, the researchers had shown that exposure to famine during early gestation had the most impact on both mental and physical health in later life, including obesity, breast cancer, coronary heart disease,

depression and even food preferences. Thus in this study, they focused on the early exposed group and took MRI scans of 118 cohort members, with 41 exposed to famine in early gestation and 77 unexposed to famine in gestation. The research team were particularly interested in brain size, structure and white matter integrity. They found no differences between exposed and unexposed groups in white matter integrity and hyperintensities. They also found no differences in structural volumes.

Moreover, when they investigated the men and women separately, they found that men who had been exposed to the famine during early gestation had smaller intracranial volume than unexposed men, with a difference of about 5%. Exposed men also showed smaller volumes of total cortical grey and white matter, cerebellar grey matter, thalamus and more

specific cortical areas. Importantly, these volume differences were not seen in famine-exposed women. One explanation may be the theory that males are more vulnerable to foetal programming, but the research team also concedes that the effect seen on males may be due to bias, as women exposed to famine show increased mortality rates after the age of 63. Consequently, this could have led to the inclusion of the more healthy women, leading to an under-estimation of the effect of prenatal exposure on women.

Studies have shown that a smaller brain size obtained in childhood is associated with an increased likelihood of developing Alzheimer's disease, as well as an increased severity of the disease and an earlier onset.

'We think it's outstanding that something that happened 68 years ago during pregnancy is still visible in the brains of these

"We think it's outstanding that something that happened 68 years ago during pregnancy is still visible in the brains of these men."

men,' commented study co-author Dr Susanne De Rooij. 'We think that this clearly underlines the importance of maternal nutrition for brain development in early life but also in later life.'

BRAINAGE

- ★ Coordinated by Jena University Hospital in Germany.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/102497>
- ★ Project website: <http://www.brain-age.eu/>

TOWARDS PIONEERING BINAURAL COCHLEAR IMPLANTS

An EU initiative has developed a prototype of a novel cochlear implant that allows users to experience more normal listening.



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'Cochlear implants' (CIs) are devices that stimulate the auditory nerve through electric pulses. They are an excellent start in bringing sound to those with hearing loss, but only allow for one-ear 'monaural' listening. Normal-hearing individuals use binaural hearing to compare information about sounds from both ears and to locate the source of sound.

The EU-funded ABCIT (Advancing binaural cochlear implant technology) project exploited the latest technologies in order to develop a binaural CI. Project partners developed a research platform that generates data which enables researchers to maximise the benefits of binaural listening in CI users. It also provides researchers with tools to

evaluate binaural functions. The portable real-time system fills an important gap in CI research by combining hardware and software within the same platform. This represents a major advancement in CI research.

The ABCIT team created new stimulation strategies for CI and designed novel software and hardware tools for recording brain activity in bilateral CI. Specifically, the first multi-channel brainstem electroencephalogram for CI listeners was developed.

Team members adapted state-of-the-art hearing-aid algorithms and developed new ones for CI devices. The speech enhancement capability of the algorithms was assessed. The algorithms significantly enhanced the speech understanding of users by removing background noise from acoustic signals before these signals were converted into electrical pulses in CI devices. Lastly, a feasibility study successfully demonstrated the capacity of the ABCIT solution.

ABCIT's technology could one day revolutionise CIs, allowing users to hear more normally and function in social settings where communication was previously near impossible. Once commercialised, the device will represent a therapeutic, cost-effective solution for a growing proportion of the global population.

ABCIT

- ★ Coordinated by University College London in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/104084>
- ★ Project website: <http://www.ucl.ac.uk/abcit>

MULTIMODAL NANOCARRIERS FOR DRUG DELIVERY

Over the years, nanotechnology has made a significant impact on medicine. In an EU-funded project, researchers have explored the application of nanoparticles for drug delivery.



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“Scientists generated drugs of poor water solubility and encapsulated them into lipid bilayer nanodisc particles.”

Nanocarriers for drug delivery have emerged as powerful tools that boast specificity, reduced side-effects and improved efficiency. The loading of hydrophobic drugs into nanoparticles also improves their pharmacokinetics, while the incorporation of surface ligands helps make targeted delivery easier. The surface modification of the physicochemical features of nanocarriers also ensures that they can circulate for prolonged periods.

The scope of the EU-funded BIONANOMUTT (Multi-compartmental biomolecular nanocarriers for multimodal targeted therapies) project was to develop multifunctional, self-assembled nanoparticle structures for biomedical drug delivery applications.

Therefore, scientists generated drugs of poor water solubility and encapsulated them into lipid bilayer nanodisc particles.

Overall, they investigated 12 different drugs. Researchers discovered a correlation between the ability of drugs to soften the lipid bilayer membrane and their drug loading efficiency in nanodisc systems. For efficient drug release, scientists modified the lipid composition of the nanodiscs while uptake by cells was monitored through enzymatic labelling of the scaffold protein.

Additionally, the consortium generated liposome-based structures with a DNA-mediated adhesion capacity. The stealth properties of these

particles could be enhanced further by functionalisation with polymer-functionalised lipids. Furthermore, the inclusion of pH-responsive motifs allowed the disassembly of DNA-linked vesicles via pH alteration.

From a translational perspective, the scientific team screened and characterised specific binding reagents for known tumour biomarkers, including FGFR1 and FGFR3 in bladder cancer. These reagents exhibited binding affinities in the nanomolar range and could be taken up by cells expressing the receptors, validating the specificity of the approach.

Taken together, the BIONANOMUTT nanocarriers look set to advance current medical treatments and have a significant impact on the socioeconomic status of the European population.

BIONANOMUTT

- ★ Coordinated by the University of Leeds in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/100191>

NEWLY FOUND ANTIBODIES COULD LEAD TO TREATMENT AGAINST BOTH DENGUE AND ZIKA VIRUSES

Other than both being RNA viruses transmitted by mosquitoes, the dengue and Zika viruses have a few things in common: they both belong to the *Flavivirus* genus and share similar envelope proteins. Thanks to joint European research, partially funded under the DENFREE project, they can now also be treated with the same antibodies.

The growth of vector-borne diseases is one of the main consequences of global warming. One of the most known forms of these diseases, the dengue virus, threatens the life of about 500 000 people every year. The Zika virus is yet another form, although it generally affects people for 2 to 7 days only. But even then, Zika patients in Brazil and French Polynesia were recently found to be

suffering from neurological complications such as Guillain-Barré syndrome. This virus is also the cause of microcephaly in foetus.

Previous efforts from the Institut Pasteur, CNRS and Imperial College London had led to the discovery of antibodies capable of neutralising the four known types of dengue virus. Thanks to funding coming notably from the DENFREE (Dengue research Framework for Resisting Epidemics in Europe) project — which aims to identify key factors determining dengue transmission and develop novel diagnostic tools — the three institutions, along with the University of Vienna, brought this research a step further by focusing on the Zika virus.

‘We wanted to see whether the antibodies isolated for dengue could be used to neutralise other flaviviruses, and Zika seemed like the best candidate,’ explained Félix Rey, Head of the Structural Virology Laboratory at the Institut Pasteur.

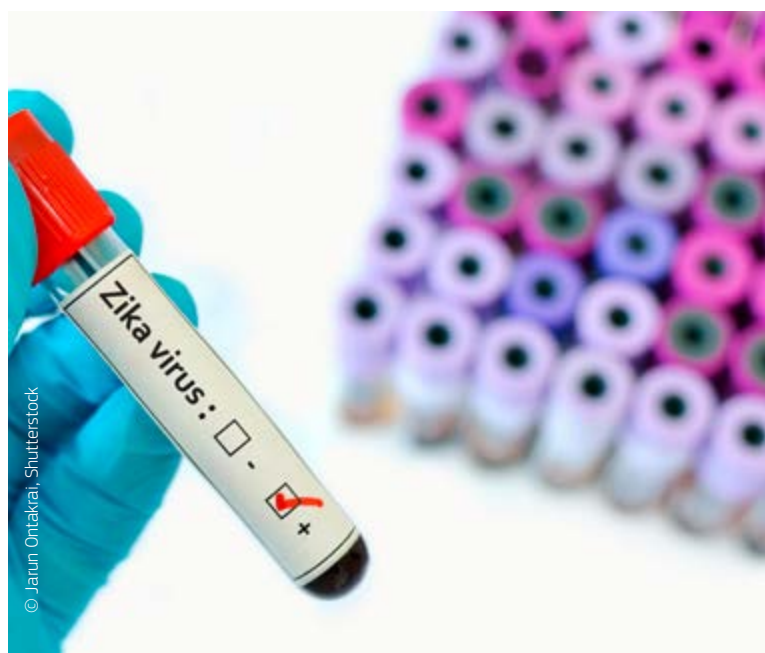
The team selected two antibodies for their research, which were both known to be capable of preventing the proliferation of the dengue virus. These antibodies were isolated in dengue patients and then presented to the Zika virus. The

results caught the team by surprise: ‘We never expected to discover that the dengue virus and the Zika virus are so close that some antibodies pro-

duced against the dengue virus could also neutralise the Zika virus so potently,’ stressed Rey. Indeed, one of the two tested antibodies was able to neutralise the Zika virus even better than it did for the dengue virus.

Another key element of the research was the use of crytallography to identify the binding site on the Zika virus. The scientists produced crystals containing the ‘antibody-envelope protein’ complex, before using powerful X-rays to create a 3D reconstruction of the precise location where the antibody binds to the envelope protein. By doing so, the team found that the dengue and Zika viruses share the same antibody binding site.

“The antibodies could be used, for example, to protect pregnant women at risk of contracting the Zika virus.”



These results could eventually lead to the development of a universal vaccine that offers simultaneous protection against dengue and Zika virus disease. They were published in the journal ‘Nature’ on 23 June 2016.

‘The antibodies could be used, for example, to protect pregnant women at risk of contracting the Zika virus, because there is currently no vaccine or treatment for this disease,’ concluded Rey.

The DENFREE project will run until the end of 2016. It is supported by the EU’s FP7 programme to the tune of EUR 8.4 million.

DENFREE

- ★ Coordinated by the Pasteur Institute in France.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/102500>

NOVEL SCAFFOLDS FOR IMPLANTS

Nowadays, post-injury regenerative medical approaches offer permanent and fast recovery. To assist this process, a European study has engineered novel implant scaffolds with bioactive surface fabrication for bone and vascular differentiation.

In recent years, the need for orthopaedic implants has risen considerably, given the increase in the aging European population and the number of accidents. Implants have the capacity to treat injured bones at a faster pace and with better recovery, thereby decreasing operational and hospitalisation costs.

New-generation implants consist of ‘three-dimensional’ (3D) scaffolds that support the growth and differentiation

of stem cells. The microenvironment or niche represented by the implant substrate requires careful consideration and design.

The scope of the EU-funded project PLASMANANOSMART (Plasma- and electron beam-assisted nanofabrication of two-dimensional (2D) substrates and three-dimensional (3D) scaffolds with artificial cell-instructive niches for vascular and bone implants) was to develop functional 2D-substrates or

3D-scaffolds for cardiovascular and bone implants. For this purpose, they used sophisticated nanofabrication technologies to generate artificial cell-instructive niches that would allow stem cell differentiation towards the osteogenic or vascular lineages.

Researchers tested novel materials and optimised their surface structuring, which was coated with metal alloys and ‘hydroxyapatite’ (HA). The HA film could be adapted in terms of morphology,

“Using X rays, researchers concluded that polymers enriched with inorganic particles offered improved mechanical and biological properties.”

stoichiometry and thickness, and facilitated efficient cell adhesion. Additionally, scientists prepared a multifunctional biocomposite based on HA coating and silver nanoparticles with anti-bacterial properties.

Considering the importance of the surface properties of medical implants in cell adhesion, proliferation and differentiation, the consortium investigated various parameters of polymer scaffolds. Using a multitude of methodologies, they determined the structure, porosity and nanoparticles distribution of the polymer scaffolds. The biodegradation and corrosion resistance behaviour of the scaffolds were also investigated. Using X rays, researchers concluded that polymers enriched with inorganic particles offered improved mechanical and biological properties.

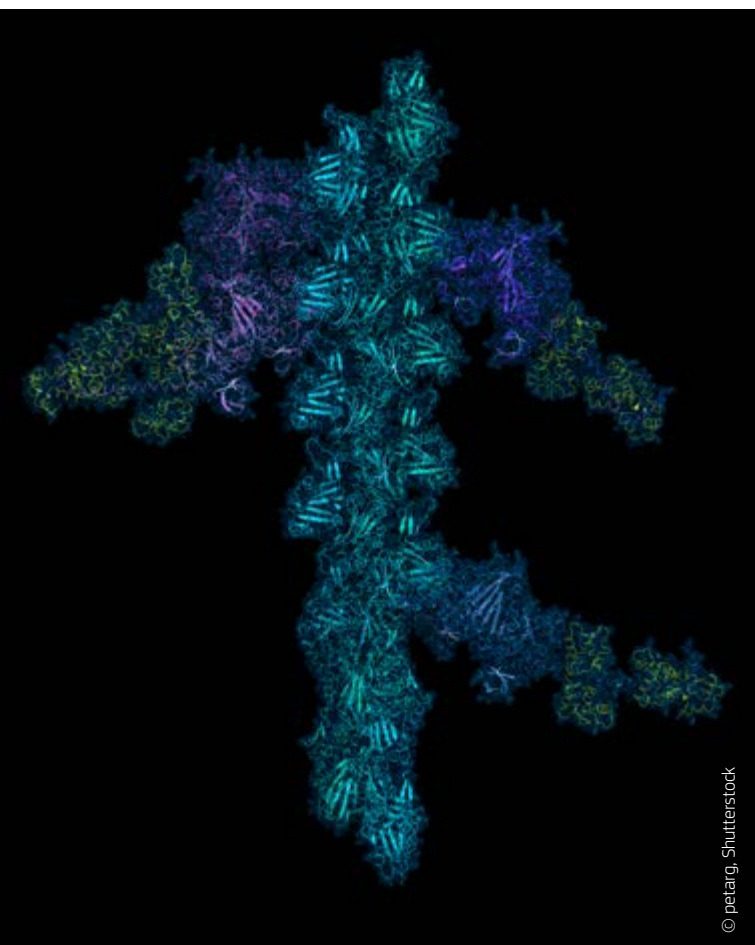
Collectively, the polymers generated during the PLASMANANOSMART project have the potential to be successfully integrated into orthopaedic practice and markets. The innovative bioengineering approach guarantees long-term support for the implanted tissue, thereby reducing the socioeconomic burden of repeated surgical interventions.

PLASMANANOSMART

- ★ Coordinated by Fraunhofer in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/109075>

SHEDDING NEW LIGHT ON THE WORKINGS OF MOTOR PROTEINS

EU-funded scientists have captured the stiff-legged walk of a motor protein moving along an actin filament for the first time. Understanding how these proteins use energy to fuel biological tasks on a molecular level could lead to therapies for movement-related disorders.



