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SPECIAL FEATURE

ROAD SAFETY: TOWARDS ZERO FATALITIES?

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cordis@publications.europa.eu

Editorial coordination

Melinda KURZNE OPOCZKY

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EDITORIAL

by the editorial team

ROAD SAFETY: HOW R&D CAN CLOSE THE TRIANGLE

From 4 to 10 May, the world will be celebrating the UN's Global Road Safety Week under the theme 'Children and road safety', which follows a 10-year series of resolutions aimed at making roads safer. Some 3 400 people still die on the road every day, which makes it the 9th leading cause of death behind the likes of heart disease, stroke, lung cancer and AIDS.

Whilst the EU presents the lowest rate of road traffic injury in the world, things are not looking so good here either. In late March, the European Commission announced its disappointment with the European road statistics for 2014 — only 1 % lower than in 2013. 70 Europeans still die on the road every day, and many more are seriously injured. According to Violeta Bulc, EU Commissioner for Transport, these figures should be 'a wake-up call', and if governments and industry choose to push the snooze button, the EU could fail to reach its objective of halving road deaths by 2020.

These statistics also beg a major question: How do we ensure that we can speed up this slow rate of improvement? The EU needs to decrease the number of road fatalities by 8 % each year, and the Commission says vehicle aspects, road user behaviours and infrastructure design must be addressed to reach this objective. These are also referred to as 'the safety triangle'.

**'70 Europeans still die
on the road every day,
and many more are
seriously injured.'**

Research and development is one of the key EU instruments in this regard. From FP4 to FP6, some EUR 150 million were invested in vehicle and infrastructure safety, raising user awareness and accidentology. FP7 pursued

these efforts with a long-term strategy, and some of the last and most promising projects are now coming to an end.

This month's 'special' section covers a handful of these projects and comprises five articles and four interviews. The topics addressed include self-driving vehicles, which are hoped to revolutionise the way we conceive transportation, as well as innovative safety equipment, driver behaviour monitoring techniques and technologies able to track and recognise vulnerable road users.

This section is followed by our usual insights into biology and medicine, social sciences and humanities, energy and transport, the environment, IT and telecommunications, industrial technologies and food and agriculture, along with a list of upcoming scientific events.

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



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Seas and oceans
– Studying
Earth's final
frontier

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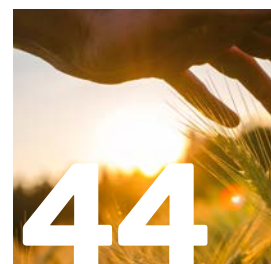
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SPECIAL FEATURE

ROAD SAFETY: TOWARDS ZERO FATALITIES?

INTERVIEW

FROM SMART TO MINDFUL
CARS: TAKING UP THE
SELF-DRIVING CHALLENGE

With about 90% of car accidents being due to human errors, a world of driverless cars sounds like the Holy Grail of road safety. But to become more efficient than humans, cars need to understand each other and make quick and sound decisions based on the information gathered. The I-GAME project is aiming to put such interoperability at the forefront of European research efforts.

If there is one thing in the world that reminds us of how time flies, it's the look of children when we mention things like typing machines, faxes or a world without the internet. Soon enough, we may have to add yet another concept to this list: that of cars relying on a driver.

The idea may still sound like science fiction, but cars that drive themselves are actually just around the corner. Technologies such as intelligent parking assist systems, dynamic cruise control or lane departure warning systems are becoming standard in new cars. Major high-tech companies are experimenting with automated driving in real-life conditions, and some car manufacturers are already rolling out software updates that see their cars drive themselves on highways or pick you up at the entrance of your favourite shopping centre.

What's still missing, however, is a guarantee that a world full of automated cars is realistic from the perspective of safety and traffic fluidity. The cars of

the future will need to be able to 'talk' and to understand each other in order to avoid crashes and optimise decisions — all this in situations that can sometimes see hundreds of cars manoeuvre at the same location.

The objective of the EU-funded I-GAME (Interoperable GCDC AutoMation Experience) team is to enable this interoperability by developing generic, resilient and fault-tolerant technologies and testing them in its 'Grand cooperative driving challenge' (GCDC) which is due to end in June 2016. This challenge will see teams compete against each other in designing and implementing the most effective cooperative vehicle system possible.

The *research*eu results magazine* had the chance to discuss the project status and the potential of self-driving cars with Bastiaan Krosse, Jeroen Ploeg and Almie van Asten, respectively programme manager automated driving, senior scientist cooperative driving and project coordinator of I-GAME.

★ **What are, according to you, the main benefits of automated driving?**

Bastiaan Krosse: The main benefits with automated driving are more comfort, more safety, more efficiency and more accessibility to a larger community, for example the elderly.

The benefits in terms of safety have already been observed with commercially available technologies such as adaptive cruise control and lane assist. Then, when it comes to efficiency, automated driving translates into more efficient use of fuel or batteries, roads and even parking spaces.

★ **Safety indeed seems to improve with each automation technology. Do you think automation as imagined by I-GAME bring us closer to zero fatalities on European roads?**

BK: I-GAME is about cooperative automation, which means interaction and cooperation between vehicles. Implementing such cooperation

— which implies that each vehicle will 'know' the intentions of others on the road — will definitely enhance safety. European statistics show that about 90% of traffic accidents are caused by human errors. The combination of both V2X and automation will potentially have a positive impact on safety.

★ **What are the main barriers to a wide-scale adoption of automated driving and how do you plan to overcome these?**

BK: Before cooperative automation can be considered for deployment on European roads, we first need to achieve interoperability between OEMs in terms of communications means and channels. The interactions and message sets must be aligned at European scale.

Another significant hurdle is the robustness of the vehicle systems under all operational conditions. I-GAME challenges vehicles in complex scenarios with high requirements for the performance and robustness of the system as a whole. But a widely-accepted testing and validation process for automated vehicles, and eventually their certification, is yet to be set up. One of the objectives of the project is to develop a safety assessment procedure for the vehicles that enter the I-GAME challenge. This procedure can be a first step towards a validation process of cooperative automated vehicles in real-world situations.

★ **Where do you stand with the development of the I-GAME architecture?**

Jeroen Ploeg: The I-GAME architecture is characterised by the four main components. First, we have the overall system architecture which was set up in June 2014 and provides the main framework for further

developments in the project. Then, there is the interaction protocol consisting of a wireless message sequence and in-vehicle controllers to execute our two scenarios. The protocol for the first scenario (cooperative and automated merging) had to be redeveloped because of its lack of accuracy in practice, so we came up with an improved version which will be tested over the coming months. The interaction protocol for the second scenario (cooperative intersection), on the other hand, has been thoroughly designed on a simulation level and will be implemented on benchmark vehicles in the coming months.

The third component of the I-GAME architecture is the in-vehicle software architecture. It has now been fully determined, although adaptations may still be required as a consequence of scenario 2 interaction protocol implementation.

Final piece of the puzzle, the communication architecture is based on the current ETSI C-ITS standards on Cooperative Intelligent Transport Systems. We want to use the currently available commercial Vehicle-to-Vehicle communication equipment to support multi-vendor solutions. In order to do this, we utilise currently available message sets as much as possible. But because current message sets are specified mostly for road and vehicle condition awareness, and not for automated driving interactions, we have been designing extensions or new messages to support the complex interactions needed in GCDC scenarios.

★ **Interoperability is necessary, but it can also be dangerous under the threat of hackers. What are your plans in this regard?**

JP: Although it is acknowledged that interoperability poses a threat to security, the latter topic is not included

in I-GAME for reasons of focus. However, ongoing developments in this field are closely monitored. A follow-up project is currently being set up, focusing on truck platooning with a significant involvement of several truck OEMs, which explicitly addresses security among other things by investigating the impact of security measures on automation performance due to, for instance, increased latency.

★ **Big companies like Google or potentially Apple are working on their own automated driving solutions. Is this compatible with the open approach of I-GAME?**

Almie van Asten: External companies are supplying the highly automated vehicles used within the I-GAME project, and the communication part will also be multi-vendor.

Enabling communication between multi-vendor vehicles and having them working together requires compatibility of interaction protocols and message sets, but not of specific hardware. Therefore any party who wants to use their automated vehicle supported by V2X and is willing to use the protocols and message sets (on a software level) provided by the project is welcome to join. Actually we challenge companies like Google and Apple to compete and cooperate in the 2016 GCDC.

★ **Speaking of the upcoming GCDC, why did you choose to involve external stakeholders in the form of a driving challenge? Are you happy with stakeholders' responses so far?**

AvA: To get wide acceptance of the developed interaction protocols and message set, we want maximum input and multi-vendor implementations in different hardware configurations. This challenge will accelerate the developments of the protocols by evaluating them in real-life conditions. As such, it is a first step towards the standardisation and implementation of these protocols and message sets for cooperative automated driving.

I-GAME

- ★ Coordinated by TNO in the Netherlands.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/project/rcn/110506_en.html
- ★ Project website: <http://www.gcdc.net/i-game>



JEROEN PLOEG – ALMIE VAN ASTEN – BASTIAAN KROSSE

SMART SEAT AND SEATBELT TO HELP SLEEPY DRIVERS STAY ALERT

EU-funded researchers have developed a driver's seat and seatbelt from smart textiles that measure heart and breathing rates. Detecting if drivers are showing signs of fatigue behind the wheel and somehow alerting them to the fact, the system could prevent thousands of fatalities every year.

Drowsy drivers die. Break the drive and stay alive. Drive alert, arrive alive. Road signs in Australia and the USA offer this sobering wake-up call to motorists who don't heed the potentially fatal warning signs of tiredness while driving.

Indeed, driver fatigue accounts for some 8.3% of all vehicle crashes and up to 35% of serious accidents in the EU each year, according to the eSafety Forum. That translates into more than 7 000 fatalities annually attributable to fatigue-related collisions. Alongside the tragic human loss and the social cost, the economic burden of road accidents is estimated at between EUR 10 and 14 billion. The cost of a fatality may be as high as EUR 1 million.

'However you look at it, tiredness on the road is a costly killer,' asserts Paulo Gameiro, coordinator of the EU-funded HARKEN (Heart and respiration in-car embedded non-intrusive sensors) project and R&D manager for the automotive textiles supplier Borgstena, based in Portugal. The team has developed a prototype seat and seatbelt with smart textiles that use built-in sensors to detect a driver's heart and breathing rates, which offer tell-tale signs of driver drowsiness. The heart rate (more specifically its variability) is a strong indicator of concentration and wakefulness, while slow and deep breathing indicate a relaxed or resting state.

'What we have here is the world's first fully-functional, non-intrusive driver fatigue detector,' says Gameiro. 'There are no cameras pointing in your face, no need to wear any kind of gadget. And it is universal, so requires no

calibration for different drivers. You just strap in and off you drive, no thought or effort required.'

Breathe easy

The project consortium included several research institutions, 'Small to medium-sized enterprises' (SMEs) in the car textile and component sector, and a biosensor manufacturer. They collaborated to develop smart sensing materials — fibres and yarns with electrical properties — which could be incorporated into the cushions of car seats and at points along seatbelts in order to pick up and process signals of a driver entering a sleepy state.

The researchers also found innovative ways to 'clean up' the signals from the sensors (filtering out vibrations from the car). They studied body types, sizes and positioning in the vehicle, blood flow in the seating area as a facsimile of the heartbeat, and other parameters to design a comfortable and safe belt and seat setup with the sensors in the right location to reliably monitor the driver's signals of tiredness.

On the road

Not all measures to counter driver fatigue are technological and not all are directed at drivers per se. Low-tech counter-measures, such as painted corrugations to help drivers

"There is the possibility of selling over 100 000 units of the product in the first five years."



keep in their lane, already exist. Publicity campaigns like those in Australia and the USA also work by reminding drivers and their passengers to think about breaks. Legislation and enforcement measurements for truckers and bus drivers, for example, already prevent long and risky stints at the wheel through the log-book system.

Technology — in the form of in-vehicle systems that can eventually warn drivers when they are becoming fatigued — is a natural next step in the battle against drowsy driving. HARKEN has focused on the sensing material systems and how they can work in typical seatbelt and seat designs. Automakers are now in a position to integrate this ground-breaking R&D in downstream applications. For example, the sensors could trigger an alarm, a dashboard or 'heads-up' warning message, or even send a small pulse through the seat to jolt or remind the driver to take a break.

Since the project ended in May 2014, former partners have continued developing HARKEN's results with the aim of getting closer to market: 'We are nearly ready to hit the road. We've had tremendous interest from manufacturers in Scandinavia already. As soon as we have submitted our

European patent application we will be able to show everything off,' Gameiro explains.

Several of the project's SMEs have already incorporated HARKEN's research into product upgrades of their own. Gameiro is confident about the future for the technology: 'There is the possibility of selling over 100 000 units of the product in the first five years. This could be worth around EUR 14 million for the project SMEs and help to prevent thousands of fatalities and injuries every year. We certainly won't be falling asleep at the wheel as we steer this work towards commercial success.'

HARKEN

- ★ Coordinated by Borgstena Group in Portugal.
- ★ Funded under FP7-SME.
- ★ http://ec.europa.eu/research/infocentre/article_en.cfm?artid=33938
- ★ Project website: <http://harken.ibv.org/>
- ★ <http://bit.ly/1HPvSvE>

INTERVIEW

FIRST-HAND INSIGHT INTO DRIVERS' NATURAL BEHAVIOUR

Naturalistic Driving is a relatively new approach to driver behaviour monitoring, where information from a volunteer's everyday trips is recorded and gathered in an unobtrusive manner, devoid of experimental control. The UDRIVE project is gathering such data with a view to helping make European roads safer and more sustainable.

Whilst the number of road fatalities in Europe has already decreased by 22 % since 2010, the disappointing performance recorded in 2014 is a clear sign that innovative solutions to increase safety on our roads are desperately needed. So far, measures have been taken based on the likes of simulations, surveys, analyses of relevant statistics, prevention campaigns, speed cameras or reinforced police controls. But do we really know what's actually happening behind the wheel, and how to best prevent it?

For the UDRIVE (european naturalistic Driving and Riding for Infrastructure & Vehicle safety and Environment) team, the answer is no. Current insights into driver behaviour are often altered by the nature of collected data, which fails to reflect the natural driving behaviour of European citizens.

Since 2012, the 19-strong consortium — which includes universities, transport research institutes, the FIA and car manufacturer Volvo — has

been handling the first large-scale Naturalistic Driving experiment ever conducted in Europe. Volunteer car, truck and motorcycle drivers from seven countries have agreed to have their cars equipped with cameras and data transmitters. These devices will ultimately allow researchers to quantify the risk of safety-critical behaviours, monitor user behaviour in relation to emissions levels, fuel consumption and environmental factors, and identify new measures to make the European traffic system safer and more sustainable.

Dr Nicole van Nes, project leader safe automation of roads and vehicles at SWOV and coordinator of UDRIVE, details the project objectives, benefits and achievements so far.

★ **The project aims to contribute to reducing the number of road accidents in Europe. How?**

Dr Nicole van Nes: The UDRIVE project aims to gain insight into daily driving behaviours on European roads, in a real-life context. CAN data,



© Nicole van Nes

DR NICOLE VAN NES

kinematic data, images from five to eight camera views and information from a smart camera are continuously collected from cars, trucks and scooters, which provides us with a good overview of what is happening inside and outside these vehicles. Taking statistics into account, it is likely that a number of crashes and near-crash situations will be recorded, and this data provides us with concrete information about the causes of accidents.

SPECIAL FEATURE

★ **What kind of data do you focus on and how do you use it?**

With our recordings, we can identify risk factors and analyse the consequences of behaviours such as texting. Other key focuses include distraction and inattention, interaction with pedestrians and cyclists, and scooter driver behaviour.

This data is really as close as we can get to a look over the driver's shoulder in real traffic conditions. We can monitor the use of in-vehicle systems or mobile phones in terms of frequency, duration and traffic situation. The impact of such distractions can also be revealed by looking at related changes in terms of speed, lane position and eye position, which are key to safe driving. And as the camera data also provides a good overview of what is happening around the vehicle, it allows us to study how drivers interact with pedestrians and cyclists: When are they recognised and how does the driver respond in terms of speed?

Finally, besides road safety, the data is also used to study eco-driving and could potentially be exploited in other areas such as traffic management and infrastructure-related questions.

★ **What were the main criteria for selecting your operation sites?**

The seven sites were selected so as to have a good representation of Europe: North, South, East and West. Additionally, the selected countries vary in their level of road safety: countries with relatively high, medium and low road safety records.

★ **Was it easy to find volunteers?**

Yes and no. There are many volunteers interested in participating in the study, so in that sense it is not difficult to find volunteers. However, the study design puts very specific requirements on the participants, such as the brand and model of their car. Only a limited number of people meet the selection criteria, which makes it harder to find relevant volunteers.

★ **What would you say are the main advantages of NDS?**

Traditionally, traffic safety research has been using driving simulators, instrumented vehicles, self-reports, analyses of crash statistics and, increasingly, in-depth crash investigation. These methods have greatly contributed to the understanding of road user behaviour.

However, each method has its limitations. Results from driving simulator studies may not always be easily transferred to real traffic situations, especially in simpler and static simulators. In

instrumented vehicle studies, on the other hand, subjects drive in real traffic environments but in a special, highly equipped vehicle, usually with an experimenter on-board. This makes subjects aware of the fact that they are participating in an experiment which, as a result, may affect their driving behaviour. In both cases, it will be difficult to observe real crashes or near crashes. The results of self-reports may be biased by socially-desirable responses as well as by perceptual and memory limitations. Crash data is objective but generally insufficient when it comes to giving proper explanations. Finally, in-depth crash analyses provide valuable additional information about how and why a crash occurred, but it is only based on information collected after the crash, with post-hoc self and witness reports.

With Naturalistic Driving observations, drivers are observed in real traffic conditions, continuously, and they are not asked to do anything specific. It is about understanding normal traffic behaviour in normal everyday traffic situations. There is no observer or experimental intervention, but we can still observe conflicts, near crashes or possibly even actual crashes without potential biases of post-hoc reports. It is much more accurate.

★ **The participants still know they are being monitored. Don't you fear this will change their behaviour on the road?**

From our previous experience with this method on a smaller scale in Europe and on a larger scale in the US, we know that people forget that they are being observed after about a week. This is visible from their behaviour: they do things someone who knows he or she is being observed would normally not do, like nose picking for example. Also, we asked our

participants in a previous study about this, and they indicated that they forgot about the equipment really quickly and started behaving normally.

★ **What have you learned from your research so far?**

We are just starting the data collection, so it is still too soon to tell.

