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SPECIAL FEATURE

LET THERE BE LIGHT: TECHNOLOGIES FOR THE VISUALLY IMPAIRED



INFORMATION AND COMMUNICATION TECHNOLOGIES

**A STEP CLOSER IN TACKLING
ONLINE RUMOURS AND
FAKE NEWS**

» PAGE 35



SPACE

**FIRST SATELLITE ABLE TO
RE-ENTER THE ATMOSPHERE
IN A CONTROLLED WAY**

» PAGE 40



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EDITORIAL

by the editorial team

R&D FOR THE VISUALLY-IMPAIRED LEAVES NO ONE BEHIND

We might not realise this until we cross paths with one of them, but our societies are far from disabled friendly. A blatant example of their two-tier evolution can be found in visually-impaired or blind people. Sure, the invention of the Braille alphabet in 1809, or that of screen readers in the early 1980s, were huge steps forwards. But whilst technology keeps evolving, whilst our cities become more crowded, fast-paced and technology-dependent, living without seeing has become increasingly difficult.

On 12 October 2017, we will be celebrating World Sight Day in the face of a thought-provoking statistic: of all the blind or visually-impaired people out there, 80% are avoidably so. For the International Agency for the Prevention of Blindness, the most effective weapon to change this fact is awareness, hopefully leading to more eye examinations in both developed and developing economies.

The question we asked ourselves when working on this issue of the research*eu Results Magazine was, how about the other 20%? Are they doomed to literally be left in the dark, or can R&D provide innovative solutions for them to catch up with this fast-paced world we live in?

Looking through the long list of research projects being funded by the EU, we found that there are indeed reasons for hope. On the one hand, those victims

‘Living without seeing has become increasingly difficult.’

of currently incurable, blinding diseases are now the focus of projects aiming to find new treatments using gene therapy or new drugs. On the other hand, engineers across Europe are designing innovative devices, either boosting the remaining senses to compensate for the loss of sight, or even creating tactile devices that will enable visually-impaired people to benefit from the increasingly graphical contents used in digital communications.

Besides these projects, which are all introduced in this magazine, others are presented across nine themes of research: health, society, transport, environment, agriculture and forestry, industry, information and communication technologies, space and fundamental research. The magazine closes with a list of upcoming events hosted by or involving EU-funded research projects.

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



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Focus on
Digging out the secrets of black holes

4 SPECIAL FEATURE LET THERE BE LIGHT: TECHNOLOGIES FOR THE VISUALLY IMPAIRED



-
- 4 **A vision of sounds for the visually-impaired**

 - 5 A bracelet to restore the sense of space

 - 6 One step closer to a licensed drug for AK

 - 8 A positioning kit for visually-impaired smartphone owners

 - 9 From pixels to taxels: a new world of opportunities for the blind

 - 10 How genome editing could help cure XLRP



12 HEALTH

- 12 **New imaging technology could predict patient response to NMD treatment**
- 13 A non-invasive way to diagnose brain tumours
- 14 Liposome-encapsulated drugs for efficient and prolonged delivery
- 15 Exploring road traffic noise pollution and associated health risks
- 16 The intricate web of gene expression control mechanisms



17 SOCIETY

- 17 **Better investing in Europe**
- 18 Tools for public engagement will make European research more effective
- 19 New recommendations for combating global food and nutrition security
- 20 Harnessing the full potential of an ageing population



21 TRANSPORT

- 21 **Putting the info into urban mobility**
- 22 Development of new, powerful battery means long-range electric ferries on the horizon
- 23 Cleaner engines for greener aviation



24 ENVIRONMENT

- 24 **Modelling ocean flows advances climate change understanding**
- 25 Impact of shrinking sea ice on Arctic seabirds
- 26 Cable bacteria shaking up our understanding of nature



27 AGRICULTURE & FORESTRY

- 27 **From bees to pest control – evaluating nature's hidden services**
- 28 Better, faster detection of AFM1 contamination in milk
- 29 Innovative FIWARE-based apps for more productive farming

30 INDUSTRY

- 30 **Bringing the promise of advanced nano-material products closer, thanks to a new process**
- 31 Software innovation lends a hand to the dredging industry
- 32 Recovery of critical metals from waste promotes green technologies
- 33 Send a thief to catch a thief: learning from nature for multi-scale turbulent flows
- 34 Computational homogenisation in magneto-mechanics