Scientists within the RMPSHSSI (Revealing myosin's power stroke with high-speed scattering interferometry) project recorded the motion of myosin 5. These proteins function just like nanoscale lorries might, travelling remarkably long distances while carrying a cargo. They also look like two-legged creatures that take very small steps.

The team used a new optical microscopy technique, called interferometric scattering microscopy, that can see tiny steps of tens of nanometres captured at up to 1 000 frames per second. This powerful imaging technique overcomes challenges associated with the limited resolution of most optical microscopes as well as the quick movement of molecules.

Using this technique, the team obtained timing and spatial information about the movement of myosin 5 along a fibrous track. These molecular motors produced motion in a mechanical step known as a power stroke.

Project findings shed further insight into how cells function, while also helping step up efforts aimed at building efficient nanomachines. Use of this new optical tool will facilitate a better understanding of cell transport as well as cell division, replication and communication.

“The team obtained timing and spatial information about the movement of myosin 5 along a fibrous track.”

Molecular motors are remarkable biological molecular machines that are the essential agents of movement in living organisms. These tiny machines harness the chemical-free energy released by the hydrolysis of 'adenosine triphosphate' (ATP) to perform mechanical work such as muscle contractions, cell motility and cell division.

RMPSHSSI

- ★ Coordinated by the University of Oxford in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/108711>

B₃ R₁ E₁ X₈ I₁ T₁

SOCIAL SCIENCES AND HUMANITIES

EU RESEARCHERS SAW BREXIT COMING

Following the United Kingdom's decision to leave the European Union on 23 June 2016, the EU-funded SENSEI project has revealed that it accurately predicted the result of the referendum by analysing 6 million social media conversations in the weeks preceding the vote.

The SENSEI (Making Sense of Human-Human Conversation Data) project aims to make sense of the millions of blog posts and social media conversations that take place every day. To do this, the overall goals of the project have been two-fold: Firstly, project partners have developed sophisticated summarisation and analytics technology to help users make sense of human interaction from diverse media channels. Secondly, they have designed and evaluated the SENSEI summarisation technology in real-world environments, with the aim being to improve task performance and the productivity and efficiency of end-users, including, for example, data and media analysts, journalists and editors.

However, the project does not just rely on technology — human intervention is also a crucial element in how the project has been analysing social media conversations, with an emphasis by the project on using a combination of 'man and machine' to predict the outcome of major votes and elections. This has included the inconclusive December 2015 Spanish general election and the Brexit referendum.

Predicting Brexit

'Over the course of this campaign, the SENSEI project's unique combination of humans and machine reading algorithms has listened to more than 6 million social media conversations relating to the Brexit vote to identify and predict voting sentiment,' commented Prof. Giuseppe Riccardi, SENSEI project coordinator. 'We are

delighted that, following our equally accurate prediction of the Spanish general election, we have once again predicted the outcome of a major political event with very high accuracy. It appears that the momentum on UK social media started to change on 21 June [two days before the referendum vote] and we watched it move.'

Whilst traditional pollsters and bookmakers were predicting a very narrow win for the Remain campaign right up until the evening of 23 June, the online conversations monitored by the SENSEI project team began to tell a different story. Earlier during the day of 23 June as polling stations opened across the country, social media chatter in the UK was 49.63% in favour of Leave and 50.37% in favour of Remain and it was too close to call.

But by late afternoon, social media chatter had changed as more and more undecided voters took their decision and there was a dramatic swing to Leave. The SENSEI system predicted a final vote breakdown of 48% Remain and 52% Leave, which was precisely the final result of the referendum that was announced in the early morning hours of 24 June. Social media, in essence, had gotten it right.

Dr Hugo Zaragoza, a member of the SENSEI project team and an expert in opinion analytics commented: 'Once again, our data told a very different story to the pollsters and we were proved to be more accurate. This is a great result for the project. The ability to listen to millions of pieces of conversations and then analyse them for

sentiment, using a combination of humans and machines, has proved once again to be more successful than traditional polling methods... at times, the social media chatter was intense and passionate. Since we started this project, we have listened to and analysed 300 000 social media conversations on Brexit every day and we're delighted to have called the result accurately.'

Commercial opportunities

By highlighting how using a powerful combination of technology-driven analytics, combined with a unique qualitative approach using human intervention, can fundamentally change the way social media chatter is understood and how it can be applied commercially, the SENSEI project is providing a highly valuable tool to help commentators to understand what is being said.

'This is a really powerful tool for politics and business after the disastrous set of predictions from the main players,' said Dr Zaragoza. 'We have demonstrated how accurate our technique is.'

The SENSEI project began in November 2013 and is due to end in October 2016. It has received EUR 2 650 000 in EU funding.

SENSEI

- ★ Coordinated by the University of Trento in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/110760>
- ★ Project website: <http://www.sensei-conversation.eu/>

CITIZENSHIP AND VOTING RIGHTS IN POST-YUGOSLAV COUNTRIES

An interdisciplinary analysis has examined the effects that political party competition has on the relationship between citizenship and voting rights in post-Yugoslav countries.

As a link between people and the state, citizenship rules and regulations establish the parameters for inclusion and exclusion in terms of who can participate in politics. This is of particular importance for post-Yugoslav countries, since their political and social realities are influenced by the parallel processes of nation-building and Europeanisation.

Questions arise regarding whether some ethnic groups are excluded from citizenship and if this is subject to change if different parties come to power. Also in question is whether differences in citizenship status affect voting rights and how party competition dynamics is reflected in voting rights legislation. These are the questions that the EU-funded project COMPCITXU (In the frame of party competition: citizenship, voting rights and nation-building in the post-Yugoslav space) sought to answer.

Objectives in this process included training through research, improving the understanding of party completion, franchise and citizenship, publishing research results through various dissemination activities and forming long-lasting collaborations. A Career Development Plan was created and outlined the project's milestones and potential impact. Work also involved the collection and analysis of secondary data, including academic publications, citizenship legislation and electoral results in the seven post-Yugoslav states. Additionally, fieldwork activities took place with the aim of collecting primary materials and interviewing major stakeholders and policy analysts.

The results of the work included a conceptual framework for pinpointing developments in the politics of citizenship and franchise between contested and consolidated post-partition states. Dissemination included publications, presentations to academic audiences via conferences and workshops, and outreach to the general public through websites.

The impact of COMPCITXU is its contribution to European competitiveness in the study of citizenship and electoral rights. It is useful for stakeholders and policymakers in the Western Balkan states in terms of legislative reform and EU accession.



COMPCITXU

- ★ Coordinated by the European University Institute in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/108522>

GENETIC IDENTITIES OF THE WORLD'S FIRST FARMERS REVEALED

Researchers partly funded by the European Research Council's (ERC) ADNABIOARC project have released new findings that reshape our understanding of the genetic heritage of modern West Eurasians.

The study, published in the journal 'Nature', has illuminated the genetic identities and population dynamics of the world's first farmers. They achieved this by undertaking pioneering, large-scale, genome-wide analyses of ancient human remains from the Near East.

The ADNABIOARC (From the earliest modern humans to the onset of farming (45,000-4,500 BP): the role of climate, life-style, health, migration and selection in shaping European population history) study reveals three genetically distinct farming populations living in the

Near East 12 000 to 8 000 years ago, which includes two newly described groups from what is now Iran and the Levant, and a previously reported group in Anatolia, part of modern-day Turkey. The findings also suggest that agriculture spread through the Near East at



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“The team overcame this problem in part by extracting genetic material from ear bones that can yield up to 100 times more DNA than other bones in the body.”

least in part because existing groups invented or adopted farming technologies, rather than because one specific population replaced another.

‘Some of the earliest farming was practiced in the Levant, including Israel and Jordan, and in the Zagros mountains of Iran — two edges of the Fertile Crescent,’ commented Professor Ron Pinhasi, from University College Dublin, a co-senior author of the study. ‘We wanted to find out whether these early farmers were genetically similar to one another or to the hunter-gatherers who lived there before so we could learn more about how the world’s first agricultural transition occurred.’

The analyses conducted by the team have altered what we know about the genetic heritage of modern people in Western Eurasia. They now appear to be descended from four major groups: hunter-gatherers in what is now Western Europe, hunter-gatherers in Eastern Europe and the Russian steppe, the Iran farming group, and the Levant farming group.’

Professor David Reich, another co-senior author from Harvard Medical School commented: ‘We found that the relatively homogenous population seen across Western Eurasia today, including Europe and the Near East, used to be a highly sub-structured collection of people who were as different from one another as present-day Europeans are from East Asians.’

Near East populations mixed with one another over time and migrated into surrounding regions to mix with the people living there until those initially quite diverse groups became genetically very similar.

Overcoming poor-quality DNA remains

Advances in ancient-DNA technology have made it possible to probe population mixing and large-scale migrations that occurred thousands of years ago, but the Near East has been one of the most challenging regions in which to successfully do this. This is due to the region’s warm climate and the subsequent degradation of DNA in unearthed bones.

The team overcame this problem in part by extracting genetic material from ear bones that can yield up to 100 times more DNA than other bones in the body. They also used a technique called in-solution hybridisation to enrich for human DNA and filter out contaminant DNA from microbes. The combined technique allowed researchers to gather high-quality genomic information from 44 ancient Near Easterners who lived between 14 000 and 3 400 years ago. These included hunter-gatherers before the advent of farming, the first farmers themselves, and their successors.

By comparing the genomes not only to each other but to 240 previously

studied ancients from nearby regions and from around 2 600 present-day people, the researchers learnt that the first farming cultures in the Levant, Iran and Anatolia were all genetically distinct. ‘Maybe one group domesticated goats and another began growing wheat, and the practices were shared in some way,’ speculated research team member Iosif Lazaridis. ‘These different populations all invented or adopted some facets of the farming revolution, and they all flourished.’

Over the following 5 000 years, the Near East farming groups mixed with one another and with hunter-gatherers in Europe. By the Bronze Age, populations had ancestry from many sources and broadly resembled present-day ones.

The descendants of each farming group, even as they began to intermingle, contributed to the genetic ancestry of people from other parts of the world. Farmers related to the Anatolian group spread west into Europe, people related to the Levant group moved to East Africa, people related to those in Iran or the Caucasus went north to the Russian steppe, and people related to both the farmers in Iran and the hunter-gatherers from the steppe spread to South Asia.

‘The Near East was the missing link to understanding many human migrations,’ stated Pinhasi.

Going forward, the research team are eager to study remains from the world’s first civilisations which succeeded the samples analysed in this particular study.

ADNABIOARC

- ★ Hosted by University College Dublin in Ireland.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/97532>

THE USE OF HOUSES IN BRITAIN DURING THE NEOLITHIC PERIOD

Houses have meant different things to different people over the course of time. An EU initiative has explored what they represented in Britain during the Neolithic period.

In the Neolithic age, farming communities in Europe began to build substantial and permanent dwellings. But what did these houses signify for the inhabitants of Britain then?

To address this question, the EU-funded HOUSE (Home sweet home: Investigating Neolithic houses in Britain through the microwear and residue analysis of tools) project considered how houses were established, how living in them influenced daily maintenance tasks and how such changes shaped Neolithic society.

To understand what types of activities took place in and around houses, project partners started with the premise that

“The HOUSE team conducted two case studies involving Neolithic houses in the Orkney Islands.”

their surroundings are spaces characterised by activities such as cooking and pottery making. They then reconstructed the character and spatial arrangement of such material

practices by analysing the tools used to carry them out. As such, researchers analysed microscopic traces of wear and tear from using tools on materials such as wood, bone and hide, and of residue left on tools, including blood, minerals and plant starch.

The HOUSE team conducted two case studies involving Neolithic houses in the Orkney Islands, where multiple settlements have been found with well-preserved stone houses, and in the settlement at Durrington Walls near Stonehenge.

The analysis conducted at the Orkney settlements offers insight into the various tasks that tools were used for. Traces show that a broad range of activities were linked to the houses, including hunting, hide working, pottery production and plant working. Scrapers in particular were used for a wide variety of craft activities. Additional findings indicate that most tools were associated with the practice of abandoning a house.

At Durrington Walls, an analysis of arrowheads shows that they were made by young and/or inexperienced flint knappers. This helped to reveal both the type of settlement in the area and the potential for learning and skills acquisition from ritual or ceremonial activities.

HOUSE shed considerable light on the role of houses in the development of Neolithic societies in Britain and consequently the people living in them.

HOUSE

- ★ Coordinated by Leiden University in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/183146>



ENERGY AND TRANSPORT

BRANCHING OUT INTO NEW BIOENERGY SUPPLIES

The EU-funded EUROPRUNING project has implemented a true pruning-to-energy value chain by introducing new technology and by removing barriers to the use of agricultural residues as an energy resource.

Every year the EU produces over 13 million tonnes of agricultural prunings. Considering that prunings can serve as an excellent source of solid biofuel, these numbers are substantial. More important, if there were a coordinated logistics chain in place, farmers could sell their prunings to the biomass market for profit. But unfortunately, this is not the case. Instead of being seen as an energy resource, prunings are treated as waste and thus either burnt or integrated back into the soil.

A pruning-to-bioenergy value chain

To overcome this challenge, the EUROPRUNING (Development and implementation of a new, and non-existent, logistics chain for biomass from pruning) project began by developing innovative machinery and logistical tools to help farmers more easily convert their prunings into bioenergy supplies. Their work included solutions for all stages of the value chain, and led to an array of new methodologies and technologies. For example, it implemented an innovative methodology for sampling and testing a field's biomass properties, and issued guidelines and best practices for evaluating pruning residues. It produced numerous prototype agricultural machines including two new harvesting machines, a baler and a chipper, capable of collecting prunings from the soil and preparing them for transportation.

These machines are accompanied by a 'SmartBoxTool' and an ICT platform for optimising collection and delivery logistics, as well as monitoring pruning quality. For example, when it comes to storage, the platform provides recommendations for how best to manage large storages of piled biomass. Once the prunings are ready for transport, a GIS-based decision-making tool allows logistic operators to reduce costs and optimise efficiency. The project also offers a truck-mounted GPS system to help drivers find storage and delivery points and calculate the best route between the two.

A new framework

Although this technological work has helped, researchers soon found that this alone was not enough, as non-technical

barriers — including a lack of policy support — stood in the way. In other words, even though the innovation was there, the rules needed to catch up.

Armed with this knowledge, the project team set out to change the 'prunings as waste' mindset that was so common amongst both farmers and policymakers. It aimed to accomplish this at both the EU and Member State level.