★ **What are the next steps in the project, and after its end?**

Before summer, all vehicles should be on the road collecting data. The next step will be to prepare for the analyses. Tools are being developed to access the data, to make relevant selections and to annotate the video data. Different partners will perform analyses on key topics: crash causation factors and associated risks, distraction and inattention, vulnerable road users, and eco-driving. Additionally, we will endeavour to apply our findings in four specific areas, notably the identification of new and promising countermeasures, the potential of simple DAS for monitoring performance indicators over time, the improvement of driver behaviour models for road transport simulation, and the possibilities of commercial applications of ND data.

The project doesn't allow much time and budget for data analyses, but it will still hold much potential after the project ends. One of our objectives is to make this data available for further analyses, subject to legal and ethical constraints.

UDRIVE

- ★ Coordinated by SWOV in the Netherlands.
- ★ Funded under FP7-TRANSPORT.
- ★ http://cordis.europa.eu/project/rcn/105406_en.html
- ★ Project website: <http://www.udrive.eu/>



CAPTURING EYES AND FACES FROM AFAR

Security in public spaces is being enhanced with more sophisticated biometric science. More advanced security software can now pick up faces and eyes from a distance.

Biometric identification represents an important innovation in furthering security, but suffers from low adoption rates due to a variety of reasons, from technological barriers to public discomfort. Now, the advent of biometrics 'on the move' is promising to capture biometric data from a distance, reducing user cooperation and intrusiveness. The EU-funded project BIO-DISTANCE (Biometrics at a distance) investigated ways to improve biometric technology applications in such contexts.

Focusing on the face and iris as the most promising aspects for developing distance biometrics, the project team worked on different software challenges and technical objectives. It studied face and iris quality measures such as motion blur, iris boundaries and occlusion.

Another challenge involved developing face and iris detection and segmentation algorithms that help recognise the eye or face even from a long distance. As the iris is a small area that is very difficult to capture, the team focused instead on the whole eye area as an intermediary step to achieving its final goals.

After investigating the detection of human faces over long distances, even in cases where the iris texture cannot be captured, the project team made progress in advanced feature extraction and matching algorithms. Much work was done on periocular recognition — i.e. around the eyes, including eyelids, lashes and brows. This led to examining the prospect of multi-biometric recognition, fusing the more accurate iris recognition with the relatively new field of periocular identification for even better results.

Research conducted within the BIO-DISTANCE project is destined to be useful in a number of applications, particularly where screening a large number of people unobtrusively is desired. This could include travellers moving



through security checkpoints or controlling access to buildings. The project's work will encourage better recognition capabilities in surveillance camera systems and further security in several ways.

Beyond security, the technology could be used in human-computer interaction and in-car applications such as pedestrian collision avoidance and driver drowsiness detection, as well as in lip reading and robotics. Security, safety and automation all stand to gain from this ambitious initiative.

BIO-DISTANCE

- ★ Coordinated by Halmstad University in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/151606_en.html
- ★ Project website: <http://islab.hh.se/mediawiki/BIO-DISTANCE>

INTERVIEW

SAFE, AFFORDABLE TECHNOLOGY OPENS THE WAY TO AUTOMATED TRANSPORT

Relying on top-notch, highly expensive vehicle parts to make automated transport a reality may provide sufficient guarantees for a large-scale deployment, but such an expensive setup might discourage investors. To resolve this conundrum, the KARYON project has developed a technology capable of adapting its behaviour to the reliability of its sensors and connection with other vehicles.

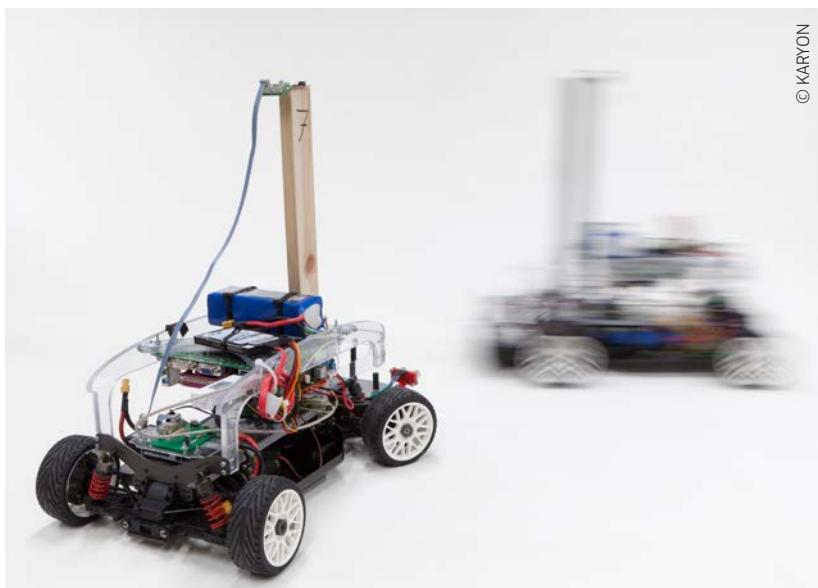
If there is one upsetting thing in an increasingly connected world, it's the absence, even for a short duration, of network connectivity under needy circumstances. But what if all cars and planes were also relying on such connections to work properly? Under such a scenario, which seems bound to happen if we consider self-driving vehicles as the future of the transport sector, the thought of a lost connectivity would make anybody's blood run cold... which

is the main reason why such vehicles are yet to be seen on our roads.

The EU-funded project KARYON (Kernel-based ARchitecture for safetY-critical cONtrol) was initiated with a view to overcoming this problem, thanks to a technology that would allow a connected car or plane to immediately contemplate a plan B when connectivity with other vehicles is not up to defined standards. From October 2011 to December 2014, the project team

worked on a technology that will ultimately allow for a better use of road space through cross-vehicle communications and automated, sensor-based driving managed by a piece of technology called the Safety Kernel.

Thanks to the Kernel, which compiles rules on how to react to uncertainties and failures of wireless communication, the team has been able to rely on a set of commercially available sensors while ensuring maximum safety. The Kernel



allows switches from cooperative to baseline, sensor-based functionality when data reliability is insufficient — for example by increasing distance between vehicles.

Antonio Casimiro, who coordinated the project for the University of Lisbon, tells us more about the project outcomes and what will come next.

★ **On the project website we can read that wireless communication, although improving performance, also introduces new safety risks. How so?**

Antonio Casimiro: If some of the vehicles' autonomous control functions rely on information that they expect to receive wirelessly (which can be a good idea, because this information can be useful), then safety becomes dependent on how well the wireless network will perform, for instance, how well it is able to deliver messages on time and avoid message corruption and loss. This can jeopardise safety because the wireless network might fail, in this case at a rate which often implies a loss of information — think about losing connection with your mobile phone in a car or train.

In a nutshell, although wireless communication may be exploited for vehicle cooperation, and hence for improving the way in which autonomous functions are performed, the design must take into account the additional safety risks that are introduced.

★ **What is the Safety Kernel and how does it work?**

The Safety Kernel is a new element in the architecture of a smart cooperative vehicle. It is responsible for setting the mode of operation of

autonomous control functions, so that the set of assumptions (we call them safety rules) on top of which the current mode of operation was designed is being satisfied.

For instance, consider that in a certain mode of operation the control system might have been designed to enforce a certain minimum safety distance to another vehicle, assuming some maximum communication delay with that vehicle. The Safety Kernel is responsible for continuously evaluating if this assumption is satisfied and, if not, trigger a change in the mode of operation so that the new mode of operation no longer requires (assumes) the same communication delay. As a consequence, the new mode of operation may enforce a larger minimum safety distance or a lower maximum speed, because it can no longer rely on the communication delay assumption. The same applies to other kinds of assumptions, namely on the quality of information collected from sensors.

★ **How do you ensure that, when wireless communication between vehicles is faulty, the driverless model remains safe?**

In the case of communication faults, it might still be possible to communicate even though the quality of this communication is undermined. So it might be possible to design a mode of operations that ensures safety based on the level of communication quality.

But let us assume that wireless communication is totally disrupted, and a vehicle can no longer communicate. In this case, the Safety Kernel will switch to a fully autonomous mode of operation, which does not rely on the wireless network and hence does not benefit

from cooperation with other vehicles. Still, as long as this autonomous mode was designed to ensure a safe operation — which can be done by relying on information collected from local sensors (as current autonomous vehicles do) — the failure of the wireless communication will not impact safety.

★ **Controlling cost is a major part of the project. How do you achieve this?**

What is great with the approach we propose in KARYON is that it does not require all vehicle (safety-critical) components to always function perfectly (technically, they do not need to be certified with the highest safety integrity level, ASIL D if we consider automotive safety standards). Just like with wireless communication components, which do not require any special safety-related certification and hence are low-cost components, other parts may also be replaced by lower cost components, with a lower integrity certification, which can still provide the necessary service most of the time and, when they don't, the system is capable of adapting the mode of operation to exclude these malfunctioning components from the safety path, at the cost of a reduced performance. Given that the cost of some components is extremely high due to the stringent certification requirements, the KARYON approach created conditions for these costs to be reduced considerably.

★ **How did you manage to integrate current road and air traffic rules into the kernel model which seems to rely solely on the most efficient behaviour?**

The concrete traffic rules have to be addressed at the application level, that is, when designing each mode of operation. Therefore, the proposed approach is generic in this respect and can be applied in both automotive and aeronautic cooperative applications. Interestingly, from a safety perspective, the existing safety standards in the two domains have many similarities, namely as concerns the definition of several safety integrity levels. Therefore, the concepts developed in KARYON are also applicable to both domains in this respect.

★ **Now that the project has ended, what are your plans for the kernel technology? Are you planning for 'real world' trials?**

In line with what was presented to the European Commission at the time of the proposal, the project did not yet



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ANTONIO CASIMIRO

have the expectation to reach the level of maturity needed to immediately use these results for the development of a final product. Nevertheless, we believe the project took the right track when we look ahead to what we believe will be the future requirements in terms of cost, safety and efficient use of roads and air space. We also believe that new business models will emerge, making use of vehicle autonomy, which will increase the needs for cooperation and adaptability that we have addressed in the project.

Concrete steps are being taken in order to bring the technology to a higher level of maturity, namely to Technical Readiness Level 7, for which we are in contact with major players in the car industry in order to create the right

"We are in contact with major players in the car industry in order to create the right consortium, able to successfully perform the work ahead."

consortium, able to successfully perform the work ahead.

KARYON

- ★ Coordinated by the University of Lisbon in Portugal.
- ★ Funded under FP7-ICT.
- ★ Project website: <http://www.karyon-project.eu/>
- ★  <http://bit.ly/1F01m5e>

ZERO TOLERANCE FOR ROAD ACCIDENTS

EU researchers with the HERMES project have developed a road vehicle equipped with cutting-edge systems to map road issues, highlight repairs, help optimise traffic and help drivers avoid trouble spots. It's hoped that the solution will help to make drivers safer than ever before.

As fatal road accidents continue to diminish, the EU is steadily moving towards 'Vision Zero'. The concept revolves around making deaths on the road as unacceptable as they are in a factory or in other transport modes such as air or rail. This, however, requires significant improvements related to road networks, drivers and cars.

The EU-funded HERMES (Innovative, highly efficient road surface measurement and control system) project has developed a solution that will help to improve road infrastructure through better measurement of roads to facilitate safety enhancement and maintenance. The HERMES purpose-built vehicle circulates at normal speeds, measuring both transversal and longitudinal planes simultaneously, detecting road issues (for example, potholes, roughness, etc.) and documenting urgent repairs. It also integrates geographical location simultaneously to facilitate data collection and processing.

Importantly, the new system is not only very precise but also much less costly than other systems currently in use. This is ideal for countries in northern climates where cycles of freezing and thawing generally degrade roads every year. It is also pivotal for reducing fuel consumption and longer journeys that result from driving in sub-optimal road conditions.

In addition, more frequent road surveys can ultimately be inputted into route optimisation applications, providing safer and better choices for travellers. Also on the digital front, the system has the ability to transmit road conditions to drivers so they can pre-empt issues and alter their driving behaviour or route accordingly.

The project team firstly defined hardware and software specifications for the system, including measurement parameters, power requirements, laser characteristics and data storage formats. It analysed and selected various components such as cameras, lenses, a 3-D laser scanner, Global Positioning System (GPS) navigation equipment, computer unit and controller, in addition to defining the complete architecture of the

system. Team members also developed a 'chessboard' based calibration of the system to guarantee high accuracy.

The HERMES team then took these solutions and implemented them into two prototype vehicles in Romania and Estonia.

Field trials were carried out during which the vehicles provided a video feed from the road profile scanner while specially developed software controlled the system and analysed the data. Images from the trials show, among other things, the system detecting potholes and documenting their shape. The various road parameters collected while the vehicle is in motion are stored in the system's SQL database.

The system aims to help road authorities achieve good ride quality in their road network, reduce fuel consumption and help maintain vehicles in better shape. Ultimately, the work of HERMES will impact a range of end-users – from road engineers and those responsible for maintenance to managers of air-fields and, of course, road users themselves.

HERMES

- ★ Coordinated by Ardon OU in Estonia.
- ★ Funded under FP7-SME.
- ★ http://cordis.europa.eu/result/rcn/151937_en.html
- ★ Project website: <http://www.hermesroadmeasurement.eu/>
- ★  <http://bit.ly/1z2gHu5>



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OFF-ROAD RUN-INS FOR DRIVERLESS FLEETS

We've seen how close we are to making self-driving vehicles a reality (see our article on the I-GAME project on page 4), but is the world ready to welcome such vehicles on its roads? This question is at the centre of the CITYMOBIL2 project, which is demonstrating automated transport systems in various locations across Europe to bring them closer to commercialisation.

It may be one of the most exciting technologies the world has contemplated in years, but making automated driving an everyday reality would also result in major changes for society. For starters, it is still uncertain how the general public would react to such a dramatic change in their daily lives — where they would have to trust computers with their own safety. Automated driving also needs to fit in the broader European plans towards a more sustainable society. It would certainly have an impact on the European economy which is still difficult to grasp and, last but not least, it is a major brain teaser for decision-makers who will be tasked with overcoming the long list of legal barriers preventing its deployment.

Answering these questions will take more than guesswork, which is why the EU-funded project CITYMOBIL2 (Cities demonstrating cybernetic mobility) has been set up. The project picks up where the CITYMOBIL project left off in December 2011, by demonstrating automated road passenger transport in large and small-scale off-normal traffic experiments in cities such as Lausanne, La Rochelle, Milan, Oristano and Vantaa.

The CITYMOBIL2 fleet comprises shuttles capable of detecting and adapting to obstacles as well as a 'Fleet supervision and management system' (FISM) that assigns missions to each individual vehicle. With evidence gathered from these tests, the team — led by Carlos Holguin from the University of Rome — is working on a socio-economic study to better understand the future role of automated transport, solutions to harmonise national legislations and create a certification framework in Europe, as well as campaigns to raise awareness among citizens.

★ **Can you tell us more about your cybercars? How do they work exactly?**

Carlos Holguin: An important clarification, to begin with, is that the building blocks for road vehicle automation technology already exist at commercial level. How they are combined and what is done with the technology in terms of transportation is another point, which is the purpose of CITYMOBIL2.

We generally don't speak about cybercars as individual vehicles, but rather about 'Automated road transport systems' (ARTS). We have two fleets of ARTS, made up of six vehicles each. Each vehicle is equipped with localisation (D-GPS and laser-based mapping) and perception systems (ultrasounds, laser scanners), which allow them to know where they are and what is in their surroundings, including static and mobile objects. They are equipped with on-board computers that process the data, make the vehicle control decisions, and transfer these decisions to the steering and engine/brakes. The vehicles then communicate with a centralised fleet and infrastructure supervision and management system, which makes decisions at fleet level, attributing missions to each of the vehicles depending on demand for transportation.

★ **What were your criteria for selecting pilot sites?**

A number of criteria — ranging from the suitability of the transport task for the ARTS fleet to the expected demand, the visibility of the demonstrator, and the willingness of the local stakeholders to cooperate — have been measured from a qualitative and quantitative point of view, and we proceeded with a ranking. In the end, three large-scale



CARLOS HOLGUIN

demonstrators, four smaller-scale ones and four showcases were selected, in six European countries.

★ **What have you learned from the pilot tests so far?**

ARTS have been enthusiastically accepted everywhere. In Oristano, the only concluded demonstrator so far, 90% of the users stated their interest in seeing these systems used permanently to complement mass transits.

In technical terms, we learned more about how to improve navigation — which requires merging at least two positioning systems — and avoid obstacles by mapping fixed obstacles and dynamically adapting the safety area around vehicles.

"Saving EUR 5 000 per year by not owning a car can be a huge gain in buying power and a good motivation for most people."

The most promising learning experience is to see how the other road users interact with automated vehicles. The qualitative impression is that most people easily adapt to the high level of safety of the system and change their behaviour accordingly. A specific task of the project will be to monitor such behaviour in more detail through enhanced video processing, with a view to defining a way to

communicate 'non verbally' with other road users.

★ **In the future, do you see ARTS replacing driver-based solutions or would they work together?**

There will certainly be mixed technologies and solutions in the future. In the short to middle term, ARTS-based transportation systems will operate in specific areas and slowly expand to reach most urban areas, always operating as a complement to the mass transit systems and providing a taxi-like service, while manually-driven vehicles will slowly have greater capabilities and expand from the motorways (which are also dedicated infrastructures) towards more open areas. The future will certainly be different, but we think it will be the economics of the future transportation systems that will define the final scenario. Saving EUR 5000 per year by not owning a car can be a huge gain in buying power and a good motivation for most people.

★ **Cost, legislation, and the shortcomings of current road rules are major obstacles to commercialisation of automated transport systems. How do you think these can be overcome?**

Overcoming this barrier is one of CITYMOBIL2's main goals! We have been working with several Transportation Ministries, not only in the countries in which we will hold or have held demonstrations, but also with other European countries. Part of that work consists in the definition of a certification procedure proposal that can guarantee, to the public and also to road authorities, a safety level equivalent to that of railway systems, that is, more than 100 times safer than today's roads! And this is not just by preventing injuries to the vehicle's passengers, but also preventing accidents with cyclists and pedestrians. This procedure includes the certification of the Automated Road Transport System together with the infrastructure and would be applied in specific areas of the road infrastructure. 'Normal' cars could use this infrastructure, but they would be obliged to respect rules specific to it.

Costs are an issue given the number of these vehicles/technologies being produced today. As more systems are implemented, the costs will go down. Today, the costs make it necessary to implement large vehicles, but as the costs go down, it will

become possible to make smaller vehicles.

★ **What will CITYMOBIL2's contribution be in this regard?**

CITYMOBIL2 will test this certification procedure during its demonstrations and eventually come up with a certification procedure that, we think, can be a good compromise for the road authorities and also other actors such as the car industry, to help everyone move ahead.