At the EU level, the project focused on changing the Common Agricultural Policy's (CAP) approach to soil quality, which encouraged farmers to integrate prunings into the soil — even when there is no environmental benefit from doing so. Instead, the project shifted the CAP's focus towards converting prunings to bioenergy supplies. At the national level, the project worked to incorporate prunings into the National Renewable Energy Action Plans of the Member States.

Big benefits

The EUROPRUNING project has successfully contributed to the effort of making cost-effective and high-quality solid biofuels out of pruning and wood residues, thus giving a boost to the biomass market's reach. Furthermore, project researchers believe that the implementation of their machinery, tools and procedures could lead to the creation of over 30 000 jobs in Europe — thus bringing many much-needed social and economic benefits to Europe's rural communities.

EUROPRUNING

- ★ Coordinated by CIRCE in Spain.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/project/rcn/105073>
- ★ Project website:
<http://www.europruning.eu/>
- ★ <http://bit.ly/2bBbNDp>

RADIOACTIVE WASTE FUELS NEXT-GENERATION REACTORS

Recycling of nuclear waste can enhance the sustainability and safety of nuclear power production. Scientists have developed techniques to decrease the long-term radioactivity of waste by reusing it in next-generation reactors.

The radioactivity of nuclear waste is by nature a result of the significant amounts of usable energy present in fissile materials. Recycling and transmutation of minor actinides is an important step towards an ultimate closed fuel cycle.

Funded by the EU, the FAIRFUELS (Fabrication, irradiation and reprocessing of fuels and targets for transmutation) project worked on developing novel fuels based on recycling of nuclear waste through re-irradiation in next-generation reactors with sustainability in mind. By increasing recycling and transmutation of nuclear waste, in which high-level, long-lived minor actinides are transformed into stable or short-lived materials, FAIRFUELS contributes to reducing the volume and hazard of radioactive waste.



Fast reactors are amongst the Generation IV nuclear energy systems recognised by the European Sustainable Nuclear Energy Technology Platform (SNETP) as a key priority of nuclear research. They are designed to strongly lower the consumption of uranium resources and liberate the remaining long-term radioactivity in nuclear waste through transmutation.

The MARIOS experiment on americium transmutation to collect data on irradiated fuel at different temperatures and porosities was successfully completed. Its aim was to investigate more closely the behaviour of minor actinide targets in a uranium oxide matrix and compare dense fuels with fuels with tailored porosity. In these targets, large helium amounts are produced and cause swelling and significant damage to the material under irradiation.

Another test conducted within FAIRFUELS was the SPHERE irradiation experiment designed to compare americium in traditional pellet form and sphere-pac. Minor actinides containing sphere-pac involve easier, dust-free fabrication processes that are highly necessary to reduce the risk of contamination. Irradiation testing was conducted in the high flux reactor in Petten, the Netherlands.

The HELIOS experiment was designed to study the in-pile behaviour of inert matrix fuels and targets containing americium. The focus was on investigating the role

“Transmutation to safer substances through irradiation will be equally applicable for use in both current nuclear waste burners and future nuclear reactors.”

americium plays in the microstructure and temperature of helium gas release and in fuel swelling. Understanding gas release mechanisms is vital for maximising transmutation yield.

FAIRFUELS' outcomes are expected to make a significant contribution to resolving the problem of radioactive nuclear waste through recycling some of the most hazardous and long-lived components. Transmutation to safer substances through irradiation will be equally applicable for use in both current nuclear waste burners and future nuclear reactors. These are important routes towards closing the nuclear fuel cycle for enhanced sustainability and reduced environmental impact.

FAIRFUELS

- ★ Coordinated by the Nuclear Research and Consultancy Group in the Netherlands.
- ★ Funded under FP7-EURATOM-FISSION.
- ★ <http://cordis.europa.eu/project/rcn/90990>
- ★ Project website: <http://www.fp7-fairfuels.eu/>

ON THE RIGHT TRACK FOR QUIETER RAIL INFRASTRUCTURE

The EU funded QUIET-TRACK project offers a noise reduction and track monitoring system which is demonstrated to be a valuable and cost-effective resource for rail infrastructure planning authorities.

As we go about our daily lives we are subject to a range of noise pollution, especially in urban areas, which has been shown to have a detrimental impact on our health and wellbeing. The QUIET-TRACK (Quiet Tracks for Sustainable Railway Infrastructures) project has set out to reduce some of this ambient noise by ensuring that noise from passenger trains is minimised and maintained at reasonable levels.

By instigating noise calculation procedures, the project — guided by its vision for a quieter city — has provided noise mitigation systems which could be used by engineers to maintain or refurbish tracks. The QUIET-TRACK system looked more precisely at low frequency noise emission and the actual

wheel-rail contact, and so offered more accurate measurements, predictions and locations of track decay for remedial attention. New solutions, which included embedded track systems, were developed to achieve noise reduction of at least 6 dB(A) in comparison to current global rolling noise amongst the network of participating infrastructure managers.

The advantages of in-service monitoring

The QUIET-TRACK project concentrated on track situations evidencing significant global 'pass-by noise'. The system monitored noise generated from the rail wheel interaction in trains travelling at moderate speeds (typically in the

range 20-200 km/h). Sound pressure level measurements were taken from in-service trains by two microphones protected by boxes and attached to the wheel apparatus. Additionally, equipment included a GPS receiver, a high-precision tachometer (measuring speed) mounted on the axle, a front-end unit and a computer for collating the data. Measurements were transmitted back to receiving units using the internet. The monitoring system could also be augmented with another microphone pair to monitor the 'Track decay rate' (TDR).

Key to the project was using in-service trains which meant that several track passages could be measured each week, providing highly precise data on track roughness (a contributing factor in the rolling noise). Another noise contributor — wheel roughness — was inferred by working backwards through the calculations once the noise level had been determined. This was useful as it is impractical to gage wheel roughness whilst vehicles are in-service.

The data was then analysed to more effectively map noise levels as well as provide parameters for maximum roughness levels, which can then be used to assist maintenance efforts. For example, the system can locate areas of wheel and rail wear in track curves. This detection can then trigger a series of alarms for infrastructure managers pinpointing areas of concern.

A planning toolkit for infrastructure authorities

One of the outputs from the QUIET-TRACK project was the creation of a Noise-related Track-maintenance and Management Tool (NMT). The NMT included a noise mapping tool which detects noise-pollution hotspots and predicted the outcome of noise mitigation efforts. By combining this data with information about the number of people affected in given areas, authorities can make informed decisions about optimum interventions. To help with maintenance, the NMT makes available a database of wheel and rail roughness, over time, for every section of the network. Overall increased monitoring accuracy results in more efficiency and cost savings as it reduces the implementation of additional catch-all



noise mitigation interventions (such as noise barriers) and track inspections and prolongs the lifetime of infrastructure.

The NMT offers a powerful tool for authorities, especially where non-track based solutions are unfeasible, as it makes cost-benefit calculations looking at the maximum noise reduction achievable against available budget and within the maintenance operational timeframe, thus indicating the economic viability of potential solutions. This will prove valuable when it comes to producing noise reduction action plans as requested by the EU's Environmental Noise Directive (END) and especially given that the solutions are applicable across the European Union not only to conventional rail tracks but also to tram, 'Light rail transit' (LRT) and metro.

QUIET-TRACK

- ★ Coordinated by Akron in Belgium.
 - ★ Funded under FP7-TRANSPORT.
 - ★ <http://cordis.europa.eu/project/rcn/109752>
 - ★ Project website: <http://www.quiet-track.eu>
-

SPECIAL STEELS AND COMPOSITE MATERIALS FOR LIGHTER, MORE ECO-FRIENDLY MERCHANT SHIPS

Today's passenger and cargo ships are increasingly large and complex. An EU initiative replaced conventional steel with other materials to minimise their susceptibility to cracking in areas where stress concentrates due to fatigue loads.

Propagation of cracks can have catastrophic consequences in large passenger and cargo ships. To address this issue, the EU-funded MOSAIC (Materials onboard: Steel advancements and integrated composites) project investigated two solutions using steel and composite materials.

Project partners introduced 'High-strength low-alloy' (HSLA) steels and composite materials to replace specific structural parts of steel ships. HSLA steels with better mechanical properties and resistance to corrosion are targeted for large structural components in areas of stress

concentration. Lightweight composites with resistance to corrosion are envisioned to replace piping or other non-critical parts.

To find possible replacements for conventional marine steels, the MOSAIC team selected, procured and characterised five appropriate HSLA steels. It evaluated the feasibility of using composites in ship structures. This was done by examining a range of factors, from design to performance enhancement and costs.

Researchers fully tested and characterised composite materials, qualified welding methods between different steels and studied an innovative technique for welding HSLA steels with conventional steel. They also performed fatigue crack growth, fracture toughness and corrosion tests on various welded steels using three different welding methods.

Replacing materials in areas prone to cracks is expected to have substantial benefits in many areas. With fewer cracks, maintenance and repair costs will be reduced as will time out of service. Fewer defects will lead to an increase in safety. Lighter marine structures also result in lower fuel consumption, leading to both cost and environmental benefits in terms of reduced emissions. In all, MOSAIC should reduce the lifetime costs associated with production, operation and maintenance of large merchant ships.

MOSAIC

- ★ Coordinated by CETENA in Italy.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/project/rcn/104600>
- ★ Project website: <http://www.mosaicships.com/>

"With fewer cracks, maintenance and repair costs will be reduced as will time out of service."

ENVIRONMENT AND SOCIETY

RECOMMENDATIONS FOR A SUSTAINABLE EU FLIGHT TICKET TAX

Researchers, as part of the EU-funded FAIRTAX project, have proposed an EU-wide tax on flight tickets that would contribute to European sustainable development initiatives.

In previous decades, direct contributions from Member States' national budgets have become the main source of funding for the EU budget. This has been widely criticised and it has been suggested that it should be replaced by a system whereby the EU is able to raise its resources through EU taxes. The research team heading the Horizon 2020 FAIRTAX (Revisioning the 'Fiscal EU': Fair, Sustainable, and Coordinated Tax and Social Policies) project has now linked this discussion over the EU's own resources with the central aim of the Europe 2020 strategy: to promote smart, inclusive and sustainable growth in the EU.

The central message of the study by economists Alexander Krenek and Margit Schratzenstaller, from Austrian FAIRTAX partner WIFO, is that a carbon-based flight ticket tax presents itself, as measured in terms of sustainability criteria, as a suitable candidate for an EU-wide tax.

The paper argues that the aviation sector is a small but fast growing emitter of carbon dioxide. The failed attempts of several EU Member States to introduce a flight ticket tax and the pressure on those Member States that are levying such a tax clearly demonstrate the limits of national aviation taxation. 'Assigning any kind of taxes on flight tickets to the EU level would greatly reduce tax enforcement problems inherent to mobile tax bases and put a stop to harmful tax competition between EU Member States,' commented Schratzenstaller.

A double dividend, consisting of a reduction in CO₂ emissions on the one hand and a boost for the economy on the other, is a likely scenario if additional tax revenues are spent in the right way, according to the researchers. 'In the paper, we propose that all revenues from a European carbon-based ticket tax should be used to reduce Member State contributions to the EU,' Schratzenstaller continued. 'This would allow national governments to reduce taxes more harmful for growth and employment, in particular the high tax burden on labour. Considering the insufficient coverage of carbon emissions from air traffic by the EU Emission Trading System (ETS), alternative price-based instruments to curb carbon emissions from air traffic are required.'

The paper provides estimations on the expected revenue from implementing a carbon-based flight ticket tax at EU-level and revenue distribution across the EU Member States. In particular, the researchers propose that every passenger departing from an EU airport and every passenger arriving from outside the EU at an EU airport should be subjected to this new carbon tax which would be calculated for every individual flight route.

The research paper uses a new and very exact data set. Depending on the country, it assigns approximately 75% to 90% of the internal and external EU routes flown in the year 2014 their CO₂ emissions per passenger, using the methodology of the International Civil Aviation Organisation (ICAO). Based on the demand, the tax revenues per passenger per route that could have been generated in 2014 by introducing a carbon-based flight ticket tax in the EU can be calculated exactly. The potential overall tax revenues from a carbon-based flight ticket for every individual EU Member State and the EU-28 are estimated for three tax rates. The paper argues that they would have reached between EUR 3.9 billion and EUR 5.3 billion for a tax rate between EUR 25 and EUR 35 per tonne of carbon emissions.

'Altogether, at the tax rates underlying our estimations, expected revenues from a flight ticket tax will be rather limited, so that they won't be able to replace a substantial share of current EU revenues. Nevertheless, a carbon-based European flight ticket tax may serve as an illustrative example to demonstrate the chances and challenges associated with international taxes in particular regarding their potential contribution to sustainable development,' concluded co-author Alexander Krenek.

FAIRTAX

- ★ Coordinated by Umeå University in Sweden.
- ★ Funded under OTH-HORIZON2020.
- ★ <http://cordis.europa.eu/project/rcn/194581>
- ★ Project website:
<http://www.org.umu.se/fairtax/english/>

ICE SHELF COLLAPSE STUDY LEADS TO IMPROVED MODELS

The collapse of the Larsen B ice shelf in early 2002 was an exceptional opportunity for scientists to observe the rapid disintegration of an ice shelf of such size in real time. An EU-funded initiative used data from this event to improve models for forecasting the impact of changing ice sheets on global sea levels.

The purpose of the MODISC (Modelling glacier response after Larsen B ice shelf collapse) project was to improve understanding of glacier and ice sheet dynamics in a warming climate, leading to more reliable forecasts for future sea-level rise.

Increased losses of grounded ice have been observed in the Antarctic Peninsula, in particular the Larsen B embayment glaciers following the collapse of the Larsen B ice shelf. Researchers used data on the collapse of the ice shelf to validate ice flow models and quantify their performance in reproducing the observed complex response of Larsen B tributaries.

Available data from before the collapse of the ice shelf was collected and processed, and included ice shelf thickness and bedrock elevations. This

information was incorporated into an ice dynamics model to simulate the ice flow in the Larsen B area before the ice shelf disintegrated.

The improved data sets were used to better understand the dynamics of coupled glacier/ice shelf systems. Through a combination of improved data sets and improved modelling techniques, MODISC attempted a first-ever simulation of the interaction between floated and grounded ice masses that could be verified through observations.

Researchers modelled the instantaneous response of the tributary glaciers to the collapse of the Larsen B ice shelf and the associated loss of buttressing, resulting in grounding line retreat and thinning. The grounding line is the name given to ice resting on the bed rock.

Scientists found significant similarities between the modelled changes in glacier flow and observations. This resulted in greater confidence in the numerical models and their ability to capture the complex mechanical coupling between floating ice shelves and grounded ice.

Loss of ice shelf buttressing due to ocean-induced melting and feedbacks associated with grounding line retreat are key processes currently responsible for mass loss from large areas of the West Antarctic Ice Sheet. MODISC increased understanding of these processes by developing a coupled ice-ocean model, which uses input from an ocean model to help determine the ice dynamics.