In terms of market, the cities that participate in CITYMOBIL2 are innovators in terms of the technology adoption curve. They are leading the way to the adoption of this technology and creating a new market.

★ **What would the main benefits of ARTS be in terms of road safety?**

Road safety is embedded in ARTS' design, as we consider the vehicles, and also the infrastructure, the communication systems and, especially, other road users present in the area, right from the design phase. The risks that arise are mitigated even before a single vehicle operates in the infrastructure. This is how we aim to reach safety levels that simply don't exist in today's road transportation system.

★ **What are the next steps in the project and after its end?**

We have already started the demonstration phase, so the project will continue working on this. The next demonstrations will be held in Vantaa (Finland), Trikala (Greece), Sophia Antipolis (France) and San Sebastian (Spain). We will also carry out show-cases (one week demonstrations) in Milan and participate in the ITS World Congress in Bordeaux and in the TRA in Warsaw. Several tasks will be running in parallel. The data that is being collected will serve to assess the systems' performance in each city, and to make a cross-comparison at the end of the project. Some cities have started planning permanent systems after the end of the project, but this will not be feasible until there is a legal framework, so we count on them to keep pushing the national governments and the European Commission to make one.

CITYMOBIL2

- ★ Coordinated by the University of Rome in Italy.
- ★ Funded under FP7-TRANSPORT.
- ★ http://cordis.europa.eu/project/rcn/105617_en.html
- ★ Project website: <http://www.citymobil2.eu/en/>



TECHNOLOGY TO ACTIVELY INCREASE SAFETY OF VULNERABLE ROAD USERS

The ARTRAC project team has designed and developed a novel 24 GHz radar sensor which can measure target range and radial velocity simultaneously with high accuracy and even in multiple target and in bad weather situations. Furthermore, the radar sensor can distinguish between different objects e.g. between cars and pedestrians. This small radar sensor can thus increase pedestrian safety.

Although casualties have dramatically decreased over the last few years due to a variety of new technologies, there is still much more that can be done. Indeed, the European Commission has set ambitious road safety goals for reducing casualties by 50% by 2020.

One reason for road accidents is that no matter how experienced a driver is, he/she has no way of measuring target range and velocity. This is why the team in the EU-funded ARTRAC (Advanced radar tracking and classification for enhanced road safety) project, coordinated by Hamburg University of Technology in Germany, with the support of its knowledge transfer arm, TuTech Innovation, set out to develop novel radar sensor technology. This includes a new waveform for radar sensors to measure target range and velocity, as well as a new antenna and a classification system for pedestrian detection and pedestrian recognition.

The project, which concluded in October 2014, succeeded in designing the road condition sensor, and defined the automatic braking and steering control algorithms, for both collision mitigation and avoidance. On the hardware side, the technology is powered by a digital signal processing board and a special antenna solution to measure the target azimuth position precisely. Meanwhile, on the software side, it involves optimised pedestrian detection and tracking and control algorithms combined with innovative object classification software.

The sensor was tested in two vehicle demonstrators. At the Fiat Research Centre, the team used the technology to develop a prototype vehicle with frontal collision warning and mitigation functionality based on the radar. The functionality is

implemented in an Autobox and can drive the brake system of the vehicle.

Likewise in the Volkswagen demonstrator, the ARTRAC radar sensor observes the frontal area. Whenever a pedestrian enters the driving path of the vehicle, an active braking manoeuvre is activated or invasive steering is initiated. Ultimately, depending on the type of scenario, the sensor allows for a variety of safety actions like automatic braking and steering recommendations. These safety measures yield an increased level of safety for vulnerable road users.

Speaking at the final ARTRAC event in Ehra in September 2014, project coordinator Prof. Dr Hermann Rohling from Hamburg University of Technology, noted: 'This radar sensor measures target range and velocity very precisely even in complicated multiple target situations. The radar sensor becomes, from that point of view, a partner for all drivers.'

It is hoped that the research results of ARTRAC will be proved useful in stimulating the development of future cars with novel approaches.

ARTRAC

- ★ Coordinated by Hamburg University of Technology in Germany.
- ★ Funded under FP7-TRANSPORT.
- ★ http://cordis.europa.eu/result/rcn/150881_en.html
- ★ Project website: <http://artrac.org/>
- ★  <https://www.youtube.com/watch?v=rvzBSZESlww>



REDUCING SKID-RELATED ACCIDENTS

Road slipperiness contributes to car accidents and fatalities. The EU-funded SKIDSAFE project set out to design novel tools and techniques to measure and ultimately prevent the loss of skid resistance.



"Based on the findings, three pavement skid-resistance management tools for mix design, variable speed limits and optimal pavement maintenance strategies were developed."

Water can have a major effect on road surface friction, and its impact on the traction produced by tyres can result in dangerous driving conditions. Existing methods and devices that measure the skid resistance of road surfaces are limited in scope and do not account for the different elements that influence tyre and road friction.

The SKIDSAFE (Enhanced driver safety due to improved skid resistance) project looked at how the pavement and the tyre interact. This helped to create

tools that predict the cumulative loss of skid resistance in relation to the wear of the pavement.

To explore the interaction between the pavement and the tyre, the project team designed and manufactured a device that carries out tests on different dry pavement surfaces and tyres. The device allowed the team to conduct tests using different pressures, different slip angles and different water film thickness. It measured friction and temperature development with speed, applying a braking test of

80 km to 0 km in 6 seconds. The device also investigated the influence of polishing for both stone and asphalt surfaces. Advanced tyre models and algorithms were used to reproduce scenarios that help cause friction and wear between the surface and the tyre.

The simulations led to the identification of factors that influence the extent and the deterioration of skid resistance on dry pavements. Tests on pavement surface skid resistance were carried out by ISFTTAR in France, GCI in Spain and NTUA in Greece. The tests involved various mix gradients, textures, binder types and contents, as well as various aggregate types and skid resistance devices. These factors were then used to examine the negative impacts of wet pavements. A test vehicle was used to demonstrate skidding due to wet road surfaces.

Based on the findings, three pavement skid-resistance management tools for mix design, variable speed limits and optimal pavement maintenance strategies were developed. Several academic papers were also published by the team. Additionally, over the course of the project, they also organised an international course on Mechanics of Tyre-Pavement Interaction as well as three workshops.

By introducing innovative pavement management solutions to measure the skid resistance of road surfaces, SKIDSAFE should reduce traffic accidents while helping authorities to determine safe speed limits.

SKIDSAFE

- ★ Coordinated by Delft University of Technology in the Netherlands.
- ★ Funded under FP7-TRANSPORT.
- ★ http://cordis.europa.eu/result/rcn/158648_en.html
- ★ Project website: <http://skidsafe.org/index1.html>

BIOLOGY AND MEDICINE
MAGAZINE EXCLUSIVE

SMART WHEELCHAIRS TO PREVENT PRESSURE ULCERS

Although it can be prevented in 95 % of cases, ‘pressure ulcer’ (PU) still costs some EUR 20 billion to the EU’s public healthcare system. New wheelchair equipment combined with a smartphone app promises to effectively prevent, detect and reverse the onset of PU — thereby reducing its financial burden for society.

The ‘Pressure Ulcer Measurement and Actuation’ (PUMA) system addresses the shortcomings of current care solutions by considering tissue viability instead of focusing solely on pressure reduction. It relies on several key components: a computer embedded in the wheelchair; a postural control system; a dynamic cushion and a smart textile embedded in a pair of shorts that measures pressure, tissue viability, and performs ‘Functional electro stimulation’ (FES); as well as a smartphone app which helps the patient control the whole system.

‘I cannot go into too much detail, to avoid problems with the current patient process, but the system measures the pressure on the ischiums and other variables to assess tissue viability. Moreover, it is also context aware,’ says José Laparra, Researcher at the

Biomechanics Institute of Valencia (IBV, Spain) and Technical Coordinator of the EU-backed project PUMA (Development of a non-invasive and portable tissue viability measurement and intelligent actuation system for the prevention and early detection of Pressure Ulcer risk in Tetraplegic SCI users).

The PUMA device is indeed capable of detecting and eliminating the risk of PU development in ‘Tetraplegic spinal cord injured’ (T-SCI) individuals relying on wheelchairs by providing them with different context-based strategies. ‘For example, the application could detect the limit time spent in the same position and, depending on the context, propose various actions to prevent PU formation: changes in chair position (back, seat and footrest), modifying the cushion or directly applying electro stimulation in risk

areas,’ explains Ignacio Bermejo, Innovation Director of Rehabilitation and Personal Autonomy at IBV.

The app is actually useful to both patients and professionals. Patients can monitor their PU risk level, consult and adjust recommended strategies based on information gathered from the cushion and shorts, select scenarios according to their daily activities, and receive alerts when the risk of PU becomes too important. Professionals, on the other hand, can also receive these alerts and adapt scenarios and strategies to the characteristics of each patient.

Multiple benefits

‘The PUMA solution is the result of a two-year research project. During the first stage, we gathered information about the needs and anthropometric and physiological characterisations of

T-SCI patients that adversely affect the occurrence of PU. Afterwards, we studied and compared different tissue viability measuring systems in order to embed them in smart textiles,' Laparra explains.

The final device was then tested and validated on real users thanks to the work of the National Paraplegic Hospital of Toledo (FUHNPAIIN) and the team of prosthetics technicians at Fundosa Accesibilidad, part of the ILUNION group. Other partners include QIMOVA AS (Denmark) as coordinator, BerkelBike (Netherlands), SensingTex (Spain), the Estonian Innovation Institute (EII) and Centexbel (Belgium).

The project was completed at the end of January, so the team will now focus on optimising the PUMA production process. The solution is expected to be commercialised within the next in two to three years, for a cost similar to that of other electrical wheelchairs. The team says it will reduce healthcare costs considerably while enhancing the autonomy of SCI users and allowing them to spend more time in their wheelchair — which in turn will make it easier for them to integrate into the labour market.

'PUMA is a clear example of the importance of involving all stakeholders, changing from a technology push approach to a user pull approach,'

Laparra concludes. 'Users know their disease and the available technology well. By involving them, we proved that, with minimum support from healthcare professionals and R&D technicians, it is possible to put the user at the centre of the development process.'

PUMA

★ Coordinated by QIMOVA AS in Denmark.

★ Funded under FP7-SME.

★ http://cordis.europa.eu/project/rcn/105669_en.html

★ Project website: <http://puma.ibv.org/>

DIAGNOSING INFECTIOUS DISEASES AT THE POINT-OF-CARE

A new 'lab-on-a-disc' technology developed by an EU project research team can diagnose malaria and other febrile infectious diseases simultaneously in just an hour — allowing faster point-of-care treatment and precise drugs administration that could save thousands of lives.

A major problem with current testing for infectious diseases in Africa is that it focuses on individual diseases and cannot reliably discriminate between them. Since most infectious diseases have the same feverish symptoms, diagnosis is often inaccurate, resulting in thousands of deaths and increased resistance to antimicrobial drugs.

Clinical surveys show that up to 30% of patients are treated for malaria without even being infected by it. Considering the approximately 200 million malaria cases worldwide, it is vital that accurate diagnostic tools are developed to distinguish between infectious diseases such as malaria, typhoid, dengue fever and pneumonia, so the right therapies are applied.

The EU's EUR 2.9 million DISCOGNOSIS (Disc-shaped point-of-care platform for infectious disease diagnosis) project has come up with a new diagnostic tool: an easily-portable lab-on-a-disc, which can test for several tropical diseases at the same time, discriminate between them and guide

healthcare personnel to proper patient treatment.

'It is a very simple and cheap system that can be used in regions with low medical infrastructure,' explained the project's coordinator

Dr Konstantinos Mitsakakis, from the Department of Microsystems Engineering (IMTEK) at Freiburg University in Germany. 'Results can be obtained from a finger prick of blood in just one hour, whereas lab culture currently takes up to three days.'



Identifying the disease at the molecular level

The doctor or nurse injects the patient's blood sample onto a plastic disc, the 'LabDisk', which is roughly the size of a CD, and then places the disc in the 'disc player'. The device weighs just 2 kg, making it perfect for transportation to remote villages. The disc has pre-stored biochemical components, which allow for fully automated analysis.

The blood sample is processed on disc and centrifugally distributed into microfluidic chambers where the disease pathogens can be identified from their DNA/RNA — whether it be from parasites (malaria), bacteria (typhoid or pneumonia) or viruses (dengue).

This generic point-of-care platform can be applied to many other infectious diseases, for example Ebola, simply by

"This generic point-of-care platform can be applied to many other infectious diseases, for example Ebola, simply by changing its bio-components."

changing its bio-components. Early diagnosis can help limit the effects of an extended epidemic.

The researchers will validate the diagnostic device in the field, before the three-year project ends in October 2015, and have chosen two locations: the Pasteur Institute in Dakar, Senegal (with 'bio-banked' samples); and the Medical Center in Bunia, Democratic Republic of the Congo (with recruitment and testing of around 100 patients).

Commercialising the technology worldwide

The economics of the LabDisk are very promising. Costs are currently estimated to be up to \$10 per disc per patient, assuming several million discs are manufactured, which is cheaper than a complete set of multiple infectious disease testing procedures currently in use in Africa.

The DISCOGNOSIS team is now seeking to increase the number of patients who can be tested simultaneously. Not

only will this be more cost-effective, but it would prove a vital help in handling future epidemics.

Other follow-up activities include performing clinical trials and developing the remote connection of the LabDisk player to a central database. 'This could mean very important progress, not just for patient management, but also for epidemiological mapping of regions and countries, as we will be able to monitor the frequency and distribution of various infectious diseases,' Dr Mitsakakis points out.

DISCOGNOSIS

- ★ Coordinated by Albert Ludwigs University of Freiburg in Germany.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/result/rcn/158815_en.html
- ★ Project website: <http://www.discognosis.eu/>
- ★ <http://bit.ly/1xEADIm>

MRI AND PATIENT SIMULATOR

'Magnetic resonance imaging' (MRI) helps detect and diagnose pathologies in most tissues in the body. A novel MRI simulator that recreates heart and respiratory motion will aid in optimisation of algorithms and training of new personnel.

Since it does not use ionising radiation, MRI is a very safe, non-invasive method for determining both static and dynamic properties of biological tissues. With EU support for the project MRISIMUL (Enhanced MRI physics simulator), scientists have developed a realistic simulation tool that runs on a single computer.

The impetus was to integrate realistic aspects of an MRI experiment to understand artefact generation mechanisms during cardiovascular MRI. This will facilitate better exam protocols without the need for more complicated and expensive human or animal experiments.

Scientists developed a MATLAB platform that supports the development of

custom MRI pulse sequences and their application to model objects. MRISIMUL exploits Bloch simulation, the most accurate way to study the effect of pulse sequences on magnetisation.

Following an analysis of computational power, the team determined that prohibitively long execution times of several days were required even with a high-end personal computer. Researchers replaced the 'Central processor unit' (CPU)-based approach with a large number of processing cores integrated with a 'Graphic processing unit' (GPU), again on a single computer.

Now, the computationally demanding core services (kernel) are executed in

parallel within the GPU environment about 228 times faster than serial processing with a CPU. This means, for example, that instead of five full days (120 hours), a simulation now requires approximately half an hour. In multi-node, multi-GPU systems, MRISIMUL demonstrated an almost linearly scalable performance with an increasing number of available GPU cards.

The team has now developed a detailed 3D model of the human heart and torso that simulates relevant motions, including respiration, heart and simple flow. The model can be installed from the project website. There, users will also find a 'fuzzy' spatial distribution of the brain, including 11 tissue types.

MRISIMUL has been warmly welcomed by the scientific community with its first description in the Journal of Cardiovascular Magnetic Resonance, acquiring the designation 'highly accessed' within less than a month of its publication. The project also paves the way for extension to other biomedical fields. EU citizens can soon expect better diagnoses and care for a variety of illnesses.

MRISIMUL

- ★ Coordinated by the University of Thessaly in Greece.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158545_en.html
- ★ Project website: <http://mri.dib.uth.gr/>



HIGH-RESOLUTION REAL-TIME NEURONAL IMAGING

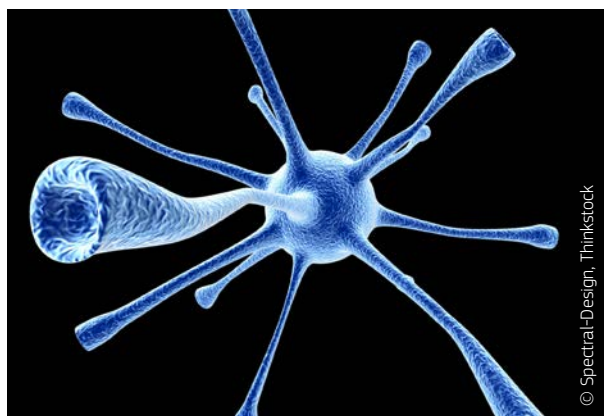
Neuronal cells have strange branching extensions with little knobby bulbs on them called spines, the places where one neuron communicates with another. In pioneering work, scientists have stimulated individual synapses and imaged spine changes.

Neurons have a unique morphology compared to most other cells in the body that are an approximate sphere. In addition to the cell body, they have specialised extensions for sending and receiving information. A branched dendritic tree comes off one region of the cell body and a single long axon off another.

Cells are small and dendrites even smaller. To complicate the picture a little more, the dendrites themselves have little knobby mushroom-shaped protrusions called dendritic spines. It is here that the synapses or junctions between neurons do their magic. It is also here that many neurological diseases find their origin.

Given their extremely tiny size and fast dynamics, studying them *in situ* has been very difficult. Scientists launched the EU-funded project DYNASPINE (Nanoscale photoactivation and imaging of synaptic spine dynamics) to develop and apply the techniques to do so. Their ultimate goal was to correlate structure and function on the single-synapse level in real time.

Neuronal signalling relies on a complicated interaction of chemical and electrical components. Voltages along the membrane change, pores in the membranes open and close, and ions and molecules move in and out. Even the number, size and shape of spines demonstrate plasticity (the ability to change). Such changes can accompany increases in synaptic strength that last for long periods of time (long-term potentiation), also induced by repeated stimulation. This phenomenon is thought to be involved in learning and memory.



Scientists applied a combination of electrophysiological recordings and one of the most advanced and high-resolution microscopy techniques available, stimulated emission depletion microscopy. The team uncaged photo-releasable glutamate, an excitatory neurotransmitter, to stimulate receptors at a single synapse.

Experiments revealed the plasticity of the spine, in particular shortening and widening of the spine neck, during synaptic potentiation. They also showed that these structural changes had unexpectedly different effects on chemical and electrical signalling, pointing to a new layer of complexity in neuronal dendritic spine function.

DYNASPINE opened a new window on functioning dendritic spines. Follow-up of this exciting research direction will be met with great interest by the neuroscience community.

DYNASPINE

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/155867_en.html

IMAGING THE BEATING OF THE HEART

A European study investigated how the inherent capacity of the heart to beat relies on its structure. The results and tools generated should prove useful in the diagnosis of pathological heart conditions.

The structure and architecture of the myocardial muscle is central to its contraction and function. Muscle cells are elongated and are stacked into sheets. Recent evidence indicates that propagation of the action potential in the heart ventricles is critically dependent on both muscle fibre orientation and sheet structure.

It is hypothesised that during contraction, myocardial sheets slide across each other thereby facilitating the thickening of the myocardium. However, due to technical limitations, this has yet to be demonstrated in living tissues.

Advances in 'Magnetic resonance imaging' (MRI) permit visualisation at the microscopic level. Using such *in vivo* 'cardiac MRI' (CMRI), scientists in the EU-funded MSIA (Application of MRI to explore

myocardial structural reorganisation accompanying contraction and the influence of this on arrhythmogenesis of the normal and post infarct heart) project set out to investigate how myocardial structure and architecture impacts cardiac excitation and contraction. They worked with the hypothesis that myocardial sheet sliding could also affect arrhythmias.

CMRI was performed on two pig models, a sheep ventricular infarction model and normal subjects. Structural and functional images were obtained and analysed, revealing that sheet structure affects the pattern of electrical propagation. These findings also support the idea that cardiac myolaminar structure develops in order to minimise shearing of the myocardium upon contraction.

The results of the MSIA study have fuelled future modelling of the structure of infarcted hearts. It is envisaged that such efforts should help explain how myocardial functioning changes in pathological situations.

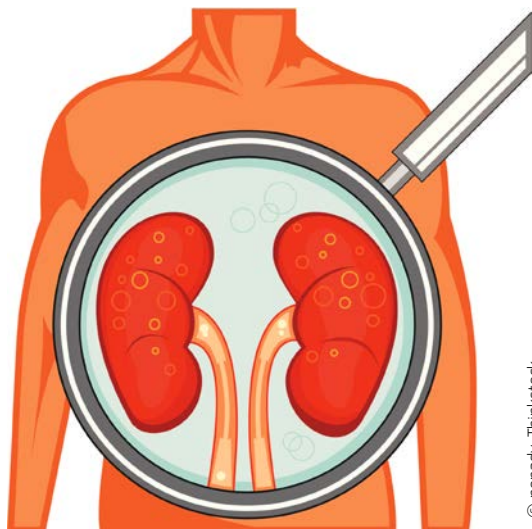
Delineation of the physiological and anatomical principles of the cardiac tissue underscores the significance of the heart. In the long term, a better understanding of cardiac development and function in health and disease should improve diagnosis of myocardial disease.

MSIA

- ★ Coordinated by CHU Bordeaux in France.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158540_en.html

EARLY DETECTION OF CHRONIC KIDNEY DISEASE

'Chronic kidney disease' (CKD) is a progressive loss in renal function over a period of months or years. The early detection of those at risk of developing CKD is necessary as the number of patients is increasing steadily worldwide.



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CKD results in renal failure and the mandatory requirement for renal replacement therapy, transplantation or lifelong dialysis. Several therapeutic strategies exist for treating CKD, with the majority involving either inhibition of the renin/angiotensin system or anti-inflammatory agents. While therapy at an early stage may be curative, therapy at late stages can only delay disease progression, highlighting the clear need for early detection.

The aim of the EU-funded PROTOCLIN (Improvement of tools and portability of mass spectrometry-based clinical proteomics as applied to chronic kidney disease) project was to advance 'Capillary electrophoresis coupled to mass spectrometry' (CE-MS) technology in CKD biomarker discovery.

To achieve portability, a CE-MS platform was established in a partner laboratory. As this multidimensional approach mandates comparability of data sets, software solutions enabling the exchange and comparison of data from different instruments were developed. First validation assays confirmed the portability and accuracy of both the platform and software. To reach this goal, PROTOCLIN initiated an intensive exchange of scientists between industrial and academic partners.

Project members demonstrated that urinary proteomic biomarkers can provide clinical information for the early detection and differential diagnosis of CKD while avoiding invasive procedures. This highlights a clear potential benefit for the application of urinary proteomic biomarkers of CKD, generalisation of their use and their implementation in a high-throughput screening tool.

"Urinary proteomic biomarkers can provide clinical information for the early detection and differential diagnosis of CKD while avoiding invasive procedures."

PROTOCLIN

- ★ Coordinated by Mosaiques Diagnostics in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158568_en.html
- ★ Project website: <http://www.protoclin.org/>

GRANZYMES IN THE FIGHT AGAINST SEPSIS

Sepsis is a major health problem that requires urgent solutions. A European study discovered that certain enzymes released by immune cells could help reduce the extent of inflammation.

Upon infection, our body initiates a process of inflammation that aims to effectively eliminate the threatening pathogen. However, when the process goes wrong, pathological situations may emerge such as in the case of sepsis. Sepsis refers to whole-body inflammation with life-threatening complications.

"Work in mice lacking one of the granzyme proteins suggested a role for these proteases in attenuating lung inflammation."

Emerging evidence indicates that granzymes, a family of proteases, contribute to sepsis. The scope of the EU-funded study GRANZYMES IN

SEPSIS (The role of granzymes A, B and M in sepsis) was to investigate the role of different granzymes in bacterial sepsis and identify which cells secrete them through both experimental and clinical approaches.

Using blood from healthy volunteers and patients with sepsis and systemic inflammatory response syndrome, scientists analysed the percentage of different lymphocyte populations expressing different granzymes (A, B, M and K). Similar work was conducted in mouse models of sepsis and in patients with pulmonary tuberculosis.

Results showed that granzyme expression was linked to the process of inflammation and not the presence of bacteria per se. Natural killer cells were identified as the predominant population expressing these proteins. In tuberculosis patients, the granzyme

levels were higher, similar to those observed during viral infections. Work in mice lacking one of the granzyme proteins suggested a role for these proteases in attenuating lung inflammation.

This protective role for granzymes in host defence against infection combined with information on their regulation opens up new avenues for their therapeutic exploitation. Future innovative treatments based on the manipulation of granzymes could serve as a means of inflammatory disease management.

GRANZYMES IN SEPSIS

- ★ Coordinated by the Academic Research Center in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158487_en.html

SOCIAL SCIENCES AND HUMANITIES

TURNING THE TABLES: RESEARCHING GAMBLING RESEARCH

We normally think of anthropologists studying 'exotic' cultures — ancient tribes that live in faraway places. But how about cultures that are closer to home? Professor Rebecca Cassidy has devoted herself to anthropological studies of European cultures of gambling. In an EU-backed project, Prof. Cassidy and her team have taken this a step further, and conducted an anthropological study of the gambling research community itself.

The gambling industry in Europe, which is already worth an estimated EUR 89 billion, is undergoing rapid growth and change. Having resisted the economic downturn, gambling is expected to be worth EUR 351 billion globally by 2015.

The nature of gambling is also changing: the impact of online gambling, cross-border gambling companies and other new phenomena enabled by technology are a source of concern to legislators and consumers, and are still poorly understood. This is why the ERC-funded GAMSOC (Gambling in Europe) project — having applied anthropological research methods to the relationships between gambling and religion, gender, age, social class and regulation — set out to apply them to the world of gambling research.

'It is more important than ever to look at how knowledge on gambling is produced,' explains Prof. Cassidy. 'As anthropologists, we participate in the same culture as the people we are investigating. And we feel this gives us a unique perspective to ask: Why do we not understand gambling better?'

Broadening the field

The project's report, entitled 'Fair Game: producing gambling research', concludes that gambling research currently is too heavily dependent on industry support. It also finds that the industry is often reluctant to share data with researchers — and there is a lack of transparency around relationships and influence between industry and researchers.

'Our report shows the need to separate fund-raising from research,' says the professor. 'We want to open up the debate: What is evidence? How does this shape the debate?'

The project concludes that research is often limited in its aims, tending to focus only on individuals whose gambling has become pathological. Funding is often only available for research into people for whom gambling has become a 'problem' or addiction, rather than the wider social and cultural implications for a society where gambling is ever more prevalent.

'Research funding is often limited to looking at "problem gambling",' says Prof. Cassidy, 'with an implicit assumption that gambling is OK for others. But this closes down questions about the broader community and gambling's impact.'

'The question is: how robust are the mechanisms for the protection of the public now?' she says. 'There tends to be resistance

to regulations until the research community can produce "causal evidence of harm". But in many cases it might not be possible.'

The report includes detailed recommendations which the researchers hope

will influence future support for research in the field. They suggest, for instance, setting up a professional code of ethics, funding research into a wider range of topics using a wider variety of research methodologies, and levying the gambling industry in order to provide public funds for such research.

"The industry is often reluctant to share data with researchers — and there is a lack of transparency around relationships and influence between industry and researchers."

Hands-on research

The four researchers in the GAMSOC team had previously carried out in-depth case studies of different gambling cultures — Chinese casinos, croupiers in Slovenia, mobile gambling in emerging economies, and Cyprus blackjack tables — published in 2013.

'For my previous research into horse racing, for example, I lived and worked in Newmarket,' Prof. Cassidy explains. 'But for this

project, the research community is very widely distributed, so we spoke at conferences, attended events and organised interviews with stakeholders.'

In all, the project approached 143 people, with 109 being interviewed. The primary focus was in the UK — with 67 subjects interviewed there — but also covered Hong Kong, Macau and Slovenia, which are in strong contrast to the mature UK market.

'There was no homogeneous industry line,' Prof. Cassidy emphasises. 'We found very diverse industry opinion — producing information that the field has not considered before, including very candid responses to the question: why is research limited?'

'Thanks to funding by the ERC, we have enjoyed a privileged position that allowed us to really examine how gambling research is carried out — in a way that would be impossible without that independent support,' says Prof. Cassidy. 'It encouraged us to take risks, asking difficult and less-obvious questions. It's a feature of ERC Starting Grants that we are encouraged to go outside the field and ask new questions.'

GAMSOC

- ★ Coordinated by Goldsmith's College in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://erc.europa.eu/projects-and-results/erc-stories/turning-tables-researching-gambling-research>
- ★ Project website: <https://gamblingacrossborders.wordpress.com/>
- ★  <http://bit.ly/1y3GgQ8>

FRAMING A NEW CONCEPT OF DEMOCRACY

A better understanding of conceptual change and controversies in the EU provides alternatives for policy decisions and institutional development.

The EU is a community undergoing constant change and in the midst of political controversy along with it. As such, many concepts and their different aspects are part of what gives shape to European integration in daily life. Yet, ways to approach conceptual history have not been adequately addressed.

In light of this, the EU-funded EUPOLCON (Conceptualising representative democracy in the EU polity by re-thinking classical key conceptual clusters for the EU multi-level polity) project set out to create a conceptual framework that represents democracy. An interdisciplinary approach with a thematic aim, the work was divided into three conceptual clusters: state-government-policy-polity; parliament-representation-politicians; and citizens-subjects.

The main aims were methodological insights of conceptual history, a research agenda for European

integration, an analysis of practices related to parliament, government and citizenship, and the establishment of a link between conceptual history and various social disciplines. Many results were achieved during the project. These include lectures and meetings, book and article publications, and workshops.

Project results add value to conceptual history sub-fields such as EU studies, comparative politics and political theory. Finally, the findings can be useful for policymakers and civil society agents as regards political debates within institutional settings.

EUPOLCON

- ★ Coordinated by the University of Jyväskylä in Finland.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158559_en.html
- ★ Project website: <https://www.jyu.fi/ytk/laitokset/yfi/en/research/clusters/eupolcon>



HOW LOCAL WELFARE IMPACTS WOMEN'S LABOUR

The women's labour market is an important part of Europe's social sustainability. It is an issue worth examining in the context of supporting welfare systems and contribution to social cohesion.



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How do local welfare systems support women's labour market participation? To what extent, and under which conditions, does female labour market integration contribute to strengthening social cohesion? These two questions formed the focus of the EU-funded FLOWS (Impact of local welfare systems on female labour force participation and social cohesion) project.

Also aiming to analyse the Europe 2020 female employment targets, project partners worked to identify facilitators and inhibitors of women's participation in the labour force. Work centred on analysing practices, structures and policies relating to women's labour force participation and social cohesion, in 11 cities across Europe.

Cities have varying capacities for integrating women into the labour market, with those on the 'least capable' side marked by high unemployment rates. However, researchers discovered that most cities surpass the 60% target of the Lisbon Agenda, and that there is a relatively high employment rate of women with children of preschool age.

Other study findings point to economic growth and the development of an advanced service sector as factors contributing to women's labour market integration. Added to that are cultural models that favour the employment of mothers of small children and an active role of men as fathers. The findings also indicate that women's educational attainment is largely accompanied by increased demand for women employees.

Project activities revealed a number of interesting findings regarding welfare provisions, such as care and human capital investment — the two types singled out as the most important for women's employment. For example, local welfare systems characterised by a high level of generosity towards public or publicly paid formal care for senior citizens are also usually generous in supporting family care.

Importantly, welfare policies at local level are not closely linked to the promotion of women's employment. The employment targets of the EU are not a major priority at the local level. FLOWS' findings point to a critical need to link labour market, educational and welfare policies, and improve political awareness of such issues at the local level.

The FLOWS project made significant contributions to the literature on women, work and the welfare state. Specific areas that have benefited include: women's motivations and preferences regarding the labour market; the role municipalities play; and the political processes of government structures in welfare policy.

FLAWS

- ★ Coordinated by Aalborg University in Denmark.
- ★ Funded under FP7-SSH.
- ★ http://cordis.europa.eu/result/rcn/90705_en.html
- ★ Project website: <http://www.flows-eu.eu/>

CONSUMER VIEWS ABOUT BUSINESS ETHICS

An EU study has investigated the reasons behind consumer impressions of the ethicality of certain businesses or brands. The study found the situation to be complex, with a bias towards recollection of negative information.

Today's consumers pay attention to companies' ethical credentials, and businesses market themselves accordingly. Yet, little is known about what causes positive or negative consumer impressions.

The EU-funded RESEARCHING CPE (Researching consumer perceived ethicality (CPE) of companies and brands)

project aimed to find out. Over two years from May 2012 to April 2014, the project studied how company behaviour affects CPE, expressed as a positive/negative scale.

Project work commenced with defining and 'operationalising' CPE, as a step towards two separate stages of quantitative analysis.



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Phase one consisted of developing a valid scale for measuring CPE. However, as a literature review revealed no such existing scale, the project surveyed consumer understanding of the term 'ethical'. The investigation revealed that consum-

"Consumers cannot easily name ethical companies, but opposite examples are particularly memorable."

ers' perceptions are based on evaluation criteria, summarised as six key themes. These cover adhering to the law, moral norms, good or bad market

action, social responsibility, avoiding damaging behaviour, and evaluating positive and negative consequences. Subsequently, the team tested and refined the proposed CPE scale and confirmed the results.

The second phase explored the dynamics of the CPE formation process, specifically how consumers resolve conflicts in the form of contradictory information, and process new information affecting a known or fictitious brand.

Findings of the combined phases suggested a negativity bias when ethical impressions are formed, which is manifested by the fact that consumers cannot easily name ethical

companies, but opposite examples are particularly memorable.

RESEARCHING CPE produced a scale for measuring consumer perceptions of the ethicality of companies or brands. Additionally, the project revealed some of the causes and factors contributing to the development of such perceptions.

RESEARCHING CPE

- ★ Coordinated by the European School of Management and Technology in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/157758_en.html

UPDATING EGYPTIAN CHRONOLOGIES

Stratigraphy is the study of rock layers and layering in geology. A research initiative has connected relative stratigraphies of well stratified and active excavations along the Levantine coast with reliable Egyptian historical chronology.



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Study sites included Ebla, Tell 'Arqa, Byblos and Sidon (northern Levant) and Tel Kabri, Tel Dan, Ashkelon and Tell el-'Ajjul (southern Levant). Researchers focused on artefacts imported onto these sites from Crete, Cyprus and Egypt. For the first time, the project considered Egyptian pottery in the Levant, studying materials at different museums and in the store rooms of particular excavation sites.

The novel approach has given new insights into trade between the two regions. For example, Egyptian pottery found at Sidon supports the connection referenced in written records that Egypt was politically active in the northern Levant during the later phase of the 'Middle Bronze' (MB) I period.

Other materials from a later date point to a wide trading network bringing foreign goods to Egypt. Included in these are imports of Middle Cypriote-period pottery, suggesting the start of copper trade with Cyprus.

Examination of stolen objects in early MB II tombs allowed the project to tie in and link events and transitions that took place in Egypt's political sphere. This is specific to the period from the time of the collapse of the Middle Kingdom to the advanced MB II period.

Shifts in power in the eastern Mediterranean had major implications for bordering countries, and gave rise to new political and economic entities, such as Cyprus. As such, the results and outcomes of EGYPT IN THE LEVANT provide a new opportunity to advance understanding of political and economic events during the time in question. They also help underline how interactions through trade impacted and shaped cultural spheres on both sides.

With the support of EU funding, the project EGYPT IN THE LEVANT (The Interconnections between Egypt and the Levant in the first half of the Second Millennium B.C. based on relative Chronologies) investigated material remains from the first half of the second millennium BC and included older published sites as well as active sites. Combining these results with scientific analyses, the study's outcomes offer a new chronological framework for reconstructing the history between Egypt and the eastern Mediterranean during that period.

EGYPT IN THE LEVANT

- ★ Coordinated by the Austrian Academy of Sciences in Austria.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/155318_en.html
- ★ Project website: <http://www.oeaw.ac.at/egypt-levant.html>



"You could compare how many people drive electric, for how long and how far, based on the current technology on the one hand, and how this evolves when technology improves, on the other."

ENERGY AND TRANSPORT

WHAT HAPPENS IF WE ALL DRIVE ELECTRICAL VEHICLES?

The technology behind the design of electric vehicles is ever improving and the EU predicts that these vehicles could be in mass production by 2020. By developing a completely new way of using information from GPS and location data shown by GSM, the EU DATA SIM project simulated the consequences of a massive switch to electric vehicles, and studied the impact on mobility and electricity distribution networks.

The forecasted large-scale uptake of 'electric vehicles' (EV) will have an impact on how we travel and on where and when we will make demands on the electrical grid.

Knowing what the knock-on effect will be once EVs are in general use is key to preparing the way for their uptake. The EU-FP7 project DATA SIM (Data Science for Simulating the Era of Electric Vehicles) carried out research to establish the consequences of a mass switch to EVs, in order to recommend actions to policy makers.