Such an approach provided better results for areas with a complex bathymetry, such as the Pine Island Glacier, and offers new evidence for the importance of bathymetry in glacier retreat and associated changes in ice shelf melt rates. This should lead to major new insights into the recent retreat of the Pine Island Glacier and the associated estimates of sea-level rise.

“This information was incorporated into an ice dynamics model to simulate the ice flow in the Larsen B area before the ice shelf disintegrated..”

MODISC

- ★ Coordinated by the Natural Environment Research Council in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/103517>



TESTING THE WATERS FOR EUROPEAN REUSE OPPORTUNITIES



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The EU-funded DEMOWARE project represents a milestone in water reuse technology, offering increased operational efficiency, improved planning ability, cost savings as well as lowering destructive environmental impacts, whilst mitigating against climate change.

Water resources across Europe are under strain, with increasing demand set against dwindling supply. What water is available is sometimes of unsuitable quality, reducing overall supply but also restricting its use value while increasing the cost of provision. This situation is exacerbated in areas of high population, low rainfall, or having intensive industry, agriculture or tourism. Additionally, climate change aggravates increased competition between water use sectors.

Water reuse measures have been posited as a potential solution but have been beset by a number of technological, institutional and social difficulties. The DEMOWARE (Innovation Demonstration for a Competitive and Innovative European Water Reuse Sector) project set out to address these multiple challenges.

Breakthrough in wastewater treatment

The pioneering work at the project's Tarragona site (Catalonia, Spain) recently won the Environmental Leader's Project of the Year (2015) accolade. In this region, municipalities and a well-developed petrochemical complex were facing water shortages due to high demand. The project processed and purified wastewater from the Spanish cities of Salou, Tarragona and Vilaseca through a water reclamation plant operated by Veolia, AITASA and ACA (Water Catalan Agency, the government-owned water supplier).

Wastewater was processed with the aid of project consortium member Dow's reverse osmosis solutions. After pre-treatment, wastewater first passed through DOW FILMTEC™ BW30XFR-400/34i extra fouling resistant membranes which afforded stable quality permeate and increased equipment lifetime, whilst keeping costs down with less need for additional cleaning. Wastewater then underwent its second pass through DOW FILMTEC™ LE-440i low-energy membranes, which delivered higher salt rejection and produced high-quality water at 33% lower pressure, reducing energy demand. Wastewater processed to the required quality was piped to various plants within the petrochemical complex for alternative industrial use as opposed to being discarded in the Mediterranean Sea, as had been the case before.

The DEMOWARE project also successfully developed treated water suitable for Dow's ethylene cracker cooling tower which had been operating solely on pre-treated water from the UNESCO protected Ebro River. The cooling tower was able to operate with up to 40% re-claimed water (160 m³/h), and reduced chemical usage by 23%. The number of cycles that the cooling towers can operate with, with the same amount of water and avoiding scaling, corrosion or bio-growth, also increased. The amount of water drained to avoid mineral build up (blow down or bleed) was also reduced by 49%.

In the case of the Camp de Tarragona complex, the target is to use reclaimed water to meet 90% of demand. Ultimately, the targeted deployment of reclaimed water — thus requiring less water from the Ebro River — made more water available overall for use by the municipality.

Water reuse as a priority solution for Europe

With increased urbanisation, as well as a mounting population, placing more strain on freshwater supply, acceptance of water reuse as a priority solution is growing. Indeed, the European Innovation Partnership (EIP) on Water included it as a priority focus in their Strategic Implementation Plan. Additionally, the European Blueprint for Water — the EU Resource Efficiency Roadmap 2011 water milestone — proposed a regulatory instrument to set water reuse standards.

In addition to evidence-based technological solutions, suitable regulatory frameworks and effective business models, water reuse uptake also requires an available skill-set alongside increased public acceptance. To increase industry coordination and create a European identity for the sector, DEMOWARE has set up Water Reuse Europe (WRE). The association cultivates enabling market conditions, increases public understanding, and enables knowledge exchange and the sharing of expertise.

DEMOWARE

- ★ Coordinated by CTM in Spain.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/111557>
- ★ Project website: <http://demoware.eu/>
- ★ <http://bit.ly/2bsnCZg>

TOWN BIRDS CLEVERER THAN THEIR COUNTRY COUSINS

The behaviour and brains of invasive bird species were investigated across a rural to urban environmental gradient. By studying different avian species across the world, EU-funded scientists were able to determine whether increased behavioural flexibility and enlarged brain size predispose animals to survival on an increasingly urbanised planet.

The EU-funded COBRA (Cognition and brains of ecological invaders) project used a collection of bird species as a model system to understand the role of behavioural flexibility in adaptation to urbanisation. Researchers also investigated the extent to which behavioural flexibility is associated with changes in brain anatomy.

Indian mynahs, European crows and small songbirds, such as house sparrows and great tits, were studied. The birds were tested in the field along a rural to urban gradient with simple problem-solving tasks such as removing a cork that was blocking access to food at a known feeder.

By examining several species in a number of geographical locations, using different measures of behavioural flexibility and describing associated brain changes, researchers were able to support the hypothesis that increasing behavioural flexibility in increasingly urbanised environments is a general effect.

“Indian mynahs, European crows and small songbirds, such as house sparrows and great tits, were studied.”



It was found that urban birds tend to be more exploratory and more risk-taking than rural birds. However, they did not show any differences in innovativeness, sociality or their response to predators. These results, therefore, showed which factors make urban birds ‘special’ and provided hints for when to expect differences between species.

COBRA will benefit conservation efforts undertaken for declining species as well as management of invasive

species. It also highlighted the importance of comparative studies at different geographical locations through close collaboration between different researchers and their working groups.

COBRA

- ★ Coordinated by the University of Vienna in Austria.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/110243>

PROMISE OF SUSTAINABLE CO₂ UTILISATION TECHNOLOGY TO BOOST EUROPEAN INDUSTRY

Holding its final conference in Brussels in June 2016, the EU-funded SCOT project has showcased its innovative work over the past 3 years on building Europe’s capacity for the development of innovative CO₂ utilisation and recycling technologies.

With growing emphasis on the need to reduce carbon emissions and create a truly circular economy, ‘carbon dioxide’ (CO₂) utilisation offers Europe an opportunity to meet both of these overarching ambitions. CO₂ utilisation is a broad term that covers a variety of innovative industrial processes, which use CO₂ from point source emitters (and in the future from direct air capture) as a feedstock to transform CO₂ into value added products. In essence, CO₂ is treated as a resource, rather than as waste or an emission.

New opportunities from CO₂ utilisation

SCOT’s (Smart CO₂ Transformation) main objective has been to define a Strategic European Research and Innovation Agenda for Europe in the field of CO₂ utilisation. It has done this by considering research and innovation needs in both chemical and biological transformation, covering three primary areas: chemical building blocks (pathways to the 2 million or so different molecules produced by the chemicals industry); synthetic fuels (aviation, for example); and mineralisation (making hard materials

which could be used for building or as a basis for fertiliser pellets). It has also worked towards the development of a Joint Action Plan (JAP) for Europe that includes structural policy measures to favour the transition to low-carbon energy industry and the paradigm of 'CO₂-as-a-resource'.

The project consortium argues that CO₂ utilisation will create new opportunities for economic growth, promote greater innovation and boost Europe's competitiveness, as well support Europe's decarbonisation and resource-efficiency agendas. The project's overall vision is that by 2030, CO₂ utilisation technologies will allow for the manufacturing of a wide variety of products and industrial solutions. Thus, there is indeed a potentially huge market for products derived from reused CO₂, but it was acknowledged during the event that it will probably always be cheaper to make a certain molecule from fossil fuels rather than synthetically.

Political challenges

A large part of the conference was dedicated to discussing how to create an adequate political environment for CO₂ utilisation efforts. One of the regions that has strongly supported this and other green initiatives is Wallonia, one of the constituent regions of Belgium. As such, one of the key speakers at the conference was Jean-Claude Marcourt, a Vice-President of the Walloon Government. He stated that he believed the work carried out by the SCOT project would help with job creation, building businesses and managing energy supply, whilst also helping to achieve environmental objectives. He also pointed out that the coordinated and collaborative efforts undertaken in SCOT have highlighted the benefits of regional cooperation within Europe and that Wallonia will be fully engaged in developing the green economy of the 21st Century that would include CO₂ utilisation technologies as a crucial component.

Rudolf W. Strohmeier, the Deputy Director General for Research Programmes at the European Commission's DG for Research and Innovation then discussed the political and regulatory challenges that must be overcome in order to viably integrate CO₂ utilisation technology into European industry. He admitted that carbon capture technology still remains highly costly and that this hampers its commercialisation

possibilities in Europe, resulting in no genuinely effective business model for such technology. He did note though that using green energy to transform CO₂ into polymers could facilitate the development of new business models and that using CO₂ as a feedstock for chemical products would be a major step in the creation of a real circular economy.

Moreover, Mr Strohmeier also highlighted the importance of a supportive regulatory framework that would allow CO₂ utilisation efforts to come to fruition and make a real impact on EU industrial and environmental ambitions. He argued that in order to create such a framework, industry must present the European Commission with concrete examples of business cases that are hampered by currently existing regulatory measures. This would empower the European Commission to make the political case for enabling CO₂ utilisation technologies.

The research conducted by the SCOT project will substantially help in putting forward the argument for the implementation of solutions, both technical and political, allowing for the development of CO₂ utilisation technologies. The project has already been successful in developing a network of supportive institutions, including university clusters, research centres, industrial partners and regions in the UK, France, Germany and the Netherlands, as well as in Belgium.

"One of the regions that has strongly supported this and other green initiatives is Wallonia, one of the constituent regions of Belgium."

SCOT

- ★ Coordinated by Pole Greenwin in Belgium.
- ★ Funded under FP7-REGIONS.
- ★ <http://cordis.europa.eu/project/rcn/111299>
- ★ Project website: <http://scotproject.org/>



IT AND TELECOMMUNICATIONS

NOVEL OS FOR SMART CITIES TURNS ENERGY CONSUMERS INTO 'PROSUMERS'

What's a smart city without smart people to run it? This question led the IURBAN consortium to develop a decision support system that collects and analyses energy consumption and production from the likes of power plants, EV charging stations and buildings. The new system is hoped to enable better management and planning in smart cities — with both producers and consumers being provided with just enough information to play their part.

Most people have been unpleasantly surprised with sudden changes in their energy bills at least once in their life. With other services like mobile telecoms, providers would be quick to react, identify the problem and suggest bespoke plans that would better fit their client's needs.

Energy consumers, on the other hand, will often be left in the dark. Providers don't have enough data available to identify solutions, whilst consumers have no access to their own consumption patterns and can't actively participate in the renewable energy market. At city scale, this realm of the unknown makes it very difficult to plan for future energy demand.

In the face of these unfilled needs, the IURBAN (Intelligent URban eNergy tool) project is providing a 'Smart decision support system' (SmartDSS) that collects, aggregates and analyses data in order to suggest optimisation plans.

'An energy router at each end-point collects data related with energy consumption and production. It ensures lossless data communication to the Smart City Database, which is located in the Cloud,' explains Tatjana Perse, leader of the project's dissemination activities. 'There, the system can visualise, analyse and take decisions for all the end points that are consuming

or producing energy at city level, allowing them to forecast and plan renewable power generation available in the city, and enabling real-time optimisation.'

From individual benefits to the greater good

There are three levels of IURBAN contribution to the development of smart cities. The first goes to citizens: the IURBAN system makes the most of big data analytics to meet their demand for affordable, clean energy services, while ensuring privacy and enabling them to participate actively in the energy market. 'Energy consumers can choose to give their data to third parties such as solar panel installers, window and insulation installers, energy providers, software and smart appliance developers or other entrepreneurs. This allows for a faster detection of problems and an identification of ways to reduce energy consumption,' Perse explains.

'The system also encourages citizens to become "prosumers", which means they not only consume but also produce energy that can be redistributed to other users. IURBAN offers the tools to manage and overcome both technical and financial barriers to the creation of such small-scale renewable energy systems.'

Of course, other energy stakeholders also stand to benefit. Energy producers and retailers can improve their demand and supply in real-time while easily making trend-based decisions about pricing, resource allocation and planning for asset utilisation. IURBAN's set of software tools covers the demands of all stakeholders involved — from ICT experts to energy managers, utilities, retailers, construction and civil engineering, and public authorities.

The idea behind the centralisation of all this data is that it can eventually benefit the city as a whole, facilitating the emergence of 'Smart energy cities' (SECs). 'IURBAN can be adopted by smart city planners as a novel OS. They may access the system to gather useful information for reporting purposes, to take decisions or simply to monitor and predict trends,' Perse notes.

The path to smart energy cities

In a recently published study, the project also offered some insight into the best way for decision makers to operate a SEC. This is an important contribution as there is currently no single approach valid for all local contexts or even a consensus on who should lead the way and what capabilities are required.

The Fraunhofer-led survey focused on soft competencies which, unlike technical know-how, are often overlooked by researchers. 'On the positive side, local governments, who may be the obvious choice for running SECs, already seem to be competent enough for both respecting consumers' privacy and working for the greater good,' Perse says. 'Unfortunately, local authorities are also perceived as neither sufficiently innovative nor able to identify market trends. They have a poor understanding of energy consumers and their behaviour, and do not benefit from enough community trust'.

Although these deficiencies might be overcome through internal capacity-building, it still remains unclear which exact local authorities should be in charge. Many surveyed experts proposed multi-sectorial coalitions for cooperative SEC operation, which would allow other sectors' strengths to complement governmental weaknesses, but it remains to be seen which option local governments will choose.

Until the question of who will run smart energy cities is answered, that of how they should be run already finds an appealing answer in IURBAN, which can provide local authorities with most of the knowledge they are currently missing. The system not only provides tools for the global management of energy consumption, production, distribution, storage and trade at city level, but it can also be extended to other applications and services needed in Smart Cities like: reducing congestion; improving emergency response and reducing crime; improving education delivery and government services, etc.

All in all, IURBAN will help local authorities to: achieve sustainability, reliability and cost-effectiveness of energy services; predict energy loads and distributed generation; raise social awareness; and build policy strategies.

IURBAN

- ★ Coordinated by Sensing & Control Systems in Spain.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/110156>
- ★ Project website:
<http://www.iurban-project.eu/>
- ★  <http://bit.ly/2cIEGfo>

COMMON E-SENS FOR EUROPEAN DIGITAL SERVICE INFRASTRUCTURES

The EU-funded E-SENS project has built on previous work to pave the way towards sustainable, pan-European Digital Service Infrastructures.