'Big data' giving a detailed picture of transport use in the EU

Until now, researchers have used general criteria, such as employment trends within a region, to map traffic flows. Road users kept diaries, logged their trips and answered questionnaires. Although helpful, this information was not totally reliable as people can be inaccurate or imprecise.

The project has developed a completely new, and highly detailed, time-space

approach based on the use of vast quantities of data from GSM and GPS.

This new behavioural model can predict what would happen if we all started driving electric tomorrow.

'For example, you could compare how many people drive electric, for how long and how far, based on the current technology on the one hand, and how this evolves when technology improves, on the other,' explains project coordinator, Professor Davy Janssens, based at Hasselt University in Belgium.

Smarter electrical grids

Working out what people are doing when they get behind the wheel, and how far they are likely to be going, also means researchers are able to establish what and where energy demands are probably going to be.

As Janssens says, 'You can see whether there is a risk of energy shortages in certain zones when a given number of vehicles are being charged. For example, if too many EVs are charged at the same time, is there a risk that the street lighting will go out?'

These answers will provide useful information for policy-makers, to reinforce the network in those specific locations or to re-design the charging point locations.

One key challenge for renewable energy is its intermittency, with peaks

and troughs in its production. DATA SIM also studied the possibility that the EVs could be used to store excess energy generated in peak periods, and that extra energy stored in the car's batteries could be fed back into the grid when needed (when the cars are parked).

Clever coordination between people and machines

Car sharing, car pooling, charging and driving — coordinating how we interact with our vehicles is central to making transportation greener.

'For the first time, data mining, database management, complex systems, transport, energy and computer science have all come together to find practical solutions for mobility,' says Janssens.

The project, which ran for three years and ended in August 2014, will continue to build on its achievements to find new solutions for the mobility market through the efficient use of large amounts of data. DATA SIM is considering the creation of two spin-off companies, with plans currently at the development stage.

The consortium that oversaw the project comprised nine partners from seven countries and received EUR 2.3 million of investments from the EU.

DATA SIM

- ★ Coordinated by the University of Hasselt in Belgium.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/result/rcn/158710_en.html
- ★ Project website: <http://www.uhasselt.be/datasim>
- ★  <http://bit.ly/1JnPat>

GOING THE EXTRA MILE WITH BATTERIES THAT BREATHE

A major challenge facing full electric vehicles is the limited range between charges. An EU-backed project has designed a new-generation battery that can potentially power a car for up to 500 km, instead of the current 150 km, before needing to be recharged. This breakthrough could encourage more people to buy electric vehicles — a major positive for the environment and Europe's competitiveness.

Lithium-ion batteries are all around us. They are popular in portable devices, such as smartphones, laptops, cameras and more. They are also common in electric vehicles and can even be found in aerospace applications. The reason for the proliferation is that lithium-ion batteries have a high energy density, a slow loss of charge and no 'memory effect' — reduced effectiveness when batteries are not completely recharged.

However, when it comes to electric vehicles that are only powered by a battery, the energy density in lithium-ion batteries still falls short. Such full electric vehicles currently have a top range of just 150 km before they need to be recharged.

'At present, the best technologies are lithium-ion batteries, but they are somewhat limited. The energy content can be increased by up to 50% but not much more than that,' explains Stefano Passerini, a professor specialising in electrochemical energy storage at Germany's Helmholtz-Institute Ulm. He says new battery technologies and chemistries, known as next-generation batteries, are needed to make electric cars more viable.

And that was precisely the focus of the EU-funded LABOHR (Lithium-Air Batteries with split Oxygen Harvesting and Redox processes) project, which Passerini coordinated when he was with Germany's Westfälische Wilhelms-University Münster. The project completed its work in March 2014.

The next-generation technology in question is the lithium-air battery (Li-air), which is both environmentally safe and requires no fossil fuels, says Passerini. Although originally proposed in the 1970s, materials technology had,



at the time, not advanced enough to design and build anything remotely on the scale required to power a vehicle.

But the past few years have brought renewed interest as electric cars, buses, motorcycles and other forms of transport have finally begun to come into their own and

researchers have been keen to find ways to overcome their limitations.

‘There has been quite a lot of work on lithium-air batteries in recent years, but it has

been focused on the fundamental science or has been limited to very small cells,’ notes Elie Paillard, a senior researcher in Passerini’s group who is working on the technical and scientific challenges of lithium-air batteries within LABOHR.

Driven by powerful ambition

Even though no workable blueprint existed for a Li-air battery to power a vehicle, LABOHR set out to design a prototype for a battery that could not only propel a vehicle but also radically increase its range.

The concept uses environmentally-benign ionic liquid electrolytes and nano-structured electrodes. These harvest dry oxygen from the air during discharge and return the oxygen to the atmosphere when the battery is recharging. This design helps to avoid cathode clogging, a common problem with conventional batteries.

LABOHR focused on both design aspects and fundamental research. The project investigated the possibility of scaling up Li-air technology into a battery-pack for electric vehicles. It studied key technological issues, such as the stabilisation of the lithium-metal electrode and the development of porous carbons and catalysts for the air electrode.

‘We came up with a design for a large battery system for cars and we also proved that the principle works on a large scale, but we don’t have a prototype yet,’ says Passerini.

He adds: ‘If we can close the gap between the engineering and the chemistry, it will be possible to make a mid-size car like the Volkswagen Golf travel 500 km with one charge.’

With the project now finished, the former project partners plan to work on getting to the prototype stage. Passerini notes that it would take about a decade before such a battery can be put into production.

Describing it as the ‘Holy Grail’ for the automotive sector, Passerini says that interest from European industry in this technology is enormous. In addition to Volkswagen, which was involved in LABOHR, BMW is also very interested and is already financing related work of the team.

LABOHR’s potential not only contributes to the EU’s environmental, energy-efficiency and transportation objectives, but can also help to advance its renewable energy policy goals.

‘This kind of battery can also be used to store renewable energy, such as that generated by wind turbines,’ says Passerini. ‘But if we can be successful with electrical vehicles, then stationary applications like this will follow, as they are simpler systems.’

LABOHR

- ★ Coordinated by the University of Münster in Germany.
- ★ Funded under FP7-NMP.
- ★ http://ec.europa.eu/research/infocentre/article_en.cfm?artid=34056
- ★ Project website: <http://www.laboehr.eu/>

NEW PATHS TO EFFICIENT ORGANIC SOLAR CELLS

EU-funded scientists have paved the way to more efficient and cost-effective ‘Organic photovoltaics’ (OPVs) through new material design and novel spectroscopic techniques.

The energy performance of OPV blend films — binary mixtures of electron-donor and electron-acceptor materials — has recently reached approximately 10%. Several loss mechanisms that prevent the extraction of the photogenerated charges account for their low power conversion efficiency. These are mainly attributed to the unfavourable nanomorphology of the OPV blends that instead of promoting free-charge extraction favour free-charge recombination.



Scientists initiated the EU-funded project DELUMOPV (Delayed luminescence spectroscopy of organic photovoltaic systems) to provide further insight into the processes that currently limit the power conversion efficiency of solution-processed organic OPV devices. To this end, focus was placed on developing a methodology for tuning the layer nanomorphology to favour charge extraction and increase photocurrent generation. Furthermore, DELUMOPV sought to identify alternative electron acceptors to the presently used expensive fullerene derivatives.

Scientists confirmed that the delayed luminescence intensity of delayed excimer (delplex) states in the micro-second timescale is intertwined with the photocurrent generation efficiency of OPV devices. In particular, the decay dynamics of the delayed luminescence of the charge-transfer states provided useful information regarding the charge transport of the photoactive layers under investi-

gation. Results from the electric field-induced photoluminescence quenching experiments showed that free-charge recombination and trapped charges in OPV devices account for the delayed charge-transfer luminescence.

Scientists designed a state-of-the-art spectroscopic rig to study delayed luminescence from different material combinations. This involved using several non-fullerene-based electron-acceptor materials and polymer electron-donor matrices. Through microscopic techniques, scientists observed a previously unidentified memory effect in OPV polymeric composites. The use of a thin interlayer in OPV devices made of a polymer photoactive layer helped in tuning its morphology to ultimately optimise charge extraction.

DELUMOPV activities aimed to maintain the EU's competitive advantage in the organic electronics and OPV fields. Project findings are expected to serve as a basis for comparisons between

"Scientists observed a previously unidentified memory effect in OPV polymeric composites."

fullerene and non-fullerene-based OPV systems. This should provide valuable feedback to scientists, enabling the design of next-generation molecular structures that will combine the advantageous characteristics of both fullerenes and other polymers.

DELUMOPV

- ★ Coordinated by the Italian Institute of Technology in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158555_en.html
- ★ Project website: <http://www.iit.it/it/risultati/progetti/projects/1837-delumopv.html>

BOOSTING NUCLEAR POWER SAFETY SYSTEMS

Joint efforts between China and the EU have helped to develop new methods of verifying safety-critical software for use in the nuclear power industry.



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sustainability. In this context, 'Instrumentation and control' (I&C) systems represent the central nervous system of a nuclear power plant, monitoring all aspects of its operation and responding with the required adjustments.

The EU-funded project HARMONICS (Harmonised assessment of reliability of modern nuclear I&C software) supported the nuclear industry in exploiting and evaluating software of high-tech safety systems. Keeping in mind the global nature of nuclear energy, the project aimed to propose practical methods to verify software through close collaboration between China and five EU countries.

"The project team designed new software verification tools and methods."

To achieve its aims, the project team designed new software verification tools and methods. It began by outlining the needs, practices and experiences in China and the EU, developing common approaches to assessing reliability and justifying safety-critical software. This involved analysing end-user needs and conducting case studies to validate relevant software.

In the process of developing software verification methods and tools, the project team assessed justification frameworks for software-based systems and outlined approaches to quantifying software failure rates. It

Nuclear energy represents an important part of the energy mix in Europe, and maintaining the strictest safety standards is paramount for the sector's

deployed formal methods, statistical testing and complexity analysis to assess software-based systems, as well as an analytical approach to quantifying software reliability. These approaches and methods were tested in case studies and the results assessed to ensure their validity.

The results from HARMONICS are expected to enhance plant efficiency and upgrade safety through new digital I&C technologies and methods. Licensing of digital I&C systems will become more transparent and cost efficient, while harmonisation in nuclear I&C among EU countries and beyond will facilitate sharing of best practices. Lastly,

the project's results are also expected to boost competitiveness among digital I&C technologies and solutions on the market.

HARMONICS

- ★ Coordinated by the VTT Technical Research Centre of Finland.
- ★ Funded under FP7-EURATOM-FISSION.
- ★ http://cordis.europa.eu/result/rcn/90954_en.html
- ★ Project website: <http://harmonics.vtt.fi/>

SOLAR HEATING SYSTEMS IN OUTDOOR WALLS

Solar water heaters may soon disappear from rooftops to be replaced by almost invisible ones built into balcony facades. This technology is also less expensive compared to conventional systems.

Solar energy is about as renewable as it gets. For millions of years to come, the Sun will continue providing heat and light that can be harnessed to meet the energy demands of human activities. Although solar water heaters have become more common in recent years, it is time for modernisation and enhanced efficiency to achieve significant market penetration.

"The technology provides a modernised version of the solar water heater."

Updating the architecture while improving efficiency was the goal of the EU-funded project HP-LP-SOLAR-FACADE (A novel heat pump assisted solar facade loop heat pipe water heating system). The target was maintenance of water at 40 to 55 degrees Celsius for general domestic use.

Scientists developed a module that minimises the length of piping, enabling creation of a modern wall or balcony facade with integrated heat-absorbing pipes that are part of the loop heat pipe. The HP-LP-SOLAR-FACADE technology consists of outdoor and indoor parts connected by conduits to transport the heat-transfer fluid.

Researchers developed a computer model to enable optimisation of parameters and prediction of performance under a variety of operating conditions. It will be equally useful in future studies.



The technology provides a modernised version of the solar water heater. Integrated into a wall or balcony facade, it eliminates the external piping and bulk, resulting in a less expensive and more aesthetically pleasing design. Sunny southern European climates such as that of Madrid stand to benefit most in terms of both cost and performance.

HP-LP-SOLAR-FACADE makes an important contribution to the EU's renewable energy agenda while

helping place it at the forefront of solar heating technology. Thus, the project has strengthened Europe's competitive position in a market poised for major growth.

HP-LP-SOLAR-FACADE

- ★ Coordinated by the University of Hull in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/154442_en.html

MAXIMISING LIGHT IN OPTOELECTRONIC DEVICES

EU-funded scientists combined metallic nanostructures with semiconductor nanocrystals to significantly improve light trapping in solar cells and photodetector devices.

Colloidal quantum dots' (CQDs) are at the centre of a new and rapidly evolving research field, with the promise of applications in efficient and cost effective solar cells. Used as the absorbing photovoltaic material, they have the advantage of having a band gap that can be tuned simply by changing the nanoparticle size. This allows them to easily absorb different parts of the solar spectrum.

However, the thickness of the CQD layer is restricted in order to retain efficient charge extraction. Therefore, novel light-trapping schemes are required to improve light absorption and efficiency. Plasmonic metal nanostructures have the potential to further enhance light trapping in the ultra-thin absorbing CQD layers.

The EU-funded project PECQDPV (Plasmonically enhanced colloidal quantum dot photodetectors and photovoltaics) studied the optical and electrical effects of embedding engineered photonic structures in simple photoconductor and photodiode devices, fabricated from 'lead sulphide' (PbS) CQD films.

Using photoconductor test devices with embedded arrays of random, self-assembled metal nanoparticles that strongly scatter light, scientists demonstrated a 2.4-factor increase in photocurrent at wavelengths around the exciton peaks of PbS quantum dots of a given size.

Furthermore, they studied the electrical effects of embedding other metal nanostructures in these devices. Depending on the metal, direct contact with nanoparticles led to photocurrent suppression or enhancement. These findings were important for designing plasmonic CQD optoelectronic devices.

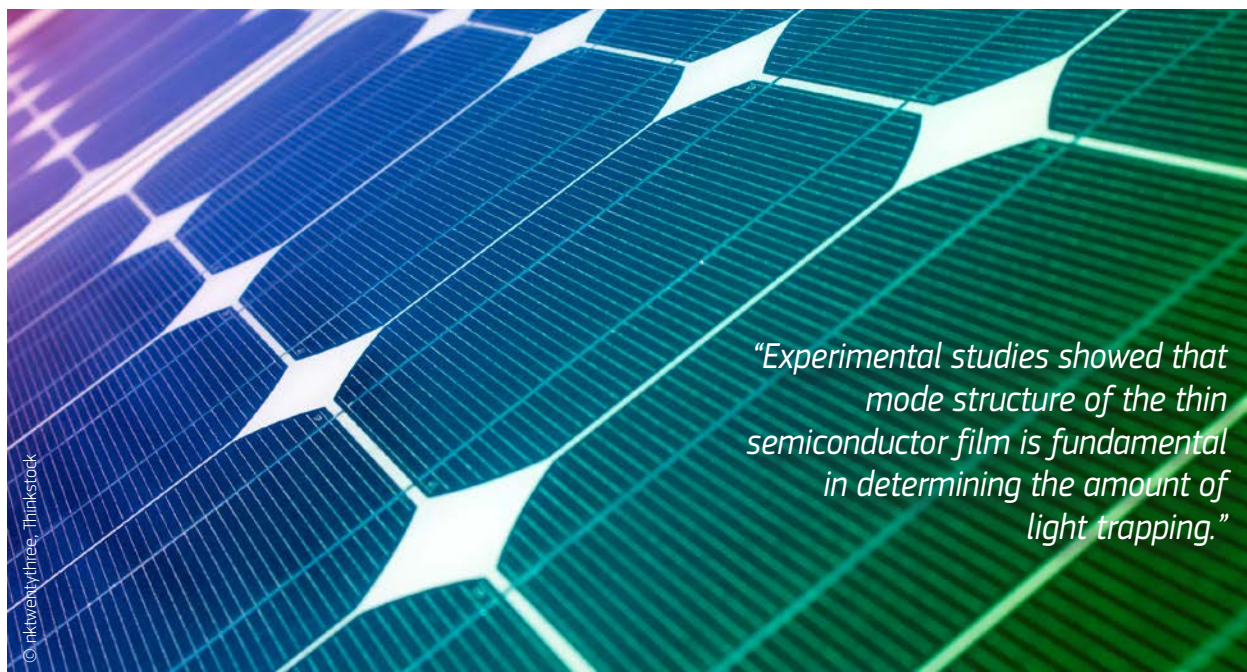
Focus was also placed on exploring the physical mechanisms behind plasmonic enhancement. To this end, scientists performed full-field optical simulations and developed simple analytical models. In simulations with Ag nanoparticles, the angular distribution of the scattered light was found to be relatively narrow, thus reducing its overall light-trapping potential. Experimental studies showed that mode structure of the thin semiconductor film is fundamental in determining the amount of light trapping.

To increase the efficiency of light trapping beyond that provided by random structures, periodically arranged nanostructures were investigated. Scientists developed a conceptual model to provide simple design rules for optimal light trapping in thin films with 2D grating couplers. The grating couplers were integrated into photodiodes as the Au back contact, and achieved photocurrent enhancements of up to a factor of 3 for thin diodes and 1.5 for thick diodes, relative to planar reference devices of similar thickness.

PECQDPV sought to enhance the absorption of CQD devices by incorporating plasmonic nanostructures. The findings enhance understanding of the challenges regarding choice of plasmonic material and methods that enhance light trapping in a CQD device of particular geometry.

PECQDPV

- ★ Coordinated by the Institute of Photonic Sciences in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158435_en.html



"Experimental studies showed that mode structure of the thin semiconductor film is fundamental in determining the amount of light trapping."

ENVIRONMENT AND SOCIETY

RED ALERT FOR RAGWEED ALLERGY

The pollen season is a difficult time for many. In Europe, *Ambrosia artemisiifolia* L., a.k.a. common ragweed, could soon be adding to the plight of allergy sufferers, and many more people could develop symptoms. Climate change will enable this highly allergenic alien species to advance across the continent, say EU-funded researchers, who are calling for urgent action to keep the invader at bay.

Allergy to *Ambrosia artemisiifolia* L. — common ragweed — is likely to become a significant public health problem throughout Europe, according to the findings of the ATOPICA (Atopic diseases in changing climate, land use and air quality) project. The expected changes in climate and land use will help this invasive alien species to spread, says project coordinator Michelle Epstein of the Medical University of Vienna.

As ragweed produces highly allergenic pollen, this development would translate into many more — or more severe — cases of allergy, and add to the burden on health care systems. It would also be bad news for farmers.