With increased citizen and business mobility, alongside ever-growing digitisation, European administrative transactions require a cross-border approach, especially if the Digital Single Market is to become a reality. The eIDAS Regulation, which came into force in 2014, provides the framework for seamless electronic interactions between businesses, citizens and public authorities, which is safe, fast and easy to use. There are already a number of 'Large scale pilots' (LSPs) with demonstrated technical solutions for a range of domains including health and public procurement to achieve this.

The E-SENS (Electronic Simple European Networked Services) project was set up to consolidate and extend the current potential of cross-border digital public services, by developing generic and

re-usable technical components (building blocks) based on five previous LSPs. The project proposed solutions that meet the needs for cross-border core eGovernment services (e-ID, e-Documents, e-Delivery and e-Signatures etc.) beyond 2020 (the tenure of the current Connecting Europe Facility).

Making connections

Adoption of eIDAS, means that all EU countries will implement the eIDAS node. However, a number of countries currently use alternative infrastructure such as that of STORK (Secure idenTity acrOss borRders LinKed) 2.0, for eID services. With considerable investment already made, countries are unlikely to be amenable to substantive change in the near future. Therefore, developing systems interoperability is a priority research and development area.



E-SENS has tested potential technical solutions for specific public administration transactions in pilot production environments. Recently, it was announced that the project's Dutch team working on the e-Agriculture pilot had created a

standalone adapter which connects eIDAS based German middleware with the Dutch STORK 2.0 PEPS (Pan-European Proxy Services). Building on this successful result, the team is now working with Icelandic partners to connect the eIDAS node with the STORK 2.0 PEPS.

The adaptor is comprised of an eIDAS node along with a plugin that converts authentication requests and responses between the eIDAS and STORK 2.0 formats. The plugin will also enable attribute mappings between STORK 2.0 and eIDAS node 'Security assertion markup languages' (SAMLs).

As the eIDAS node is utilised as an eIDAS connector it is not directly linked to EU country specific services like Attribute Providers or Identity Providers. This means that the system design looks and feels as though the country running STORK 2.0 architecture has actually implemented the eIDAS node.

Beyond 2020 vision

By looking closely for synergies amongst the previous LSPs across the domains, E-SENS was able to integrate sustainability considerations into future recommendations. This is evidenced by the way in which its new adaptor enables connectivity to the eIDAS network for countries enabling eID with STORK 2.0 architecture.

Additionally, the project presented principles and a proposed structure for IT governance which reflects the key contribution of current technical building blocks and domain communities (representing the range of sectors involved). E-SENS also outlined the wider legal framework within which governance may have to function.

It is estimated that overcoming current barriers to the European digital economy could add EUR 415 billion to EU

"The team is now working with Icelandic partners to connect the eIDAS node with the STORK 2.0 PEPS."

GDP by expanding markets, improving services and creating more job opportunities. With this in mind, creating comprehensive 'Digital service infrastructures' (DSIs) offers the prospect of an investment well made.

E-SENS

- ★ Coordinated by NWR-Justiz in Germany.
- ★ Funded under CIP.
- ★ <http://cordis.europa.eu/project/rcn/191953>
- ★ Project website: <http://www.esens.eu/>
- ★ <http://bit.ly/2bfyz0j>

MAJOR CINEMA BREAKTHROUGH COULD ALLOW FOR GLASSES-FREE 3D

A team of US and Israeli researchers, partly funded by the EU, have developed a truly pioneering cinema screen that can show 3D films without the need for glasses.

In a new paper, the team from MIT's Computer Science and Artificial Intelligence Lab (CSAIL) and Israel's Weizmann Institute of Science have demonstrated a display that allows cinemagoers to watch 3D films without the need for the cumbersome accompanying glasses. The paper was presented at the SIGGRAPH computer-graphics conference that took place in Anaheim, California, from 24 to 28 July 2016.

Introducing Cinema 3D

Dubbed 'Cinema 3D', the prototype system uses a special array of lenses and mirrors to enable viewers to watch the same film in 3D from any seat in the cinema. In a regular 3D cinema which requires the use of glasses, only one barrier is utilised. 'Existing approaches to glasses-free 3D require screens whose resolution requirements are so enormous that they are completely impractical,' commented Professor Wojciech Matusik from MIT. 'This is the first technical approach that allows for glasses-free 3D on a large scale.'

Although this is a major breakthrough that could revolutionise the 21st century cinema experience, the research team are keen to stress that the technology is currently not market-ready. However, they are optimistic that future versions will allow the technology to advance to a stage where the majority of cinemas will be able to offer glasses-free alternatives for 3D films.

Glasses-free 3D already exists but not in a way that allows it to be scaled down to cinemas. Traditional 3D methods for televisions use a series of slits in front of the screen (a 'parallax barrier') that allows each eye to see a different set of pixels, resulting in the creation of a simulated sense of depth. But because parallax barriers have to be at a consistent distance from the viewer, this approach is not practical for cinemas, where viewers are sat at different angles and distances from the screen.

Other methods, including one also developed at MIT, involve developing completely new physical projectors that cover the entire angular range of the audience, but this often comes at a cost of reduced image resolution.



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How Cinema 3D works

The key insight with Cinema 3D is that people in cinemas move their heads only over a very small range of angles limited by the width of their seat. As a result, it's enough to merely display a narrow range of angles and replicate it to

all seats in the cinema.

"The Cinema 3D system encodes multiple parallax barriers in one display, such that each viewer sees a parallax barrier tailored to their exact position in the cinema."

In effect, the Cinema 3D system encodes multiple parallax barriers in one display, such that each viewer sees a parallax barrier tailored to their exact position in the cinema. That range of views is then repli-

cated across the cinema by a series of lenses and mirrors within the system's special optics system. This takes advantage of the fact that the cinema experience is set in a fixed position (sitting down in one seat), whilst a 3D television has to account for people moving around to watch from different angles, which means that there has to be a dividing up of a limited number of pixels projected. This is so the viewer can

see the image from wherever they are in relation to the television.

However, Cinema 3D is currently not particularly practical, with the team's prototype requiring 50 sets of mirrors and lenses, yet it is barely larger than a standard pad of paper. Prof. Matusik says that the team now hopes to build a larger version of the display and to refine the optics further to improve the image resolution. 'It remains to be seen whether the approach is financially feasible enough to scale up to a full-blown cinema,' he stated. 'But we are optimistic that this is an important next step in developing glasses-free 3D for larger spaces, such as movie theatres and auditoriums.'

The EU funding that assisted in the development of Cinema 3D was awarded to the Weizmann Institute of Science under the COMPCAMERAANALYZ (Understanding Designing and Analyzing Computational Cameras) project.

COMPCAMERAANALYZ

★ Coordinated by the Weizmann Institute of Science in Israel.

★ Funded under FP7-IDEAS-ERC.

★ <http://cordis.europa.eu/project/rcn/96846>

INTERVIEW

FROM PHOTOS TO REALISTIC VIDEO GAMES, IN THE BLINK OF AN EYE

Companies willing to stand out in today's video game industry need three core assets: an original concept and scenario, an intuitive gameplay, and photo-realistic game environments. As vibrant as it may be, the European video game industry is caught up in this race, and small companies can hardly win without tremendous budgets being invested in their 3D environments. Technology developed under the CR-PLAY project — which enables the creation of realistic gaming environments based on photos and videos — may increase their chances.

The CR-PLAY (Capture-Reconstruct-Play - An innovative mixed pipeline for videogames development) technology enables developers to turn houses, buildings, trees, cars and any other real life object into realistic 3D graphics based only on photos and videos. It is able to reconstruct any existing environment, saving considerable development time and cost in the process.

To make this possible, the project consortium relied on two existing techniques: 'Image-based modelling and rendering' (IBR) and 'Video based modelling and rendering' (VBR). They developed user-friendly capture devices based on low-cost components, overcame existing problems with IBR and VBR algorithms (low quality of distant objects, modification of light conditions and absence of treatment of dynamic conditions such as elements moving with the wind or flames) and are now preparing for exploitation by the European game development community.

Dr Ivan Orvieto, coordinator of the project, expands on the results of the project and his hopes for an adoption by

game developers across Europe within the next year and a half.

★ **How important is the role played by ever more realistic engines in the increased production cost of video games?**

Dr Ivan Orvieto: The increase of costs in game development is caused by several factors and is strongly affecting the European game industry. Creating a realistic look and feel is certainly one of the most expensive tasks nowadays. This is due to the effort spent in creating assets such as buildings, cars, forests, etc., but also for the development of engines for physics, weather phenomena, crowd simulations, artificial intelligence, etc.

★ **How does CR-PLAY contribute to reducing this cost? What kind of technologies does it resort to?**

CR-PLAY is an innovative technology aimed at radically changing the way environments and assets for video games are created.

Backgrounds and objects can be captured by simply taking a few pictures and short videos of a building or area. These images are then processed by a semi-automatic software



© Ivan Orvieto

DR IVAN ORVieto



which reproduces high-quality scenes within the game engine Unity3D. The obtained photo-realistic assets can be combined with traditional textures and polygons used in the standard process of videogames creation.

The backbone of this new approach is the innovative technologies of IBR and VBR.

★ **What type of market players and gaming platforms do you target?**

CR-PLAY technology is currently integrated within Unity3D, allowing game developers to deploy their games on mobile and Windows-desktop platforms. Depending on developers' preferences, CR-PLAY technology can also be integrated with other game engines such as the Unreal Engine.

★ **Can this technology be used for creating past or non-existing environments as well?**

The CR-PLAY technology can be used for projects where past-present comparison is required, as it allows 3D artists to integrate traditional assets. Nevertheless, to make the most of the simplicity and cost-effectiveness of the core technology, it is suggested to represent existing environments and objects in games created with CR-PLAY.

★ **When can we expect to see the first commercially-available games using your technology?**

Since CR-PLAY is an RTD project, its outcomes are intended to be at prototypical stage. Nevertheless, given the strong results obtained so far, the adoption of

"The obtained photo-realistic assets can be combined with traditional textures and polygons used in the standard process of videogames creation."

our technology in commercial projects is not going to be too far in the future.

Further engineering activities will essentially revolve around optimisations in space required on devices and performances. Thus, from a technological point of view, we can expect an 18-month window from the end of the project to a potential release of the technology to game developers.

★ **How do you see your technology performing in the game industry in a few years from now?**

This is very difficult to answer, as the game industry changes at lightning speed.

The main aim of CR-PLAY is to put cost-effective and high-quality technology in the hands of small game development studios in order to help them overcome the budget difficulties they face every day. Once the engineering activities are completed, there is a real potential to see CR-PLAY technology adopted not only in game production but wherever it is required to reproduce photo-realistic environments for affordable budgets, such as in real-estate, tourism and cultural heritage markets.

CR-PLAY

- ★ Coordinated by Testaluna in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/110377>
- ★ Project website: <http://www.cr-play.eu>

NEW TELECOMS ARCHITECTURE TO BOOST DATA SPEED AND CUT TECHNOLOGY COSTS

EU researchers have developed new, highly-efficient components and telecommunications architecture that could speed up the delivery of digital data to users.

An EU-funded project, FABULOUS (FDMA Access By Using Low-cost Optical Network Units in Silicon Photonics), has created innovative new components to be used in digital telecommunications including digital radio, television and internet that are lower cost and more efficient than currently existing technology. The project has demonstrated that its technology will allow higher bit rates — the speed at which basic units of information are processed — in computing and digital communications.

The overall goal of the project was to create a flexible communications architecture compatible with current infrastructures using low-cost components based on silicon photonics. Developing this technology is key to rolling out mass fibre-to-the-home ultra-fast broadband digital telecommunications services.

The FABULOUS components have been designed for 'Next-generation passive optical network' (NG-PON2) technology. NG-PON2 is the current telecommunications network standard for passive optical networks that allows users to receive digital radio, television and internet services.

The project demonstrated passive optical networks that use Frequency Division Multiplexing at the electrical level on a

per-wavelength basis. The system allows each Optical Network Unit — the device installed in the user's location — to handle its dedicated data traffic alone, and not the full aggregated bit rate as is currently the case for other NG-PON2 technologies. It also showed how its technology can be used in Passive Optical Local Area Networks, as well as potentially being used in 5G networks.

Meanwhile, the FABULOUS project has created new silicon-based photonic integrated circuits, showing the potential of using silicon photonics in the telecommunications market. The project demonstrated a reflective upstream transmitter made of a 'Silicon photonic integrated circuit' (SiPIC). The system comprised a reflective Mach Zehnder modulator and its flip-chipped CMOS electronic integrated circuit driver. The two Integrated Circuits were linked using high-density, low-parasitic copper pillars.

FABULOUS carried out sub-system demonstrations to show the effectiveness of the standalone components. It also carried out a whole system demonstration of the full architecture using its Optical Network Units and real-time data traffic.

The project found that designing the system and its components together is essential to paving the way for lower-cost silicon devices to enter the telecoms market. FABULOUS has several large industry leaders and telecom operators within its consortium. Working alongside these partners, the next steps for the project will be towards full standardisation of the technology.



FABULOUS

- ★ Coordinated by ISMB in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/104608>
- ★ Project website:
<http://www.fabulous-project.eu/>

A LIFELIKE VISION FOR COMPUTERS

An EU exchange project has helped to develop European research capacity concerning computer vision. Drawing from biology, outcomes of the 48 secondments included a new neural network chip design to aid human-machine interaction.

Computers having realistic vision would be a real advantage in many applications, however achieving this goal is difficult in practice. But all is not lost, as biologically inspired artificial neural systems may offer a way forward.

The EU-funded EYE2E (Building a visual brain for fast human machine interaction) project built international capacity and cooperation in the field, via a staff exchange programme. The research involved software simulation and hardware production, ultimately to design very large-scale integrated

chips with applications in human-machine interaction. Such chips follow parallel computing principles. The work also addressed the modelling of biologically-plausible visual neural systems and the integration of multiple visual systems.

Researchers successfully achieved all goals as a result of fostering staff exchanges and running training seminars, joint workshops and conferences. Around 48 researcher secondments covering periods of 1 to 2 years took place. Additionally, the research yielded over 30 journal and conference papers.

The EYE2E project's new chip designs advance the field of machine vision, specifically the area concerning human-machine interaction. The results could yield applications in areas such as intelligent robots, surveillance and video games.

"The results could yield applications in areas such as intelligent robots, surveillance and video games."



EYE2E

- ★ Coordinated by the University of Lincoln in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/99726>

INDUSTRIAL TECHNOLOGIES

SHINING A LIGHT ON FACTORIES OF THE FUTURE

The EU-funded HALO project has extended existing laser technology for material processing to create more adaptable options, increasing operational quality and speed, whilst reducing overall cost.

Over the last few years, the industrial use of high powered lasers, especially in the automation of production lines, has become increasingly commonplace. They are used with metals, ceramics, glasses, semiconductors and plastics for cutting, marking, joining and patterning. As such, lasers are now integral to the production of many of the things that make up our daily lives, such as the components for the electronic devices powering the information age.

However, one size does not fit all, with varying processes and materials necessitating different lasers. For European industry to be more globally competitive it needs a more adaptable generation of laser tools. The HALO project set out to create such a breakthrough.

Getting into shape

Laser use in materials science involves balancing many complex variables, such as power, pulse, wavelength, shape, duration and beam profile. Through experimentation, the HALO (High power Adaptable Laser beams for materials prOcessing) project team established the current state-of-the-art, with results stored in a database. Additionally, the laser cutting process was meticulously analysed with high speed video. Using known data points, meta-models then helped to ascertain the best parameters for laser use in various scenarios. These models pointed to fruitful paths for increased adaptability, including varying beam shape.

The spot of light that a laser generates when it shines onto a surface is brightest

at its centre. Light intensity reduces further from the centre, creating the classic bell-curved shape (Gaussian distribution). However, this arrangement is not ideal for all laser applications. Other shapes might be better suited for precision cutting, such as those having a halo effect, with a brighter ring around a darker centre. Utilising an altered shape has been shown to increase the efficiency of some processes by up to 30%.

HALO principally looked at exploiting the adaptability of laser cutting for three industrial application areas. Firstly, by examining the usage of fibre guided 'continuous wave' (CW) systems for cutting sheet metal (1 mm – 25 mm thickness), which constitutes the largest market share for industrial laser usage. HALO techniques improved edge quality with shorter dross length. Secondly, by looking at pulsed lasers emitting at new wavelengths for glass and thin metal sheet cutting (under a mm thick), which represents the consumer market for items such as mobile phones and computer components. Here techniques reduced roughness and improved bend strength. Lastly, by analysing sapphire cutting using lasers guided by water-jet for the first time, with HALO techniques reducing heat damage with less contamination.

The shape of things to come

As the laser designs and processes used in HALO were novel, the project developed many components, some previously not available, that included; capillary tapers, isolators, acousto-optic modulators, an

in-cavity acousto-optic Q-switch, and segmented waveplates for tailored polarisation.

As regards sheet metal cutting, the optimal laser beam polarisation was established along with advances in the use of high-speed videography in the process. Additionally, the project developed a 2 micron (μm) laser which could cut transparent polymers. In terms of glass cutting, ultra short pulsed lasers using customised beam shapes, and multi-spot patterns were further developed. These delivered enhanced cutting quality and speed as well as minimised problems such as micro-cracking.

Project learning was captured in the interactive HALO IT-tool for planning and evaluation, which enables operators working through an interface to interrogate modules, ascertaining optimum laser optics and processes for their needs.

Perhaps the major implication of HALO's work is that it offers the opportunity to use one adaptable laser for factory processes, such as robots cutting rubber and metal parts in car production, where currently multiple lasers are in operation.

HALO

- ★ Coordinated by Gooch & Housego in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/104675>
- ★ Project website: <http://halo-project.eu/>

PUBLIC SAFETY INCREASED WITH THE ABILITY TO REMOTELY DISABLE VEHICLES

To increase public security, the EU-funded SAVELEC project has demonstrated a prototype device that can stop non-cooperative vehicles, both safely and at distance.

In its endeavour to keep the public safe, one of the key challenges facing European security services is the ability to control and stop, at distance, non-cooperative vehicles posing a threat. However, this ability presents more than a technical challenge. To comply with EU legislation, as well as adhere to ethical concerns, the technology would also have to be safe for the user, the driver (and passengers), as well as members of the public and the material infrastructure of the surrounding environment.

The SAVELEC (Safe control of non cooperative vehicles through electromagnetic means) project developed a prototype device, after testing signals (magnetic pulses and microwave), which interfered with key car components, forcing it to slow down and stop. With the contribution of security forces as the ultimate end users, the researchers were able to simulate the technology's use in realistic scenarios.

Prototype device for a variety of security scenarios

SAVELEC first set up an end-user advisory panel comprising of law enforcement agencies and associated security organisations from different European countries, to better understand the likely operating environment for any technology developed. Scenarios were identified in terms of operational distance, target speed, distance to nearby persons and any immediate environmental considerations. As the project's coordinator Dr Marta Martínez Vázquez points out, 'This analysis included land and maritime missions, with the device implemented on a ground, seaborne or airborne platform.'

Developing the technology itself first required a review and cost analysis of what was currently available on the market, as well as establishing the car components best targeted for remote interference. In lab bench testing, SAVELEC evaluated signal frequency, waveform and duration — principally of 'electromagnetic pulses' (EMP) and 'High power microwaves' (HPM) — to determine which could best disrupt the functioning of a vehicle's electronic components.

Assessing the project's success, Dr Martínez Vázquez asserts that, 'An EMP/HPM car-stopping device prototype at a bread-board level was designed, fabricated and tested. Its performance was successfully demonstrated in an open field controlled track, in the presence of SAVELEC affiliated end-users.' The capacity of the prototype also surpassed expectations. 'It demonstrated the functionality of the whole device, with a car moving on an open air track,' she comments. 'Conservative expectations had been to only demonstrate a sub-system of the device, or the whole system, but with a stationary car.'

The project also used the simulated environment to investigate the wider impact of the technology on humans and materials. For example, it looked at driver reactions to loss of vehicle control under six different scenarios including high speed, dense traffic and narrow roads, and involving over 70 volunteers. A literature review of previous results allowed the assessment of the likelihood of petrol tank explosions

from electromagnetic exposure or damage to airbags. Additionally, it assessed three different electromagnetic exposure scenarios for the pedestrian/bystander, car driver and device operator to ascertain safety limits.

Beyond proof-of-concept

A core outcome of the project, with the help of the European security forces and an Independent Ethics Advisory Board, was a regulatory framework proposal within which this technology could function. The framework included compatibility with European legislation which ensures the safety of all those exposed to electromagnetism.

For the prototype device to progress beyond the successful proof-of-concept stage, there are two principal challenges which would have to be overcome. 'Further investigation should concentrate on the miniaturisation of the different components, and on extending its operational range (by increasing the power that can be generated),' Dr Martínez Vázquez says. She also recommends that different car models should be tested, as SAVELEC concentrated on only one. There should also be further investigation on human health and safety implications.

Whilst SAVELEC specifically tested the technology on cars, it could easily be adapted to other vehicles such as fast vessels, trucks or motorbikes. The project's results have also contributed to improvements in other fields, such as the study of human exposure to electromagnetic fields and the development of better driving simulators.

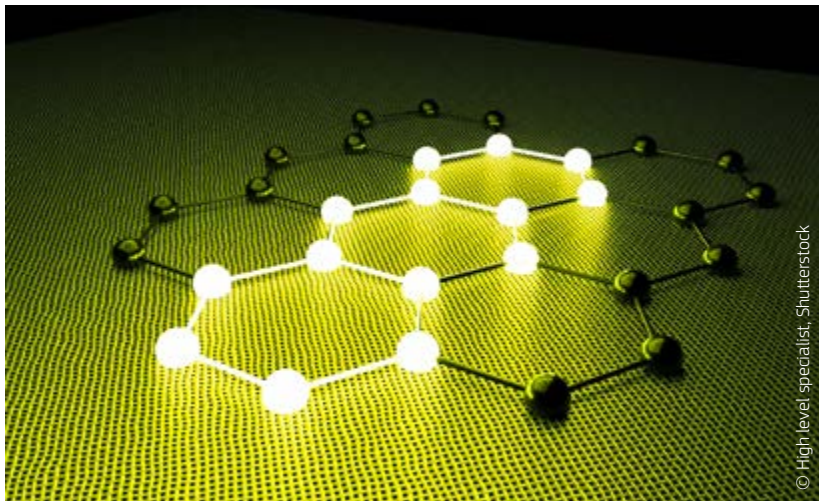
SAVELEC

- ★ Coordinated by IMST in Germany.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/project/rcn/102072>
- ★ Project website: <http://savelec-project.eu/>



ULTRA-LONG LASERS CHALLENGE CONVENTIONAL KNOWLEDGE ABOUT LASER TECHNOLOGY

A new type of compact laser source was demonstrated by the EU-funded GOSFEL project, which exploits graphene to create a solid-state free electron laser.



"We have already demonstrated beyond state-of-the-art THz modulators that could be used as part of future communications systems."

There are many applications within industries ranging from communications (e.g. free space communication), to security (e.g. missile counter-measures) and sensing (e.g. explosives), which would benefit from laser sources that are both compact and cost-effective. Gaps in the spectrum, especially much of the far-infrared and THz, hold out promise for the development of new sources. At the same time, 'Free electron lasers' (FELs) offer a radical alternative to conventional lasers being potentially the most efficient, high powered and flexible generators of tuneable coherent radiation from the ultra-violet to the infrared. However, currently, FELs are prohibitively large and expensive.

The GOSFEL (Graphene on Silicon Free Electron Laser) project exploited the recently identified, special qualities of graphene. In doing so it achieved what project coordinator Prof. Geoffrey Nash has referred to as a long-held goal of physicists and engineers, namely, to create a compact, relatively inexpensive, solid-state version of such a laser.

From theory, to design and build

The GOSFEL project's first priority was to advance a theoretical understanding of the underlying physics and principles, before going on to design and construct a graphene-metamaterial

hybrid, functioning as a laser cavity and significantly boosting the light-graphene-interaction.

FELs typically work when electron beams emit radiation by travelling in a vacuum and passing through an undulatory magnetic field. The emission wavelength is established by the electron beam energy and the period of the magnetic field.

Rather than use a magnetic field, the GOSFEL team came up with a new structure, based on patterning of the graphene, to accelerate/decelerate electrons to make them emit radiation in the range of 0.2 to 10 THz. Devices incorporating this structure are currently being tested and the team is confident that they will demonstrate the principle of operation over the next few months. In addition, a new electromagnetic feedback cavity has been developed in parallel and will ultimately be integrated into the device.

One somewhat unexpected consequence of the hybrid device was that as Prof. Nash puts it, 'The graphene-metamaterial hybrid was developed to act as the cavity for the laser, but we found that it also acts as an exciting platform for studying the physics of light-matter interactions.'

Numerous applications

Prof. Nash points out that GOSFEL's demonstration of a graphene based FEL would challenge prevailing views about

laser operation (such as room temperature operability), as well as offering the prospect of progress on a number of research and development fronts. A new graphene based component industry (possibly offering cheaper devices than the current semiconductor based ones) is likely to be of great interest to sensor, analyser and instrument manufacturers.

When asked about some of the likely specific applications, Prof. Nash states that, 'We have already demonstrated beyond state-of-the-art THz modulators that could be used as part of future communications systems, and also cavity enhanced graphene based photodetectors.' He goes on to assert that, 'The tunability of the hybrid modes provides a route toward spectrometer-free sensing, which combined with the integrated detector, opens up the possibility of highly sensitive, low-cost, and miniaturised sensors for point-of-care medical applications for example.' He adds that the technology could also inaugurate new sensors for more effective monitoring of atmospheric pollutants, such as nitrogen dioxide, leading to better mitigation and control measures.

Looking to the future, the professor asserts that once the right funding is secured, the work will build on these proof-of-principle modulator and detector devices and will build prototypes of interest to component and sensor industries.

GOSFEL

- ★ Coordinated by the University of Exeter in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/104129>
- ★ Project website: <http://www.gosfel.eu/>

NOVEL GREEN TREATMENT FOR FUNCTIONAL SURFACES

EU researchers have introduced a new plasma technique for thermochemical treatment that improves the corrosion and wear resistance of surfaces. Medical implants, fuel cell plates, solar panels and tiny mechanical devices will be the recipients of some good fortune if the technology is exploited to create innovative products.

'Direct current' (DC) plasma techniques for thermochemical surface treatment are widely used to improve the surface hardness, corrosion resistance and fatigue life of steel components. These methods involve alloying steel surfaces with interstitial elements such as carbon or nitrogen. Despite the potential of these techniques, no plasma technology has so far been developed that can generate multifunctional surfaces by alloying with both interstitial and substitutional elements.

Within the MULTI-SURF (Towards novel multi-functional surfaces — Development of innovative plasma surface alloying technologies) project, researchers successfully leveraged a new triple-glow plasma technology by synergising the double-glow plasma and active-screen plasma technologies, to create functional stainless steel surfaces. The surfaces combined both interstitial elements (carbon and nitrogen) and substitutional elements (silver, platinum and niobium).

Using this new plasma technique, researchers successfully developed high-performance steel surfaces for two applications. These included antibacterial stainless surfaces for medical and

food processing devices, and surfaces with low interfacial contact and high corrosion resistance for fuel cell bipolar plates. The team filed a patent application for this newly invented technology, which was dubbed triple-glow plasma.

MULTI-SURF technology is expected to further improve the efficiency and cost effectiveness of plasma thermochemical surface treatment technologies, which are already widely recognised as environment-friendly processes.

"Using this new plasma technique, researchers successfully developed high-performance steel surfaces for two applications."

MULTI-SURF

★ Coordinated by the University of Birmingham in the United Kingdom.

★ Funded under FP7-PEOPLE.

★ <http://cordis.europa.eu/project/rcn/107434>

GRAPHENE'S COUSIN SILICENE TO REVOLUTIONISE NANO-ELECTRONICS

An exotic form of silicon, called silicene, could see a new generation of more powerful nanoelectronic devices enter the picture.

Silicene is a 2D allotrope of silicon, with a hexagonal honeycomb structure similar to that of graphene. Despite graphene's phenomenal properties, its growth over large areas and integration into current silicon-based nanotechnologies are facing significant challenges.

Experimental synthesis of silicene stimulated major theoretical investigations into its physical properties, notably its electronic ones. For instance, researchers demonstrated that silicene's band structure resembles that of graphene, featuring Dirac-type electron dispersion in the vicinity of the corners of the hexagonal Brillouin zone. In addition, it was found that silicene can sustain a stable quantum spin Hall effect.

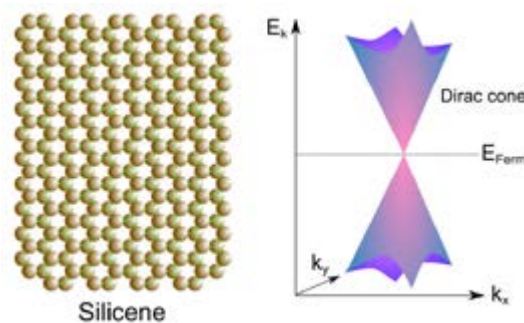
Free-standing silicene has been difficult to synthesise until now. Within the SILINANO (Silicene, a new material for nanoelectronics) project, scientists successfully experimented with growing silicene on silver substrates. However, strong interaction between silicene and metals, in this case silver, can be detrimental to silicene's electronic properties.