ATOPICA involved researchers from fields as diverse as biology and climatology. It has developed modelling techniques that could support similar prospective studies for other invasive species, and it has generated a wealth of clinical data that could hold new clues about the development of allergies.

Ambrosia forever?

Ragweed, an alien species that originated in North America, has been proliferating in Europe since the 1940s. Invasive and resilient, it now infests many parts of the EU, reducing crop yields and affecting the population's quality of life.

ATOPICA conducted clinical trials and laboratory studies to shed new light on the prevalence and mechanisms of ragweed allergy. It also developed scenarios of likely changes in air quality, climate and land use to project the evolution of the ragweed threat to human health by 2050.

With ATOPICA coming to an end in March 2015, final figures and conclusions are expected soon. However, says Epstein, the key message is clear: ragweed is highly likely to spread from its current footholds in Europe across most of the continent.

Weed now or weep later

Action to halt the spread of ragweed should be taken sooner rather than later, says Epstein. 'It's a vicious allergen,' she notes. 'Very aggressive. People who are already allergic to other types of pollen will likely become allergic to ragweed, and their symptoms may be more severe.'

And time is of the essence. 'We really need to address this because it's expensive to deal with ragweed. You have to balance getting rid of it in the short term, before it spreads too much, and dealing with the health care cost in the long run if you don't.'

Already, at least one European in five suffers from a respiratory allergy such as hay fever, according to estimates. If this allergy is caused by pollen, moving closer to a ragweed area — or ragweed moving closer to the patient — will make the problem worse. And *Ambrosia* also causes other types of allergic reaction, such as eczema.

What the victory march of ragweed means for individual patients will vary. For some, the symptoms may be mild. For others, they could include potentially life-threatening asthma attacks.

Tough and aggressive

How to tackle ragweed is another matter. It is extremely tough, says Epstein, and the plant's seed and pollen can survive for several decades. Whether you use fire, herbicides, a sharp knife or biological controls such as ragweed beetles, she explains, it will be a costly, lengthy struggle.

Ragweed produces most of its pesky pollen in August and September. Climate change is likely to make it even more prolific, says Epstein. 'Warmer temperatures in the fall will extend the ragweed season,' she notes.

More time for ragweed to thrive. All the more reason for decision-makers to act.

ATOPICA

- ★ Coordinated by the Medical University of Vienna in Austria.
- ★ Funded under FP7-ENVIRONMENT.
- ★ http://ec.europa.eu/research/infocentre/article_en.cfm?artid=34156
- ★ Project website: <https://www.atopica.eu/>
- ★  <http://bit.ly/1GKxpo3>

HOW ARCTIC GEESE OUTRUN CLIMATE CHANGE

Scientists have studied traditionally Arctic-breeding geese that managed to reproduce successfully in new temperate regions. They investigated physiological trade-offs that the geese make to thrive in Arctic vs. temperate Central Europe habitats.



As the Arctic is experiencing some of the most rapid and severe climate changes on Earth, its animal species must adapt or die. Scientists are keen to understand adaptive responses so that they can better predict the ecological impact of climate change.

“The GOOSEPHYSIOL team showed that geese in climate-harsh Arctic conditions grew much faster than temperate-breeding geese.”

The EU-funded GOOSEPHYSIOL (Resilience to global change in long-lived species: physiological comparisons between Arctic and temperate-breeding barnacle geese) project approached this problem by studying Arctic barnacle geese, which have successfully spread into new temperate environments over past decades.

Scientists predicted that geese from the Arctic would have decreased parasite pressure. This hypothesis was supported, with researchers finding fewer intestinal parasites in Arctic geese than in temperate-breeding geese, meaning the risk of infection is greater in the

novel temperate breeding environment. They also found evidence of adjustments in immunocompetence, with temperate-breeding geese upregulating some but not all of the investigated immune factors.

The GOOSEPHYSIOL team showed that geese in climate-harsh Arctic conditions grew much faster than temperate-breeding geese, reinforcing the supposed benefits of breeding at higher latitudes. Importantly, this has laid the foundation for future research investigating possible trade-offs between immune defence and energy metabolism in young geese raised in the different environments.

This research has yielded novel insights into the types of physiological adaptations a species must make in order to adjust to rapidly changing environments. It also highlights the importance of animal migration and the ability to move to new habitats undeveloped by humans.

GOOSEPHYSIOL

- ★ Coordinated by Lund University in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/157760_en.html

DECISIVE STEP IN SAFEGUARDING EUROPE'S POLLINATORS

Completed in January, the STEP project has considerably advanced our understanding of trends affecting pollinator populations in Europe, while suggesting concrete measures to help safeguard the most important species.

Did you know that three quarters of the world's food crops and 90% of wild plants depend on pollination to thrive? If insects like bees, whose population is declining because of various environmental stressors, were to disappear, the damage in terms of biodiversity, food security and economic growth would be immeasurable. Food products as ubiquitous as coffee and chocolate would become memories of the past, which partly explains why some of the planet's most renowned scientists have been hard at work trying to curb this trend.

For the STEP (Status and Trends of European Pollinators) team, taking on this challenge can only be done with sufficient information on the extent and nature of the decline, which species we need most and why, and the main drivers impacting

population levels. ‘The STEP project is helping us better understand the causes of pollinator declines including habitat loss, climate change, diseases, invasive species and pesticides. Early results suggest that it is a combination of several of these pressures on pollinators that has resulted in the massive losses of wild bees and honeybees,’ explained Dr Potts, coordinator of STEP, a few months after the project started.

Now completed, the project announced this week the publication of the ‘Climatic Risk and Distribution Atlas of European Bumblebees,’ where climate change is identified as one of the main threats to this group of pollinators. The report, the latest in a series of over 50 STEP publications, expands on the likely consequences of different scenarios of global warming for the



years 2050 and 2100. It underlines that as many as 14 and 25 species are projected to lose almost all of their climatically suitable areas under the intermediate and most severe scenario respectively, and that strong mitigation strategies will be needed to preserve this important species and ensure the sustainable provision of pollination services.

To each problem its solution

'The STEP project has generated a substantial body of knowledge on how to conserve pollinators, safeguard the pollination of crops and better understand how to mitigate against threats,' says Dr Potts. One of these solutions, presented in a DG Research article last month, would consist in covering crop land margins with a mix of flowers to attract pollinators and help them colonise new spaces. The team observed a 500% growth in pollinator abundance thanks to this initiative.

Communications was also a big part of the STEP plan, with awareness campaigns having been organised in schools and supermarkets across Europe. The team also actively participated

in international events and initiatives pursuing similar objectives.

The project released a final brochure containing its main recommendations in January. It includes a Red List of European Bees to help direct conservation efforts at the national and continental level, as well as a set of tools and methodologies to help with future monitoring and assessment of both pollinators and the services they deliver, and support planners and decision makers in managing the wider landscape. For the team, European decision makers should now focus on developing robust scientific evidence to underpin policy and practice measures aiming to safeguard our pollinators.

STEP

- ★ Coordinated by the University of Reading in the United Kingdom.
- ★ Funded under FP7-ENVIRONMENT.
- ★ http://cordis.europa.eu/news/rcn/122439_en.html
- ★ Project website: <http://www.step-project.net/>

PINPOINTING BLACK CARBON SOURCES

Researchers have gained new insights into sources of carbon-based aerosols that intensify the impact of climate change in the Arctic.

Airborne 'black carbon' (BC) and 'brown carbon' (BrC) collect in the Arctic, where they can accelerate the effects of global warming. If we are to mitigate this effect, researchers must first know from where, and from which combustion sources, these aerosols come.

The EU-funded ARCTIC BC14 (Source apportionment of climate-forcing black carbon in arctic aerosols by compound-specific radiocarbon analysis) project was established to find some answers using techniques that can distinguish between fossil fuel and biomass combustion. These techniques can also provide information on the relative importance of wood and grass biomass, including crop residues.

Researchers found that in south Asia, biomass combustion and biogenic sources played a bigger role than in East Asia. This data was based on samples collected at the Maldives Climate Observatory in Hanimaadhoo (Republic of the Maldives).

They also studied BC and BrC sources from research centres in Kathmandu (Nepal) and the Himalayas. Furthermore, much time was spent on investigating polycyclic aromatic hydrocarbons and plasticogenic aerosols during long-range transport out of Asia.

ARCTIC BC14 has helped identify the sources of BC and BrC emissions, which will aid efforts to reduce these emissions. This is particularly important for slowing or delaying the

melting of snow, glaciers and sea ice in the Arctic.

"Much time was spent on investigating polycyclic aromatic hydrocarbons and plasticogenic aerosols during long-range transport out of Asia."

ARCTIC BC14

- ★ Coordinated by the University of Stockholm in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/156598_en.html

CAN URBAN GREENING IMPROVE HEALTH?

Researchers have modelled and evaluated different urban greening practices for their ability to influence air pollution and decrease temperatures in cities.

Air quality and urban heat islands in European cities are a growing concern as more and more of the population relocates to urban areas. Different configurations of avenues, roof gardens and green facades may be able to influence air quality and reduce air temperatures in cities.

To test this idea, the EU-funded VEG-AIR (Vegetation and urban air quality: CFD evaluation of vegetation effects on pollutant dispersion) project developed improved models on the influence of vegetation on airflow and temperature in urban areas and provided some initial guidance to urban planners.

The project first investigated the effects of avenue trees on ventilation and air pollution. It did so by testing various airflow models against experimental data. This part of the project identified one model that was the most accurate. Using this model, researchers showed that avenues of trees limited airflow and overall increased the concentration of airborne pollutants.

VEG-AIR also examined whether different greening measures had an effect on air temperatures in cities during hot summer days. Avenue trees reduced urban air temperatures the most, while green facades had a small effect and roof gardens only negligibly affected temperatures.

These results show that using urban greening to improve air quality is far from straightforward. The implications of greening for the urban microclimate are manifold and complex. Nevertheless, the work of VEG-AIR has taken important steps towards using vegetation as an air remediation strategy.



VEG-AIR

- ★ Coordinated by Eindhoven University of Technology in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158572_en.html

ADVANCING EVOLUTIONARY BIOLOGY

The role of 'phenotypic plasticity' (PP) in driving the genetic evolution of a species has attracted much interest. An EU initiative studied a non-native marine species to determine if PP facilitates genetic evolution.



PP — the ability of an organism to modify its traits in response to environmental changes — is pervasive in nature and may accelerate, hinder or have little effect

on evolutionary change. Changes to an organism's characteristics include morphology, development, and biochemical or physiological properties and behaviour.

To understand how PP may affect marine environments, the EU-funded ALIEN SPECIES (Biological invasions in marine ecosystems – The role of phenotypic plasticity) project set out to investigate the Pacific oyster. The species was introduced into Scandinavian countries for commercial purposes about 40 years ago.

The knowledge generated will be key to gaining further insights into the negative impacts and disruption of invasive or non-native species on habitats and bioregions. Another undesirable effect is genetic pollution, gene flow from invasive species to indigenous ones.

Scientists examined what produces PP, its outcomes for the oyster in Sweden and for the evolution of snails and slugs, the harm it causes and its limitations.

When aquaculture operations were suspended, the oyster population was believed to have disappeared, since the waters were not conducive to their survival. On the contrary, oysters have thrived in Denmark, Norway and Sweden over the past 10 years.

Research findings indicated that their traits had evolved, allowing the species to adapt to varying conditions. The oyster was a product of hardwired developmental processes together with external

environmental factors. Scientists also examined how the oyster affected and transformed the animal life of the region and the marine ecosystem.

The team assessed the features and benefits of two new methods that have been developed to study PP. In addition, it held a symposium that brought together PP experts from around the world.

ALIEN SPECIES advanced knowledge of PP as a key mechanism in enabling organisms to cope with and respond to change. The importance of the outcomes will also be seen in the research domains of developmental biology, ecology and evolution.

ALIEN SPECIES

- ★ Coordinated by Lund University in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158567_en.html


 Wholesale

"The project is continually adding new items to GitHub so users can acquire COMPOSE smart 'objects' or modules from the repository."

IT AND TELECOMMUNICATIONS

THE MARKET PLACE OF THE INTERNET OF THINGS

A consortium of EU researchers, software developers and standardisation bodies is creating a new business ecosystem to unleash the power of the Internet of Things for every type of user — from shoppers and motorists to holidaymakers and sports enthusiasts.

Partners in the EU-backed COMPOSE (Collaborative Open Market to Place Objects at your Service) project have built a cloud platform that helps developers navigate their way smoothly through the booming, but often chaotic, Internet of Things (IoT). Their mission is simple: to allow developers to create apps that provide people with internet services and launch them onto the market quickly — whether shopping or traffic information systems, or home-based apps for monitoring, say, energy and water use.

'We give developers a one-stop shop where it is easy to design and deploy IoT applications, providing building

blocks so they can create their own dream apps,' explained project coordinator Benny Mandler, of IBM Research in Haifa, Israel. 'We hope that opening the door to this realm for smaller developers will lead to higher innovation.'

For this, COMPOSE has developed and uploaded libraries of software, all of which can be downloaded free from its open source code repository, GitHub, the largest code host in the world. The project is continually adding new items to GitHub so users can acquire COMPOSE smart 'objects' or modules from the repository.

They can combine these to create their own apps easily and quickly. It

saves building any app from scratch, avoiding wasting time and development money in the process, by using basic blocks that have been developed by programmers in the past and shared through the COMPOSE project.

Shopper behaviour, car sharing and happy skiers

COMPOSE is conducting three pilot projects. One of these involves the start-up U-Hopper, which has won awards for its COMPOSE-based retail analytics platform, RetailerIN, currently on trial at the SAIT-COOP supermarket in Trento, Italy. Shoppers' carts and baskets are tracked to create a

heat map of where customers spend their time in the store. From the office, the store manager can monitor the effectiveness of displays and campaigns, and the queues forming at various counters, changing the supermarket's strategies to suit.

The second pilot involves car sharing among around 750 staff and students at the University of Tarragona in Spain. Through social media, the app encourages car sharing by linking it to reserving spaces in the university car park, thus reducing the number of vehicles travelling to the university every day.

In the third pilot at a resort in Trentino, Italy, skiers get real-time snow and weather conditions fed to their smartphones from a network of meteorological stations. The app, Go2Ski, also helps friends meet up and share

photos, and even informs on the length of queues at ski lifts. And it is truly an app for all seasons! When the snow melts it uses the same meteorology network, but for warmer weather sports such as cycling.

Creating a developer community

The basic aim of COMPOSE is to connect developers to businesses and consumers in a standardised way in order to make some sense out of the muddled state the IoT has represented to date.

The COMPOSE portal has achieved wide visibility among developers, being accessed by more than 8000 users in 70 countries. Five 'hackathons' held in Zürich, London, Bolzano, Barcelona and Trento, have seen around 200 external developers

become actively involved in the validation of the COMPOSE platform. COMPOSE has also launched a Web of Things standardisation initiative for open markets for applications and services based on the IoT and Web of Data.

COMPOSE is a three-year project receiving EUR 7.4 million from FP7, and is made up of 12 partners in six countries. It ends in October 2015.

COMPOSE

- ★ Coordinated by IBM in Israel.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/result/rcn/158809_en.html
- ★ Project website: <http://www.compose-project.eu/>
- ★  <http://bit.ly/1yVfy7w>

MORE REALISTIC VIRTUAL CHARACTERS

An EU team has extended and consolidated key mathematical techniques for improving the realism of computer-generated characters. In addition, the partnership devised means of improving computer capacities to interpret and respond to human movement.

The simulated characters populating virtual worlds, for example in training scenarios, are often unrealistic and unbelievable. Achieving realism (known as 'presence') requires several key advanced graphics technologies.

With EU funding, the project HIFI-PRINTER (High Fidelity Presence and Interaction: convergence of computer graphics, vision and robotics for improving human-robot and

human-computer interaction) aimed to unite essential high-fidelity presence technologies, to make computer-generated characters more lifelike and believable. The single-member project ran

between April 2011 and March 2014, and was administered under the Seventh Framework Programme (FP7) as part of the Marie Curie Action programme.

Project researchers studied a novel framework, based on geometric algebra, allowing real-time simulation. Unlike previous disjointed techniques, the new method unifies and smoothes various simulation technologies.

The project team also investigated options for allowing virtual characters to detect, interpret and appropriately respond to human movement, such as hand gestures or expressions. Researchers received training in the latest methods for making such processes explicit, and the opportunity to apply the concepts in practice.

Project research resulted in several significant publications, including conference presentations, a book chapter and an edited book.

HIFI-PRINTER investigated unifying key methods of adding realism to computer-generated characters. The study also involved methods for allowing simulated characters to interpret human movement.



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HIFI-PRINTER

- ★ Coordinated by the Foundation for Research and Technology Hellas in Greece.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158570_en.html

“Unlike previous disjointed techniques, the new method unifies and smoothes various simulation technologies.”

DESTROYED MOSUL ARTEFACTS TO BE REBUILT IN 3D

Precious artefacts from the Mosul Museum in Iraq may soon rise from the ashes thanks to an EU-led initiative.



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It didn't take long for the scientific community to react. Two weeks after the sacking of the 300 year-old Mosul Museum by a group of ISIS extremists went viral on YouTube, researchers from the ITN-DCH (Initial Training Networks for Digital Cultural Heritage: Projecting our Past to the Future) and 4D-CH-WORLD (Four Dimensional Cultural Heritage World) projects launched Project MOSUL to restore damaged artefacts virtually and make them accessible from virtual museums.

'We assume that much of the museum's contents were looted, and anything small enough to be easily removed will be appearing soon on the antiquities market. Anything too large to remove for sale, appears to have met a violent end at the hand of ISIS extremists. In both cases, it is possible to virtually recreate the lost items through the application of photogrammetry and crowdsourcing. Given enough photographs, digital or scans of analogues, it is possible to reconstruct the artefacts and create digital surrogates of those artefacts. This provides

two immediate benefits: helping to identify looted items and recreating destroyed items,' the project website reads.

To reach this objective, the team is planning to use 4D-CH-WORLD's technology to reconstruct and model Mosul artefacts virtually from crowd-sourced images available online. 4D-CH-WORLD has spent the past two years designing what it calls the 'first worldwide fully automated 4D reconstruction system capable of handling large image galleries in the wild.'

The result of this virtualisation process is already showcased on the project website, where 3D models of artefacts such as the Lion of Mosul are made available. With only a dozen pictures taken from different angles, the team is able to create a faithful copy of the original artefact.