To this end, the team's efforts were aimed at adsorbing organic molecules (metallo-porphyrins) on its surface.

Using an experimental technique called 'Angle-resolved photoemission spectroscopy' (ARPES), scientists thoroughly studied how the organic molecule properties can affect the electronic structure of the silver-silicene surface.

Importantly, researchers successfully upgraded the experimental setup and developed a standard protocol for conducting temperature-dependent photoemission experiments. This enabled identification of the most suitable growth conditions for silicene and furthered their understanding of its surface chemistry.

The team also experimented with functionalising graphene on an iridium substrate by intercalation of cobalt and forming other covalent 2D-sheet networks using temperature-programmed X-ray photoelectron spectroscopy. Greater understanding of the formation of the 2D layer as a function of molecular and co-deposited catalyst



coverage should enable such layers to be developed on an industrial scale.

Combining the properties of silicon and graphene, silicene represents a step forward in the goal of miniaturising nanoelectronics even more. Unlike its graphene counterpart, silicene has a small bandgap, which makes it suitable for use in nanoelectronics applications, especially for transistors.

SILINANO

★ Coordinated by TUM in Germany.

★ Funded under FP7-PEOPLE.

★ <http://cordis.europa.eu/project/rcn/188008>

FOOD AND AGRICULTURE

EU RESEARCHERS SHOWCASE THEIR INTEGRATED AND FLEXIBLE SMART IRRIGATION SYSTEM

The EU-funded FIGARO project has now completed the development of a precision agriculture Decision Support System, allowing growers to benefit from innovative developments in irrigation technology.

The system aims to substantially improve irrigation management for high water-consuming crops, including potatoes, citrus fruit and maize. It achieves this by increasing water productivity and optimising the use of irrigation water and energy consumption. The new FIGARO (Flexible and Precise Irrigation Platform to Improve Farm Scale Water Productivity) platform was formally unveiled at a project partners' meeting that took place in Kavalla, Greece, from 1 to 2 June 2016.

The platform collects climate, soil and crop data captured by soil water sensors, satellite data and meteorological stations which is then fed into weather forecasting, and hydraulic and crop models, using real-time and forecasted data. This then allows for accurate recommendations on how much and when farmers should irrigate individual fields, with most data input being automatic, minimising the time that farmers have to spend on setting up the system. In contrast, many existing decision support systems currently on the market require farmers to input large amounts of data, which is both time consuming and technically demanding.

Once a farmer has set up the system, the platform sends them a customised seven-day scheduling plan for irrigation and fertigation (the process of applying fertilisers through the irrigation system). This is updated daily, and to increase accuracy, farmers are able to add commercial wireless sensors to their fields to include soil and plant data in the system's overall calculations.

Additionally, to encourage and persuade farmers to use the FIGARO platform, the system has also been designed to be both modular and flexible, so that new technologies and agronomic models can be easily integrated, and growers are able to customise the system to meet their own individual needs. From a practical viewpoint, the system is easily accessible through a computer or tablet, and the project partners are even considering the development of an iPhone

and/or Android application that could allow the system to be accessed on a mobile phone.

As well as providing a cost-effective and accurate system to farmers to support their irrigation efforts (with the project partners estimating that the system can save 20-60% of users' irrigation water for the same yield of crop, with a starting investment of EUR 5-20 per hectare), the FIGARO platform could also help farmers contribute to the EU's broader policy ambitions, such as its ambitious water productivity targets.

'After more than three years of hard work, the FIGARO platform is finally applicable for growers in everyday practice,' commented project coordinator Lior Doron. 'By using FIGARO, farmers and the wider community can now benefit from cutting-edge developments in irrigation technology, optimise the use of irrigation water and energy consumption, and increase water productivity.'

Following the introduction of the FIGARO platform, the project partners intend to begin a series of live demonstrations of the benefits and capabilities of the system, conducting field days at six FIGARO sites, which include Denmark, Greece, Israel, Italy, Portugal and Spain.

The FIGARO project began in October 2012 and is due to finish in September 2016. The project received nearly EUR 6 million of EU funding.

FIGARO

- ★ Coordinated by Netafim in Israel.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/project/rcn/105374>
- ★ Project website:
<http://www.figaro-irrigation.net/>
- ★  <http://bit.ly/2bJsLgN>

NOVEL TECHNIQUES TO ENSURE SAFE, SPICY AND DELICIOUS FOOD

EU researchers have developed tools and guidelines to help protect Europe's spice and herb commodity chains from deliberate, accidental and natural biological and chemical contamination.

From aniseed, basil and cinnamon to curry, paprika and pepper, spices play a big part in some of Europe's favourite dishes. But because these spices are usually added to our meals without any direct heating, they are particularly vulnerable to contamination. Furthermore, the entire production and supply chain — from planting to harvesting, production to packaging and shipping to selling — is ripe for contamination by microbiological and chemical agents. Add in the fact that most spices are imported from outside of Europe and what you could have is a recipe for risk.

The EU-funded SPICED (Securing the spices and herbs commodity chains in Europe against deliberate, accidental or natural biological and chemical contamination) project aims to mitigate these vulnerabilities by implementing best practices specifically geared to ensuring the safety of our spices and herbs. This is a novel approach to food safety, as traditionally experts have focused on major food ingredients, thus failing to properly identify contaminated spices and herbs as the cause of many food-borne infections and intoxications.

New tools, processes and techniques

To accomplish this, project researchers focused on the spices most susceptible to contamination, such as pepper, paprika, nutmeg, vanilla, parsley, oregano and basil. First, they developed tailored tools for both detecting and preventing deliberate, accidental and natural contaminations, such as salmonella and e-coli. This included characterising the heterogeneous matrices of spices and herbs, implementing on-site and high-throughput diagnostic methods for detecting contamination, studying their intra- and inter-plant production and supply chains within the context of biological and chemical hazards, and improving the overall knowledge-base of relevant biological hazards.

Based on this initial work, the project team created innovative processes for reducing chemical alterations and ensuring the authenticity of spices and herbs. For example, the project demonstrated how sampling strategies that use non-targeted fingerprinting methods provide better hazard detection. Likewise, an exemplary spice and herb production and processing chain was developed, thus closing the door to key vulnerabilities. For spices like paprika and pepper, whose production and trade has been stagnant for decades, the project evaluated the entire value chain and made recommendations for updated best practices.

Another innovative strategy coming out of the project is techniques for de-spiking dry spices and herbs that are contaminated with microorganisms. To better protect against chemical hazards and reduce the threat of food terrorism, the project issued standard operating procedures for a more robust verification of the authenticity of spices and herbs. The procedures aim to facilitate the exchange of analytical methods amongst and between laboratories, producers and consumers.

Guidelines for ongoing safety

To further ensure that the project's work is utilised across the EU and becomes standard practice, SPICED has produced various guidelines to help differentiate between natural and intentional incidents. Additionally, data on currently available decontamination methods for spices and herbs, along with production facilities, have been collected.

Even though the project ended in June 2016, the work undertaken by the SPICED consortium will continue through the tight network built up by the project during its three-year lifetime.

SPICED

- ★ Coordinated by the Federal Institute for Risk Assessment in Germany.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/project/rcn/108959>
- ★ Project website: <http://www.spiced.eu/>



TWO FISH PATHOGENS IDENTIFIED AND SEQUENCED

EU researchers have sequenced the genomes of two bacteria that cause disease among farmed fishes and losses to the aquaculture industry.

Aquaculture is a growing industry and a crucial part of the effort to meet the food needs of an increasing global population. Pathogens that infect farmed fish can have a big impact on the success of such operations.

By identifying and studying the different types of pathogens that attack farmed fish, scientists help the industry to manage and address this threat. The EU-funded CHLAFISH (Novel fish pathogens of the Chlamydiae: Genomic, proteomic and metabolomic investigations) project used genomics to identify bacteria in the phylum *Chlamydiae* that affect high-value farmed fish species in the Mediterranean.

The scientists identified three species of bacteria that cause white cysts on the gills (epitheliocystis) of two valuable aquaculture species: gilthead and sharpnose seabream. Before this research, two of these bacterial species were not known to science.

One of the most valuable outputs of the project was the draft genome sequences of the two novel bacteria (*Ca. ichthyocystis* and *Ca. Endozoicomonas cretensis*). This is the first time that scientists have identified causative agents of epitheliocystis.



The results of this project have contributed to our understanding of the diversity of pathogens that affect farmed fish. In the future, this will help in treating and controlling these pathogens in commercial aquaculture facilities.

CHLAFISH

- ★ Coordinated by the University of Zurich in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/108324>

GENETIC MARKERS IN FOOD AND FEED

An EU team has developed a method for determining the presence and abundance of genetically modified ingredients in food and feed products. The method involved designing new genome-reading genosensors that detect transgenic markers.



Europeans are concerned about the impact of 'Genetically modified organisms' (GMOs), and therefore restrict development and use. Nevertheless, production abroad is increasing, meaning that Europe faces large quantities of imported food and feed products that potentially skirt European laws.

Europe thus requires a method for detecting GMOs in food/feed products and for

measuring the GMO components, so as to verify legislative compliance. The EU-funded GMOSENSOR (Monitoring genetically modified organisms in food and feed by innovative biosensor approaches) project has provided such a method.

Work yielded an easy, rapid and cheap solution involving genosensors, which read a target genome. The project designed the sensors using an exchange of knowledge research mode.

The group evaluated two assay formats: direct and sandwich. The detection of transgenic markers involved electrochemical principles and surface plasmon resonance spectroscopy. Achieving the required level of accuracy required amplification strategies involving enzymes and gold nanoparticles.

Researchers validated the results via comparison with conventional DNA-based techniques.

The GMOSENSOR project's assessment method helps Europe to enforce its laws, while the technology can also help determine the extent of the imported GMO problem.

GMOSENSOR

- ★ Coordinated by ISEP in Portugal.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/109520>

$$E = mc^2$$

PHYSICS AND MATHEMATICS

IN QUEST OF A UNIFIED THEORY

Einstein sought a unified theory that would extend general relativity and provide an alternative to quantum theory. Scientists from around the world are still working towards their unification in a complete theory that gives a full account of all four fundamental forces of nature.

Despite more than half a century of strenuous efforts, integrating the force of gravity with the other three fundamental forces has not yet been achieved. The most promising approach has been that of string theory, in which all subatomic particles are represented as different states of mathematical 'strings' vibrating in an abstract space.

String theory has given insights into early universe cosmology and models beyond the standard model of particle physics. It has also provided powerful tools for scientists in the UNIFY (Unification of fundamental forces and applications) project to use to study open problems in theoretical physics and interpret data from the Large Hadron Collider and gravitational waves detection experiments.

The aim of the EU-funded project was to enhance knowledge exchange and establish collaboration among internationally recognised experts in Canada, Europe, Japan and the United States. Over its four-year lifetime, the UNIFY network also served as a training platform for young scientists commencing studies on the fundamental workings of nature.

Three different lines of research were pursued. Although string theory provides an attractive route to quantum gravity, alternatives were explored towards conformal field theories. Researchers sought to create new links between quantum theory and gravity through the gauge/gravity duality.

Numerical approaches were also adopted to describe cosmological singularities and the nature of dark matter.

UNIFY has notably been successful in reviving the bootstrap theory, which was eclipsed by the success of the standard model. This theory is based on the idea that nature cannot be reduced to fundamental fields and the corresponding particles. On the contrary, it proposes the concept of particles as interconnections in an inseparable cosmic web, which arises in quantum theory and acquires its dynamic nature in relativity theory.

All in all, the UNIFY network's efforts have contributed significantly to enhancing our understanding of the physics of strong interaction as well as the physics behind unifying theories that include strong gravitational fields. However, the complete unification of all of physics will not be possible until the fundamental problems of quantum theory are resolved.

UNIFY

- ★ Coordinated by the University of Porto in Portugal.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/99291>

QUANTUM SYSTEMS OUT OF EQUILIBRIUM

Development of experimental techniques that prevent energy dissipation in quantum many-body systems has triggered the interest of EU-funded scientists working on non-equilibrium dynamics.



All matter changes its state upon heating or cooling. Although we might expect no room for much change at absolute zero temperature where there are no thermal fluctuations, in nature, quantum fluctuations survive. By applying pressure or a magnetic field, this form of agitation, which is feeble at room temperature, can be amplified, giving rise to a state change.

Scientists believe that at this quantum critical point lie the keys to many mysterious properties of matter. Within the project QUANTUM QUENCH (Universality in the non-equilibrium dynamics of strongly correlated quantum systems),

they sought to develop a theoretical framework that captures what happens across a quantum critical point out of equilibrium.

The focus was put on a system isolated from its environment that may arise in cold atom quantum experiments after it has been disturbed out of equilibrium. The way scientists chose to take it out of equilibrium was by using a so-called quantum quench. In specific terms, a parameter of the system was changed abruptly, and the system was allowed to evolve independently.

The QUANTUM QUENCH team analysed entanglement properties after the quantum quench and showed how they resemble thermodynamic entropies of the generalised ensemble describing the steady state. Conventional thermodynamics ensembles fail to describe quantum many-body systems that exhibit non-trivial conserved quantities. Generalised ensembles have been predicted to maximise their entropy.

However, contradicting the belief widely held by scientists, the generalised ensemble predictions failed to capture the steady state after the quantum quench. An alternative theoretical description was therefore developed to agree with the time

evolution of the system, as this is computed numerically.

This line of research ultimately led to a new, non-perturbative numerical method for studying the out-of-equilibrium evolution of strongly interacting systems. The method has been benchmarked against exact analytic results available in the literature on quantum quenches.

QUANTUM QUENCH work has opened up a new avenue towards a better understanding of closed quantum many-body systems with implications for precision measurements and quantum computing.

QUANTUM QUENCH

- ★ Coordinated by the Budapest University of Technology and Economics in Hungary.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/107267>

“The focus was put on a system isolated from its environment that may arise in cold atom quantum experiments after it has been disturbed out of equilibrium.”

SINGLE-MOLECULE ELECTRONIC DEVICES COME A STEP CLOSER

The ever-increasing miniaturisation of electronic devices has spurred researchers to study conductors at the nano scale and find the thinnest wire imaginable: single molecules. EU scientists have demonstrated efficient current conduction in a molecular switch controlled by light and chemical stimuli.

Molecular wires are the proposed building blocks for molecular electronic devices, connecting different parts of a molecular electrical circuit. Attaching the ends of the molecules to the electrodes, so that the electrons can move freely in and out of the wire, is one of the biggest problems that researchers encounter in their bid to create reliable and reproducible electrical contacts.

Anchoring molecules to the electrodes is one way to obtain good electrical contact. Proper choice of chemical groups making the connection governs the stability and electrical properties of single-molecule devices. Within the SINGLE-MOLEC-SWITCH (Developing single-molecule switches for applications in nanoscale organic devices) project, scientists reported the formation of stable molecular junctions with contact groups that were used for the first time (1-alkynes).