Gathering these pictures, however, will not exactly be a walk in the park. The Mosul Museum has been closed since the outbreak of the Iraq war in 2003, which means relevant images can prove very difficult to find. Pictures of the destroyed museum objects, including Assyrian and Hatrene artefacts, will be retrieved from the Open Access repositories of FLICKR and PICASA, the EU digital library Europeana and anyone else willing to contribute images of his/her own. The team is also calling on volunteers to help

them to sort and tag pictures, process them, take care of coding, etc.

Project MOSUL is coordinated by Dr Marinos Ioannides from Cyprus University of Technology, and Matthew Vincent and Chance M. Coughenour, who are also members of the ITN-DCH project.

"With only a dozen pictures taken from different angles, the team is able to create a faithful copy of the original artefact."

ITN-DCH's ultimate goal is to boost the added value of cultural heritage assets by re-using them in real application environments such as the protection of cultural heritage, education, the tourism industry, advertising, fashion, films, music, publishing, video games and TV. If successful, Project MOSUL will be a case in point for such novel applications.

ITN-DCH

- ★ Coordinated by Cyprus University of Technology in Cyprus.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/news/rcn/122604_en.html
- ★ Project website: <http://www.itn-dch.eu>
- ★  <http://bit.ly/1GoLV6h>

DIGITISING GOVERNMENT SERVICES ACROSS EUROPE

Government services in Europe are being modernised and made accessible online for people and companies across borders in a large-scale project that could save society billions of euros over the coming years.

An EU project aims to connect Europe better by digitising a range of public services, with the promise of making cross-border procedures simpler and more accessible for people and companies, radically reducing bureaucracy and lowering costs.

The EUR 27 million, three-year E-SENS (Electronic Simple European Networked Services) project, half-funded by the EU's Competitiveness and Innovation Framework Programme (CIP), involves public administrations, agencies and companies from 20 countries.

'Digital services vary across Europe, which results in a number of barriers when it comes to cross-border transactions,' explained E-SENS project coordinator Carsten Schmidt, Ministry of Justice, North-Rhine Westphalia (Germany).

'Also the approach towards digital services is different — communication via e-mail or electronic forms — formalities are different and cultural aspects also come into play, not to mention difficulties understanding different business terms or documents. All those challenges need to be addressed,' he said.

Examples of Electronic ID and Document Delivery

During the European Commission preparation of the electronic identification and trust services (e-IDAS) regulation, the businesses involved in consultations said Europe needed an electronic identification (e-ID) that is simple, quick, user-friendly, trustworthy and usable in different

countries for exchanging documentation covering a wide range of public and private sector activities.

This is only one example of the European Union regulatory context in which the E-SENS project has been generated: it builds on the solutions developed in earlier 'Large-scale pilot projects' (LSPs) in the areas of health, justice, business mobility and electronic procurement.

These previous LSPs created the technical building blocks for e-ID and document delivery to work seamlessly in most EU countries, as well as e-Signature, e-Documents and e-Invoicing, to mention a few. Now the E-SENS team is focusing on consolidating, extending and combining the use of these generic building blocks by launching a series of 65 pilots in 18 countries from April 2015 to April 2016 to prove they can be deployed across Europe sustainably and to make them ready for the market.

The aim is to get people and businesses to electronically carry out, on a wide basis, administrative procedures between countries. This could entail anything from accessing health

services to starting a business abroad, bidding for contracts in another country or issuing a claim in a foreign court.

Cost savings and EU investment

'Digitisation of public cross-border services will bring tangible benefits and savings to both public bodies and citizens and entrepreneurs, in terms of money and time,' Mr Schmidt pointed out.

Total savings by reducing administrative burdens in the area of company law alone have been estimated at EUR 69 million per year. Just boosting online cross-border access to patient summaries will save more than EUR 36 million, according to another study. And registering a new legal entity will be over EUR 32 000 cheaper. These are just a few examples of the large benefits that can be obtained, said Mr Schmidt.

In addition, Europe's Connecting Europe Facility, a new financing instrument for trans-European networks in the fields of transport, energy and telecoms through to 2020, is investing some EUR 970 million for Digital Service Infrastructures to deliver networked cross-border services for citizens, businesses and public administrations. This is based on the achievements of E-SENS and is aimed at making the Digital Single Market in Europe become a reality in the very near future.



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E-SENS

- ★ Coordinated by NRW-Justiz in Germany.
- ★ Funded under CIP.
- ★ http://cordis.europa.eu/result/rcn/158775_en.html
- ★ Project website:
<http://www.esens.eu/>
- ★  <http://bit.ly/1FBsYKM>

CONNECTING THE INTERNET OF THINGS TO THE MARKETPLACE

Researchers in the BUTLER project have built a platform to encourage expert cooperation and make the Internet of Things an everyday reality.

The achievements of a landmark EU-funded initiative designed to expand the Internet of Things (IoT) in a cooperative and seamless manner have been published. The three-year BUTLER (uBiquitous, secUre inTernet-of-things with Location and contExt-awaReness) project, officially completed in October 2014, launched a portal to bring together new technologies and devices in order to fully exploit the potential of IoT.

As a result, new connected solutions can now be developed with the potential to reach market in a remarkably short space of time.

The IoT is the common term used to describe the network of physical

objects (or 'things') that have been embedded with electronics, software and sensors, and which can connect with other devices through the internet. These devices collect useful data, which then autonomously flows between other devices.

Current examples already on the market include smart thermostat systems and washer/dryers that utilise Wi-Fi for remote monitoring. Future applications include heart monitoring implants, biochip transponders on farm animals and cars with built-in sensors. The interconnection of such embedded devices is expected to usher in an era of automation across numerous fields, improving our quality of life.

A key challenge however has been ensuring that adequate infrastructure is in place to cope with the anticipated increase in data flows, and that compatibility between devices and objects exists. The BUTLER project, which received EUR 9.7 million in EU funding,

"This system is able to alert merchants about the optimal moments for sending notifications to citizens."

launched an Open Platform portal in order to provide a meeting place for IoT application technologies, and to

ensure cooperation and coordination as IoT expands.

The portal also documents the interoperability of innovations, and makes reference to existing use cases. It was built with the express purpose of becoming the point of reference in the field of IoT, long after this project's official completion.

The Open Platform has already led to new links forged between consortium members, and helped to match device providers with viable solutions to bring innovations to market. Some technologies developed through the platform are at the stage of field trials. This includes the large-scale deployment

in the Spanish city of Santander of a 'Smart Shopping' application.

This system is able to alert merchants about the optimal moments for sending notifications to citizens based on an analysis of the urban environment, incorporating the city's agenda, parking information, banking information and environmental data.

The BUTLER project has also produced a comprehensive analysis of ethics, privacy and data protection issues related to IoT applications. The end result is a set of guidelines that provide a complete framework for privacy-aware and user-oriented IoT technologies. The socioeconomic impact of IoT development has also

been investigated, along with obstacles to large-scale deployment of IoT.

The comprehensive nature of the BUTLER project has enabled it to make a major contribution to IoT research in Europe. Project partners have been published in more than 85 peer reviewed conference papers and 18 peer reviewed journals and have filed several patents.

BUTLER

- ★ Coordinated by inno AG in Germany.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/news/rcn/122487_en.html
- ★ Project website: <http://www.iot-butler.eu>

EFFICIENT SOLUTION TO COPING WITH THE MOBILE DATA REVOLUTION

The EU-funded DUPLO project is ensuring that the next generation of mobile phones can cope with the expected massive increases in data traffic.

Cutting edge research into developing mobile communication technology that uses limited radio bandwidth in a more efficient manner is being presented by the DUPLO (Full-Duplex Radios for Local Access) project at the Mobile World Congress in Barcelona, Spain, which runs from 2 to 5 March 2015.

The DUPLO project has sought to develop practical solutions for coping with massive increases in mobile traffic volumes, along with an anticipated explosion in the number of wireless devices. Mobile and wireless traffic volume is expected to increase a thousand-fold by 2020 compared with 2010.

Adequate infrastructure is needed to cope with this forecasted increase in traffic, in much the same way that Europe's road network has had to be upgraded to meet the rapid increase in the number of cars on the road. Furthermore, the sheer variety of applications and traffic types originating from or reaching our mobiles will soon be significantly larger than today, and will result in more diverse requirements for services, devices and networks.

The solution devised by DUPLO aims to make better use of available bandwidth in an energy-efficient manner through what is known as full-duplex radio transmission. This technology enables the same carrier frequency to be used for data

transmission and reception at the same time, allowing more data to travel within the same radio bandwidth.

At the Barcelona event, a stand-alone multiband electrical-balance duplexer is being presented as a viable alternative to fixed frequency 'Surface-acoustic wave' (SAW) filters which currently feature in mobile phones. 'Our solution paves the way to integrated reconfigurable multiband front-end modules for frequency division duplexing in next-generation mobile phones,' said Joris Van Driessche, programme manager of reconfigurable radios at IMEC, a partner in the DUPLO project.

Indeed, sending and receiving at the same time on the same frequency band opens up new possibilities for improving wireless communication system performance and introducing full-duplex transmission to future 5G (fifth generation) systems. This will also help Europe continue to be a pioneer in the mobile communications revolution, which is driving major technology breakthroughs ranging from wearable devices to connected cars and homes.

In order to get to this point however, the DUPLO project team first had to deal with challenges such as the issue of self-interference caused by transmitting and receiving on the same bandwidth. Technical solutions were studied and developed in order to enable full-duplex transmission to function in a variety of wireless communications networks, including mobile devices.

A proof-of-concept test platform was then established to integrate these technical solutions together into a functional full-duplex communication system.

The 2.5-year DUPLO project, which has received EUR 3.3 million in EU funding, is scheduled for completion at the end of April 2015. Final findings will be discussed at a conference in Glasgow, Scotland in May 2015.

DUPLO

- ★ Coordinated by the University of Oulu in Finland.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/news/rcn/122463_en.html
- ★ Project website: <http://www.fp7-duplo.eu>



INDUSTRIAL TECHNOLOGIES

THE ULTIMATE IN SEMICONDUCTOR MINIATURISATION

A European research project has taken an important step towards the further miniaturisation of nanoelectronics, using a highly-promising new material called silicene. Its goal: to make devices of the future vastly more powerful and energy efficient.

Silicene, a new semiconducting material combining properties of silicon and graphene, is one of the most promising candidates for manufacturing even tinier electronic circuitry for future smart devices.

'Electronics are currently embedded in many layers of silicon atoms. If they can be manufactured in a single layer, they can be shrunk down to much smaller sizes and we can cut down on power leakage, at the same time making devices more powerful and energy efficient,' explained Dr Athanasios Dimoulas, coordinator of the EU's 2D-NANOLATTICES (Strongly anisotropic Graphite-like semiconductor/dielectric 2D nanolattices) project.

Graphene is an interesting substance in that it occurs in a single layer of atoms, but does not have the 'energy gap' needed to be a semiconductor material. Silicene, a 2D form of silicon, brings its semiconductor properties into the world of 2D materials. The problem with silicene, however, is it is modified in contact with other substances such as metals.

Electronics that are 100 times smaller

Condensing electronics into a single layer of silicene and retaining electronic performance has proved a difficult task for researchers — until now that is. The 2D-NANOLATTICES project has produced a significant innovation worldwide by making a 'Field effect transistor' (FET) out of the material to operate at room temperature.

FETs are a key switching component in electronic circuitry. Embedding a FET into just one layer of silicon atoms (in silicene structure), then transferring the layer, grown on a silver substrate, to one made of a more neutral substance, silicon dioxide, is a considerable success. 'Tests showed that performance of silicene is very, very good on the non-metal substrate,' said an enthusiastic Dr Dimoulas from Demokritos, Greece's National Center for Scientific Research.

'The fact that we have this one transistor made of just one single layer of material like silicon has not been done before and this is really something that can be described as a breakthrough. On the basis of this achievement, it could be possible to make transistors up to 100 times smaller in the vertical direction,' Dr Dimoulas added.

Seeing the potential

Now that the transistor has been shrunk vertically into just one 2D layer of atoms, the dimensions can be shrunk laterally, too, meaning the same area on a chip could accommodate up to 25 times more electronics, Dr Dimoulas calculated.

Additionally, the use of a single, narrow channel to conduct electrical current reduces power leakages, a problem that has been worrying the semiconductor industry for some time: how to go even smaller without devices overheating in the form of power leakage.

This is good news for chip manufacturers, as the race to produce the next wave of communications technologies heats up with the advent of 5G mobile networks.

2D-NANOLATTICES, which received EUR 1.63 million of funding from FP7 (through the Future and Emerging Technologies scheme), took place from 1 June 2011 to 31 August 2014 and involved six partners in four EU countries.

2D-NANOLATTICES

- ★ Coordinated by the National Center for Scientific Research Demokritos in Greece.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/result/rcn/157643_en.html
- ★ Project website: <http://www.2dnanolattices.eu/>

ROBOTS TAKE OVER THE IRONING



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EU-funded researchers have developed a robot capable of sorting through and folding piles of rumpled clothes.

Advancements in robotics have enabled humankind to automate a whole range of industrial processes, leading to more efficient and safer production and helping to expand our knowledge through scientific discovery. Why is it, however, that we can send a robot into space to take samples of Martian rocks, but still can't get a household robot to do the ironing?

The recently completed EU-funded CLOPEMA (Clothes Perception and Manipulation) project may finally have a solution to this problem. A robot has been developed, with tests showing it to be capable of organising 'deformed' fabrics (i.e. sorting through a pile of crumpled clothes), and then folding each item neatly. What makes this process so complex is that clothes, unlike objects usually

manipulated by robots, do not retain their shape. A new way of receiving and processing information was therefore required.

One of the novel challenges of this project has been designing the clothes-folding prototype robot from (mainly) off-the-shelf components. A variety of components were assembled — such as cameras and a range of other complex sensors — and integrated into one operating system. A special built-in camera for example enables the robot to see the fibres up close, and to differentiate light fabrics from dark and starchy materials from more flexible ones.

In tests, various garments were presented in a random pile on an arbitrary background, and random requests made to sort, fold, etc. With a mechanical arm, the robot chooses a random fabric, which it then folds and places neatly on a surface. Results were measured and analysed within three carefully defined demonstrator projects of increasing difficulty.

In order to provide help, the robot perceives and manipulates garments in 3D through an active binocular robotic vision system. A database of 80 colour images with corresponding horizontal and vertical disparity maps was created. This database is based on 16 different off-the-shelf garments. Each garment was imaged in five different pose configurations on the project's binocular robot head.

The end result is a state-of-the-art robot capable of independently perceiving and

manipulating all kinds of fabrics, textiles and garments. The operating software is based on a 'Robot operating system' (ROS) and written in C++, Python and Java.

So is this the future of ironing? A commercialised domestic ironing robot may still be some way off. Human hands are highly complex; certain subtle movements such as unbuttoning a shirt are still challenging tasks for robots to perform.

"With a mechanical arm, the robot chooses a random fabric, which it then folds and places neatly on a surface."

The most likely practical use for this prototype robot might be in sorting through fabrics in an industrial setting, with human assistance. The project team has already made contact with a clothing manufacturing company in Italy to investigate the possibility of commercially exploiting robots in the manufacturing sector.

CLOPEMA

- ★ Coordinated by the Centre for Research and Technology Hellas in Greece.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/news/rcn/122523_en.html
- ★ Project website: <http://www.clopema.eu>
- ★  <http://bit.ly/1UOm09>

CATCHING THE MAGNETIC WAVE FOR NEW DEVICES

Magnonics is an emerging and rapidly growing field of research dealing with magnetic phenomena associated with spin waves, a magnetic analogue of sound or light waves. EU-funded scientists have pushed the frontiers of understanding in this field towards creation of a novel type of metamaterials — so called magnonic metamaterials.

Natural materials interact with electromagnetic radiation because they have charges, even if they are neutral overall. However, materials also interact with electromagnetic radiation as a result of spin, a fundamental property of elementary particles. In particular, some atoms have a net spin or magnetic moment and so are called magnetic.

Metamaterials are man-made materials that exhibit unique and interesting properties not seen in nature. The creation of artificial structures in magnetic materials could open the door to unexpected properties, functionalities and applications, including magnetic field-controlled non-volatile electromagnetic devices. EU funding enabled scientists to push

the frontiers of magnetism and its applications through work on the project NOWAPHEN (Novel wave phenomena in magnetic nanostructures).

Magnons are collective excitations of electron spin structure in a crystal lattice. Magnonic crystals, analogous to photonic crystals possessing a frequency range in which light wave propagation is forbidden (the band gap), are metamaterials that possess a periodic structure that prohibits spin wave propagation in restricted bands.

NOWAPHEN scientists, through multi-lateral transfer of knowledge and expertise, conducted a plethora of innovative, proof-of-concept studies to lay the groundwork for future



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development of magnonic metamaterials. Their research covered fields including spintronics, magnonics, electromagnetics and microwave electronics.

Numerous unprecedented results and a wealth of publications attest to the project's success. Highlights include novel characterisation methods for studying magnonic devices and

magnetic properties at interfaces. Scientists discovered enhanced spin wave transmission in nanowires with a zigzag-like magnetisation state. This opens the door to utilisation of effects on propagation velocity in a velocity modulation magnonic transistor. The team also discovered a new form of magnetic anisotropy and a new class of non-reciprocal spin wave phenomena inherent to metallised magnonic crystals.

Magnonics and magneto-photonics are at the forefront of a new era of discovery and magnetic devices with wave control in solids far beyond that offered by photonics and plasmonics. NOWAPHEN scientists have increased knowledge and understanding tremendously, making an important contribution to European excellence in a field that promises to be of great socioeconomic importance.

NOWAPHEN

- ★ Coordinated by the University of Exeter in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158552_en.html

IMPROVED NANO-SCALE PHOTODETECTORS

Systems that detect 'electromagnetic' (EM) radiation in the 'infrared' (IR) region are invaluable in many fields. Novel IR photodetectors with significantly enhanced performance should thus have important benefits for EU manufacturers and the economy.

All objects emit and absorb IR radiation, 'visible' to people as heat. From military surveillance to chemical monitoring, biomedical imaging and machine vision, IR technology is used for a myriad of applications. Enhancing the sensitivity while decreasing the cost will ensure a competitive position for the EU in a large global market sector.

The EU-funded project COQUADOT (Colloidal quantum dot infrared photodetectors) set out to meet the challenge. Its goal was to combine the advanced properties of solution-processed colloidal quantum dots with low-cost, large-scale fabrication methods compatible with monolithic thin-film silicon technology.

Quantum dots are tiny nanocrystals of semiconducting material. COQUADOT scientists explored routes to high-sensitivity optical sensing in the visible and IR regions of the EM spectrum exploiting quantum dots and plasmonics. Plasmonics is a relatively new field. It

studies the enhancement in optical near-fields of sub-wavelength when the EM field interacts with conductive electrons at a metal interface or in metallic nanostructures.