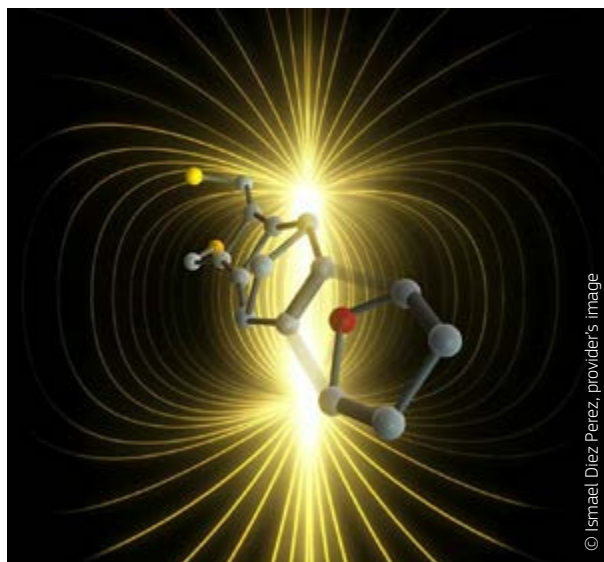
Results demonstrated that alkyne groups are stable and have high affinity to gold, opening the door for further studies of single-molecule transport on semiconducting electronic platforms. The use of different types of semiconducting electrodes and doping meant that charge transport across the junctions could be controlled.

Scientists introduced a new concept for building highly-efficient single-molecule electrical contacts by exploiting coordination complexes. Instead of using costly and time-consuming methods to modify porphyrin molecules, the team functionalised two electrodes with pyridine ligands that bonded to the porphyrin metal centre. The result was a new flat configuration of porphyrin molecules forming single-molecule junctions with very long lifetimes and high conductivity.

Controlled manipulation of single molecules is very necessary when designing nanoscale circuits. Scientists successfully synthesised a unique type of photoswitch based on spiropyran, which is known for its photochromic properties. This molecular switch could be reversibly shifted between its conjugated form and the ground state upon light irradiation. In addition, it is the first single-molecule switch that shifts between two states triggered not just by light but also by a combination of other external influences.

Furthermore, a scientist was able to speed up the reaction of individual molecular wires using electrical fields (2016 Nature, 531, 88-91). This is the first piece of experimental evidence of electrical fields catalysing non-redox reactions at the single-molecule level.

Controllable molecules forming reliable electrical contacts will someday soon be the next electronic building blocks, replacing current micro-sized circuit elements. Tiny molecular circuits will reduce the cost and size of electronic devices, leading to revolutionary technology that will highly benefit the environment and healthcare. Analytical devices for the early detection of harmful chemicals and biological markers indicating disease onset are just some of the many exciting applications for molecular electronics.



© Ismael Díez Pérez, provider's image

SINGLE-MOLEC-SWITCH

- ★ Coordinated by the University of Barcelona in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/107097>

LIGHT CONTROL AT THE MICRO SCALE

The possibility of overcoming the limits of focusing and collimating laser beams and achieving sub-wavelength resolution has been the focus for imaging applications. It has led scientists to develop digital light switches and engineer materials' electromagnetic properties for this very purpose.

High-speed laser scanning has found applications in monitoring moving objects, capturing transient information of dynamic processes and observing biomolecules' motility. Scanning a wide area in a short period of time is also essential in atmospheric studies, geological surveys and other similar activities.

Various techniques enabling higher scan rates have been proposed. For example, galvanometric mirrors have been used for beam steering. The scanning speed of such mechanically scanning mirrors is limited to ~ 100 Hz in 2D. However, all-optical techniques

based on acousto-optic deflectors have achieved micrometre resolution.

In the EU-funded project REALTIMEIMAGING (Real time imaging with near field focusing plates), researchers turned to 'Digital micro-mirror devices' (DMDs). This technology is particularly suited for real-time imaging because it provides exceptional controllability over thousands of 'microelectromechanical system' (MEMS) micro-mirrors.

By spatially switching the light through micro-mirror arrays, researchers were able to utilise DMDs as digital reflective light modulators. Such devices provided 2D scanning speeds up to 32.5 kHz for a wide range of wavelengths and twice as high diffraction efficiency compared to commonly used liquid crystal display technology.

DMDs have also been used in dispersive imaging systems, but their relatively low power efficiency often poses limitations on performance. The REALTIMEIMAGING team sought an alternative for sub-

wavelength phase manipulation for micro-scale light control in 'Gap-plasmon metasurfaces' (GPMs).

Researchers fabricated a GPM-based grating operating at 1550 nm to replace existing gratings in dispersive imaging systems. The power efficiency of this array of unit cells was measured at as high as 75.6%, and the resolution achieved when incorporated into the dispersive imaging system as low as 300 µm.

Sub-wavelength manipulation of the wavefront phase at the infrared wavelength opens the door to a wide range of telecommunication applications. This is notably the case since the proposed device is planar and can therefore be easily integrated with other components — a key property in future miniaturisation of complex systems.

MEMS micro-mirror arrays for beam steering by individually tuning the mirror angles have in fact already been used to achieve an imaging area of 5 mm x 5 mm in a 50 ns timeframe. The details are described in a paper published in the Journal of Micro- and Nano-manufacturing.



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REALTIMEIMAGING

- ★ Coordinated by Istanbul Şehir University in Turkey.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/97221>

EVENTS

DECEMBER
01 ▶ 02

Rotterdam, THE NETHERLANDS

CONFERENCE

EBSF_2, ZEEUS AND ELIPTIC PROJECTS AT 2016 ANNUAL POLIS CONFERENCE

The EU-funded EBSF_2, ZeEUS and ELIPTIC projects will be presented at the 2016 Annual Polis conference that will take place in Rotterdam, the Netherlands, from 1 to 2 December 2016.

The three projects will all be presented during a speech entitled 'Solutions for cleaner, innovative and attractive bus fleets: EBSF_2, ZeEUS and ELIPTIC', which will be part of the wider session 'Transport in the 21st Century' that will take place on the second day of the conference.

Polis is a network of European cities and regions working together to develop innovative technologies and policies for local transport. The Polis Annual conferences provide an opportunity for cities and regions to showcase their transport achievements to a large audience and for the wider transport community to engage with representatives of city and regional authorities on innovative transport solutions.

For further information, please visit:
<http://www.polisnetwork.eu/2016conference>

DEC.
06

Brussels, BELGIUM

CONFERENCE

C-IPM FINAL CONFERENCE

The EU-funded C-IPM project will host its final conference in Brussels, Belgium, on 6 December 2016.

The objectives of the final conference are to discuss the main outcomes, including an overview of accomplishments, the presentation of the C-IPM strategic research agenda, main outcomes of mapping and knowledge-sharing activities (research areas, minor uses, and infrastructures), outcomes of C-IPM calls, added value of networking, and the future of C-IPM.

The conference audience will include C-IPM members and stakeholders, representatives from the European Commission, SUD experts, SCAR steering committee members and other relevant stakeholders.

For further information, please visit:
<http://c-ipm.org/news/nyhed/artikel/an-end-and-several-beginnings/>

DECEMBER
07 ▶ 09

Paris, FRANCE

CONFERENCE

CARTOON PROJECT AT NANOP 2016

The EU-funded CARTOON project will be represented at the NANOP 2016 conference that will take place in Paris, France, from 7 to 9 December 2016.

Professor Laurent Vivien, the coordinator of the FP7-funded CARTOON (CARbon nano-Tube phOTonic devices on silicon) project will be giving a plenary speech on Day Three of the conference (9 December), entitled 'Recent advances in silicon photonics.'

The Nanophotonics and Micro/Nano Optics International (NANOP) Conference is an annual event that hosts high-profile plenary speakers, world class researchers, oral and poster presentations, workshops, sponsor exhibits and afterworks. The overall theme of the conference will be 'Optics at the frontiers.'

The primary goal of the CARTOON project is the development of a novel strategy for hybridising silicon based photonic devices, exploiting 'Semiconducting single-walled carbon nanotubes' (s-SWNT) as integrated light source, modulator and detector.

For further information, please visit:
<http://premc.org/nanop2016/>

DEC.
07 ▶ 09

Cork, IRELAND

CONFERENCE

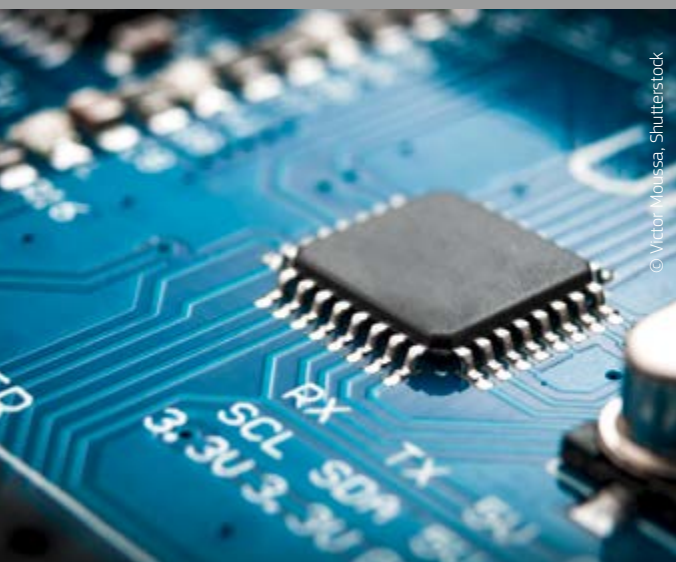
THE EU-FUNDED DEEPEN PROJECT WILL HOLD A WORKSHOP AND CONFERENCE IN CORK, IRELAND, FROM 7 TO 9 DECEMBER 2016.

This workshop will run for three days, with the objective of bringing together leading experts in the field of theory of group IV, III-V and wider semiconductors together with post doctorates and students who will benefit from an introduction to a very vast field at this influential point in their careers.

A training day for PhD students and early career researchers will be held on day 1, followed by 2 days of contributed, poster and invited presentations.

Topics will include but not be limited to: density functional theory calculations; tight Binding, pseudopotential and effective mass models for electronic structure; multi-scale approaches; dilute magnetic semiconductors; 2-D systems; Photonic Structures; and Plasmonics.

For further information, please visit:
<http://www.nmp-deepen.eu/euro-tmcs-ii>



DEC.
12

Basel, SWITZERLAND

CONFERENCE

**SSL WORKSHOP AND
LASSIE-FP7 PROJECT
DESIGN COMPETITION
FINAL**

The EU-funded LASSIE-FP7 project will announce the winner of its design competition in Basel, Switzerland, on 12 December 2016 during the annual SSL workshop.

The LASSIE-FP7 design competition aimed to explore alternative and innovative ideas for applications and products, as well as new design concepts, for either professional or architectural luminaires that integrate the LASSIE project's innovative modules: LED foils with light management foils and colour-changing films providing a colour tuning of the light.

The workshop itself will present the final results of LASSIE-FP7 and will also feature a session devoted to technical developments and industrial applications in the field of smart lighting.

For further information, please visit:
<http://www.swissphotonics.net/workshops/workshop-datenbank?2972geconfig=resource&rid=15213>

DEC.
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Amman, JORDAN

CONFERENCE

**MED-SPRING
MEDHACKATHON
WORKSHOP**

The EU-funded MED-SPRING project will be holding a MedHackathon workshop in Amman, Jordan, from 14 to 15 December 2016.

The workshop will be a regional co-working event to develop solutions to specific problems and challenges identified by the private sector. The main thematic focus will be on water, food and energy.

The MedHackathon will feature a marathon of young innovators selected through an on-line call to be published in September 2016. The best co-working team will win the possibility to develop the solution proposed and will be supported by the MED-SPRING project consortium to do so.

The MED-SPRING project aims to contribute to the quality of the Euro-Mediterranean research area, with a particular focus on the bi-regional Euro-Mediterranean S&T cooperation, research and innovation, policy dialogue and cooperation monitoring.

For further information, please visit:
<http://medspring.eu/event/euro-med-hackaton>

DEC.
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Brussels, BELGIUM

CONFERENCE

**EUPATI FINAL
CONFERENCE**

The EU-funded EUPATI project will be hosting its final conference in Brussels, Belgium, on 14 December 2016.

Entitled 'All Aboard for a Better Health Future', the conference will set the foundation for fruitful collaboration between all stakeholders with a role in the medicines development process. The focus of the conference will be on what is exactly meant when referring to a 'Better Health Future', and all relevant stakeholders, from policymakers to patients' organisations, academia, regulators, industry and journalists are invited to attend and contribute.

The conference programme will also highlight some of the key results from the project, including the successful training of over 100 Patient Expert Fellows.

For further information, please visit:
<http://www.eupati-events.eu/>

EVENTS

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



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Brussels, Belgium

CONFERENCE

SMART@FIRE FINAL CONFERENCE

The EU-funded SMART@FIRE project will host its final conference in Brussels, Belgium, from 14 to 15 December 2016.

Every year, more than 100 firefighters lose their lives whilst saving others. To reduce the risks associated with firefighting, innovative ICT solutions need to be developed and integrated in a smart Personal Protective System.

However, the ICT solutions that are currently available on the market are not fully satisfactory. The SMART@FIRE project has investigated the possibility of developing these technologies using a method of innovative procurement known as 'pre-commercial procurement' (PCP).

This conference will highlight the key results and findings of the project, with panel debates, lessons learnt and interactive discussion amongst all relevant stakeholders.

For further information, please visit:
<http://www.centexbel.be/files/event-invitation/finalconferenceSmart@fire2016.pdf>



NOW ON CORDIS

Independent living in an ageing society through innovative ICT solutions

Europe is facing a major societal challenge due to a rapidly increasing ageing population. Real solutions are needed to ensure that older citizens are able to live healthy, fulfilling and independent lives whilst keeping health and care systems sustainable. The European Commission, through its Horizon 2020 and FP7 programmes, the **Active and Assisted Living Joint Programme** and the **European Innovation Partnership for Active and Healthy Ageing**, is supporting researchers and innovators as they develop and bring such solutions to market.

On 13 September 2016, **CORDIS** published a new Results Pack that explores eight EU-funded projects that will not only care for and support Europe's citizens during their 'golden years' but will also contribute to the growth of a real 'Silver Economy', one which will provide an abundance of exciting economic opportunities.

Please see the following link for more information:

http://cordis.europa.eu/article/id/400060-independent-living-in-an-ageing-society-through-ict_en.html

ABOUT CORDIS RESULTS PACKS

CORDIS Results Packs are a new set of products grouping EU-funded project results per topic and target audience. The point is to disseminate information about new studies, scientific findings and technologies to the relevant target audience, in order to facilitate their exploitation across Europe.

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