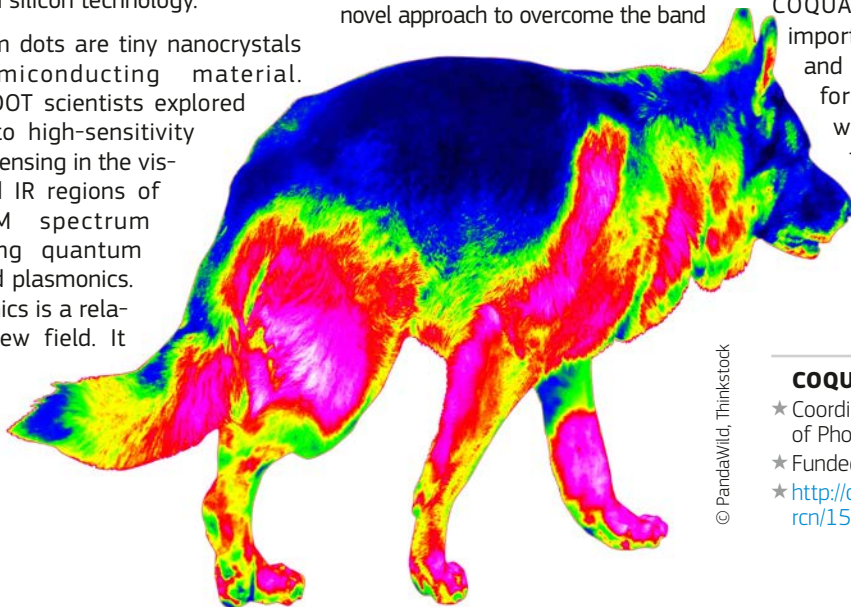
Integration of quantum dots with plasmonic structures including novel nano-focusing architectures such as bull's eye gratings offered significant performance enhancement. Novel hybrid photodetectors coupled colloidal quantum dots with graphene and other 2D semiconductors. These led to unprecedented performance (responsivities and sensitivities). The innovative photodetectors were further developed to operate in both the IR and visible regions.

A second line of inquiry investigated a novel approach to overcome the band

gap limitations of quantum dot semiconductors. Hot carrier plasmonic-based photodetectors take advantage of energetic electrons generated by the relaxation of plasmonic resonance. The latter is an excitation, a surface phenomenon at certain material interfaces in which photostimulation results in a resonant oscillation of conduction electrons.

The metallic nanostructure was designed such that the spectral responsivity of the photodetector is determined by the geometry and not by the band gap of the semiconductor. The route is expected to lead to new ways of optical sensing and low-cost IR photodetectors.

COQUADOT outcomes make an important contribution to a strong and growing field. Enhanced performance of IR photodetectors will not only enhance penetration of current markets but open the door to new high-tech ones as well.



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COQUADOT

- ★ Coordinated by the Institute of Photonic Sciences in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158584_en.html

NANOPARTICLES AS COMPACT LASER SOURCES

'Quantum dots' (QDs) are nanocrystals of semiconductor materials so tiny that they are considered dimensionless. Scientists explored their growth and integration in novel lasers as an alternative to conventional solid-state devices.



Ranging from 2 to 10 nm (10–50 atoms) in size, QDs exhibit quantum size effects such as discrete quantised energy levels. Manipulation of those effects has opened the door to applications in quantum computing, medical imaging, photovoltaics and detectors.

Nanocrystals can produce different colours depending on the size of the particles. The colours, representing different energies, can be exploited in laser sources as an alternative

to expensive, complex and cumbersome solid-state devices. Scientists set out to develop novel materials, devices and design systems relevant to QD-based compact laser devices with EU support of the project QDLASER

(Development of novel quantum dot based materials for compact laser devices for potential telecommunication and biophotonic applications). The focus was on epitaxial growth of QD-based laser structures and associated testing and measurements of materials and devices.

Researchers targeted QD materials working in the spectral range of 1.0–1.6 microns for highly efficient, ultra-short

pulse (down to 100 femtoseconds) laser sources. They utilised the indium arsenide/indium phosphide material system that has a wavelength range around 1.5 microns.

QDs were synthesised primarily via self-assembly (using the Stranski–Krastanow growth method). Following characterisation, scientists evaluated the properties of the assembled QDs as a gain medium. The QD materials were implemented in laser devices (narrow-ridge single-mode lasers and photonic crystal cavity lasers) in which lasing in the continuous mode was successfully demonstrated. Scientists developed tailored growth regimes for the self-assembly of QDs and also conducted an initial experiment on a new approach to QD synthesis (selective area growth approach assisted by diblock copolymer lithography).

The team is on its way to femtosecond laser operation and an emission wavelength of 1.5 microns, expected to be accomplished in the near future. Technology has the potential to enhance the performance of a number of devices in applications including telecommunications, medical imaging and metrology.

QDLASER

★ Coordinated by the Technical University of Denmark.

★ Funded under FP7-PEOPLE.

★ http://cordis.europa.eu/result/rcn/158553_en.html

“The team is on its way to femtosecond laser operation and an emission wavelength of 1.5 microns, expected to be accomplished in the near future.”

FOOD AND AGRICULTURE

NEW SENSOR SYSTEM SNIFFS OUT MYCOTOXINS IN WHEAT

Mycotoxins — produced by fungi — contaminate about 25 % of food crops worldwide, according to the latest estimates. Detecting contamination quickly and reliably is essential for food safety, as mycotoxins could be transferred to bread, for instance, making it unsafe to eat. The MYCOHUNT project developed a system that can sniff out mycotoxins almost immediately. It is expected to be on the market within two years.

Mycotoxins are toxic substances produced by moulds. In agriculture, such moulds can infect a variety of crops, including wheat, barley, oats and maize. Their consumption can cause serious health issues in both humans and animals, ranging from minor ailments to organ damage and a compromised immune system. Before they enter the food and feed chain, heavily contaminated crops must be destroyed.

While exact figures are not available, world economic losses resulting from mycotoxin contamination are staggering. In 1998, the direct and indirect losses following a wheat epidemic in Hungary alone were estimated at roughly EUR 100 million.

Finding the culprit — fast!

In an attempt to speed up the detection process, the EU-funded MYCOHUNT (Rapid Biosensor for the Detection of Mycotoxin in Wheat) project developed an innovative rapid biosensor for 'deoxynivalenol' (DON) in wheat. DON is a mycotoxin most commonly formed in wheat, barley, oats, rye and maize. During the flowering period, a fungus can invade the plant and then start to generate DON — a very stable substance that resists high as well as low temperatures. The European Union currently sets the maximum limit for DON at 1 250 micrograms per kg ($\mu\text{g/kg}$) in food and 8 000 $\mu\text{g/kg}$ in animal feed.

Traditional detection methods — usually performed off-site — rely on the sampling of the wheat grain and require human intervention, which leaves greater room for error. The MYCOHUNT system automatically samples the dust of the wheat grain on-site during harvesting or transfer.

Connected to the transportation pipes or purifying units of the wheat processing facility, the device collects dust samples from each lot and forwards them to the measuring unit. This unit contains a highly sensitive biosensor with specially developed DON-detecting antibodies.

'The main idea, which came from one of the SMEs on the project, was that there is a correlation between mycotoxin content in the wheat grain and in the dust,' says scientific and technical project coordinator Emese Karácsonyi from Ateknea Solutions Hungary.

Calculated on the basis of this correlation, the computer-based control and monitoring unit shows the results within 20 to 30 minutes, depending on the amount of wheat. Traditional methods can take days. This enables traders, millers or growers to monitor crop quality more quickly and efficiently.

Push the button and go

The project consortium made a point of developing a user-friendly system that has also been translated into different languages. 'The operator only has to push the go-button, which makes the system easy to use for farmers or traders on their own after they have received some training,' stresses Karácsonyi.

Testing of the prototype under laboratory conditions and in the field, as well as the training provided to the participating SMEs, went well. Additional tests are now necessary before the finishing touches can be introduced to the system to make it market-ready. They are hoping to introduce the working industrial unit to the market within two years of project completion.

MYCOHUNT

- ★ Coordinated by Ateknea Solutions in Hungary.
- ★ Funded under FP7-SME.
- ★ http://ec.europa.eu/research/infocentre/article_en.cfm?artid=34316
- ★ Project website: <http://mycohunt.eu/>
- ★  <http://bit.ly/1qvH4b7>

HOW RICE ROOTS REGULATE WATER TRANSPORT

Plant scientists have investigated the adaptive mechanism in plant roots that enables them to adapt to non-biological stress such as salinity and drought.

It is predicted that in the next 20 years almost half of the world will be facing severe water stress. Therefore, plant science technologies should be employed to protect this vital resource by improving water-use efficiency in crops.

Rice is a major food crop around the world, but little is known about its aquaporin function and water regulation at the cellular level. The EU-funded ORYZAQUA (Cell biology of rice aquaporins) project addressed these gaps in knowledge in different rice cultivars and changing conditions.

Aquaporins are proteins in the plasma membrane of plant cells that act as water channels and are critical to water regulation. Hydraulic conductivity, water permeability and osmotic potential regulation are some of the key factors involved in water regulation in plants.

ORYZAQUA researchers studied a range of rice aquaporins, root architecture and hydraulics, and subjected them to salt stress and drought conditions. This was then compared to stress-free conditions. In addition, researchers successfully cloned rice aquaporin sequences and

tagged them with 'fluorescent protein' (FP); the transformation of other rice isoforms and cultivars is ongoing.

Researchers successfully cloned the fluorescently-tagged OsRab1 sequence (aquaporin) for co-expressing endomembrane markers tagged with the mCherry FP. Work was also conducted to express other aquaporin sequences that include OsGAP1 and OsNST1. Furthermore, studies were carried out to assess aquaporins' sub-cellular localisation and function in stressed and stress-free conditions in these rice plants.

Work conducted by ORYZAQUA established for the first time the strong inhibitory effect of salinity on the root water transport of young rice plants. It showed a physiological mechanism that can respond to environmental challenges within an hour. Since this inhibitory effect is so rapid, it indicates that the regulation of aquaporin activity is a significant factor in whole-plant response to salinity.

The project will help explain complex interactions between the molecular

pathways for signalling in response to abiotic stress and those controlling cell and organ responses. It will also help to improve agricultural production through better adaptation to climate change and to develop agriculture in marginal lands.

ORYZAQUA

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/92164_en.html



CONTROLLING MUSSEL AND OYSTER PATHOGENS

European shellfish producers are now better equipped to diagnose and control disease outbreaks in their farms.

International and intra-EU trade in cultured marine bivalves like mussels and oysters is on the rise, and this increases the risk of pathogen transfer. To ensure sustainable aquaculture in Europe, the health of farmed shellfish populations must therefore be a priority.

"Researchers improved the efficiency of disease diagnosis, and they developed means to eradicate pathogens in bivalve hatcheries."

with new insights into bivalve diseases, along with practical control strategies. It focused on the most important production species: the Pacific oyster (*Crassostrea gigas*) and two mussel species, namely *Mytilus edulis* and *Mytilus galloprovincialis*.

The EU-funded project BIVALIFE (Controlling infectious diseases in oysters and mussels in Europe) provided the industry

The EU-funded project BIVALIFE (Controlling infectious diseases in oysters and mussels in Europe) provided the industry

Researchers improved the efficiency of disease diagnosis, and they developed means to eradicate pathogens in bivalve hatcheries. They also implemented ultraviolet treatments to inactivate disease-causing agents in live feed without affecting the feed itself.

The project brought various EU research organisations, laboratories and smaller businesses focused on controlling infectious diseases together for a more integrated approach. This resulted in increased capacities and knowledge about pathogen life cycles, as well as environmental and farm risk factors.

BIVALIFE thus strengthened the competitiveness of the European shellfish production sector, ensuring a steady supply of seafood to consumers.

BIVALIFE

- ★ Coordinated by Ifremer in France.
- ★ Funded under FP7-KBBE.
- ★ http://cordis.europa.eu/result/rcn/156605_en.html
- ★ Project website: <http://www.bivalife.eu>
- ★ <http://bit.ly/1y4CGp2>

UNDERSTANDING ASCOCHYTA BLIGHT PATHOGEN

Researchers finally understand how a common and destructive fungus infects and overwhelms its legume hosts.



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Ascochyta blight is a fungal disease that affects peas, chickpeas and other important legume crops. This disease is currently a major limiting factor to the productivity of these crops, which are valued for food and their ability to improve soils.

With the support of EU funding, the ASCOTRANSSEQ (Identification of pathogenicity and virulence genes of

the necrotrophic fungus *Ascochyta* spp. by genome-wide transcriptome analyses coupled to high-throughput next-generation sequencing) project aimed to better understand the fungus that causes ascochyta blight by using high-throughput sequencing techniques. Specifically, researchers looked for genes that were associated with pathogenicity (i.e. infectivity and plant damage).

An important output of the project was a consensus genome sequence of one ascochyta species, *A. rabiei*, pieced together from four variants of the fungus. Another aspect of the project identified all of the genes transcribed by the fungus during its growth in the presence and absence of its host. More than 22 000 genes were identified as part of this process; 597 of these are more expressed when the fungus is growing on a plant. From this information, researchers determined individual genetic changes

that enable the fungus to infect the plant.

Among these, ASCOTRANSSEQ identified genes to disable plant defence systems and plant cell wall-degrading enzymes, as well as toxins to kill plant cells and enzymes to digest dead plant cells.

ASCOTRANSSEQ has produced a vast amount of information about the genetics of the *Ascochyta* fungus. This will underscore research into methods to prevent and treat ascochyta blight, and may have a far-reaching impact on legume agriculture.

ASCOTRANSSEQ

- ★ Coordinated by the Goethe University Frankfurt in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/158634_en.html

NEW TECHNOLOGY FOR SENSING SOIL NUTRIENTS

Researchers have advanced a sensor system that will, for the first time, allow farmers to assess the nutrient status of their soils anytime, anywhere.

Farmers need accurate information about soil nutrient content if they are to apply the correct amount of fertiliser. Traditional laboratory testing is however laborious, taking up to three weeks to complete.

Now, a cost-effective, real-time soil nutrient sensor that delivers a result in less than five hours has been advanced

“A cost-effective, real-time soil nutrient sensor that delivers a result in less than five hours has been advanced.”

by the EU-funded NUTRI-STAT (Real-time, in-situ, N, P, K, pH and electrical conductivity soil-analysis system to facilitate accurate nutrient manage-

ment) project. The device measures nitrogen, phosphorus and potassium micronutrients, as well as the electrical conductivity and pH of the soil.

The sensor components, including electrodes and advanced lab-on-a-chip technology, are enclosed in a porous ceramic/PVC material, with readings displayed on a remote LCD controller. This allows farmers to bury the device itself in the soil indefinitely, without fear of damaging it.

NUTRI-STAT has thus provided the agricultural sector with a pioneering technology that ensures the efficient application of fertiliser. This is important for ensuring proper disease management, boosting crop productivity and also complying with strict EU fertiliser legislation.

NUTRI-STAT

- ★ Coordinated by Ateknea Solutions in Malta.
- ★ Funded under FP7-SME.
- ★ http://cordis.europa.eu/result/rcn/156603_en.html
- ★  <http://bit.ly/1aSEPVS>



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FORUM

GEOSPATIAL WORLD FORUM 2015

The Geospatial World Forum 2015 will take place from 25 to 29 May 2015 in Lisbon, Portugal.

Organised by INSPIRE, the Geospatial World Forum 2015 Secretariat, the conference will welcome over 350 speakers. The theme, 'Convergence: Policies + Practices + Processes via PPP', aims to address the need for greater coordination among policymakers, technology providers and users to benefit the industry, and to highlight geospatial workflows as an enabler for successful PPPs.

Alongside the conference, there will also be an exhibition which offers a platform for technologists, service providers and users of this domain to connect with their peers from the rest of the world. The conference registration fee for five days is EUR 555. This drops to EUR 370 for two days and EUR 250 for one day. These rates apply to those who register by 5 May 2015.

For further information, please visit:
<http://www.geospatialworldforum.org/index.htm>

MAY
28 ▶ 29

Athens, GREECE

EVENT

EUROPEAN MARITIME DAY 2015 – MATCHMAKING EVENT

The European Maritime Day 2015 — Matchmaking Event will take place on 28 May in Athens, Greece.

The event is organised in the framework of the [European Maritime Day Conference \(EMD 2015\)](#), which will take place from 28 to 29 May. EMD is an annual event which gathers together EU maritime stakeholders and EU policymakers to discuss, debate and exchange best practices. This networking event targets innovative companies, universities, researchers, public authorities and other organisations interested in sharing new project ideas and finding collaboration partners to: build partnerships for future funding calls; find technologies to partner with, licence or acquire; or find buyers or development partners.

The Matchmaking Event is free of charge; however, participants need to register for the European Maritime Day Conference in order to participate.

For further information, please visit:
<http://www.b2match.eu/emd2015>

JUNE
01 ▶ 03

Reykjavik, ICELAND

CONFERENCE

INTERNATIONAL CONFERENCE ON COMPUTATIONAL SCIENCE

The International Conference on Computational Science (ICCS 2015) will be held from 1 to 3 June 2015 in Reykjavik, Iceland.

This year's event will focus on the crucial role of computational science in tackling problems within natural systems. It will analyse recent developments in scalable scientific algorithms, advanced software tools, computational grids, advanced numerical methods and novel application areas.

The event attracts around 350 participants every year. It brings together scientists and researchers to discuss problems and solutions in the area, identify new issues and shape future directions for research. Participants include scientists from mathematics and computer science as well as researchers from various application areas pioneering computational methods in other sciences such as physics, chemistry, life sciences, and engineering, but also in the arts and humanitarian fields.

For further information, please visit:
<http://www.iccs-meeting.org/iccs2015/>

JUNE

▶ 11

EVENTS

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

THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION

HORIZON 2020

Ostrava, CZECH REPUBLIC

EVENT

BROKERAGE EVENT HORIZON 2020 — RESEARCH, DEVELOPMENT AND INNOVATION

'Brokerage Event Horizon 2020 — Research, Development and Innovation' will take place on 11 June in Ostrava, Czech Republic.

The event is aimed at organisations intending to prepare a proposal for Horizon 2020, ERASMUS+ or EUROSTARS. It will provide an opportunity for such organisations to find partners for collaborative international R&D projects by meeting face-to-face at the event. The ultimate aim is to nurture research projects, accelerate innovation and facilitate business development.

The event is free of charge and participants will have the opportunity to take part in pre-arranged bilateral meetings lasting for 20 minutes.

For further information, please visit:
<https://b2bharmo.com/OSTRAVA2015>

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