35 INFORMATION AND COMMUNICATION TECHNOLOGIES

- 35 **A step closer in tackling online rumours and fake news**
- 36 ICT solutions to enhance urban water management
- 37 A push towards decentralised online social networks for an enhanced future digital economy
- 39 Toward a practical use of phase-sensitive optical amplifiers



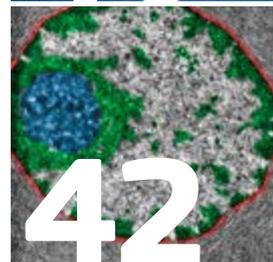
40 SPACE

- 40 **First satellite able to re-enter the atmosphere in a controlled way**
- 41 CubeSat technology validation
- 41 The secrets of young and dying stars



42 FUNDAMENTAL RESEARCH

- 42 **Novel methods lift the veil on chromatin's role in gene expression**
- 43 Self-replicating molecules provide clues to how life may have begun
- 44 Low-cost, flexible substrates for nanoplasmonic sensing
- 45 Looking to insects to understand our biological rhythms
- 46 New insights into the function of fast-spiking, parvalbumin+ GABAergic interneurons



47 EVENTS

**SPECIAL FEATURE****LET THERE BE LIGHT:
TECHNOLOGIES FOR
THE VISUALLY IMPAIRED**

A VISION OF SOUNDS FOR THE VISUALLY-IMPAIRED

The idea of sensory compensation – where remaining senses make up for the loss of another – is a long-standing source of inspiration for both mythology and scientific studies. Now, a technology called ‘Sound of Vision’ combines sensors with sound and tactile feedback to firmly root it in the day-to-day life of visually-impaired people.

The EU-backed SOUND OF VISION (Natural sense of vision through acoustics and haptics) project is all about creating and conveying an auditory representation of the surrounding environment. Composed of 3D cameras and inertial sensors, the device processes data from surrounding objects and feeds it back to the user in the form of spatial sounds and vibration from a wearable belt.

‘Our system can identify and warn the user about potential collisions or falls, suggest best free paths, and even scan for and read texts,’ says Prof. Rúnar Unnþórsson from the University of Iceland. The user is provided with clear, naturalistic visual-to-audio and tactile metaphors, making Sound of Vision an invaluable helpful tool in otherwise highly stressful and unsecure environments.

At first glance, the device could be considered as just another offering in a growing list of similar assistive technologies already available or currently being developed. But that would be ignoring the very features that make it unique and that convinced the EU to invest almost EUR 4 million in its development.

‘There are several important aspects that distinguish Sound of Vision from alternatives,’ Prof. Unnþórsson explains. ‘It works both indoor and outdoor; it can render on audio and/or tactile

channels as required; it provides increased functionality with the likes of free paths and text reading; and it comes with an elaborated set of training procedures that allow for an intensive use of virtual environments to enable self-training. Finally, it offers several alternative methods for encoding and rendering the extracted information. The user can select the most suitable one at any time, based on needs and preferences.’

Sound of Vision is also highly customisable: The user can select different sound and tactile models and fine tune parameters at will.

On to the next prototype

Several prototypes have been developed over the duration of the project, starting with one including only the basic functions, then a more advanced one including most of the above-mentioned features. Each new version was thoroughly tested by volunteer visually-impaired people, confirming the device’s good performance and enabling the team to identify issues. ‘Most complaints have been highly valuable for improving the prototypes, allowing us to keep the most useful encodings and fine tune them,’ says Prof. Unnþórsson.

The team is currently working on their final prototype, which they expect to be ready in October 2017, with a final round of



testing to take place in October/November. Users can expect better reliability, more efficient scanning, encodings and renderings, as well as improved wearability and ergonomics.

'At the top of our list is the continuous improvement of the acquiring and processing of the 3D data. We also need to finish the physical design of the final prototype, and keep fine tuning: for instance, adjusting audio and haptic encodings, fine tuning parameters and improving software reliability and energy efficiency, which are both very important for a wearable device,' Prof. Unnpórsson explains.

As soon as the project gets wrapped up at the end of this year, partners plan to look for continuations and industrial partnerships, in order to further miniaturise the system and start its mass production and commercialisation.

'Small-scale commercialisation can start six to 12 months after the project ends. The device would first go to a small selected group of visually-impaired people willing to help with refining the product. Before full commercialisation, however, we estimate that two years will be needed for the commercial product development, including miniaturisation, cost optimisation, refining, testing and certifications,' Prof. Unnpórsson concludes.

SOUND OF VISION

- ★ Coordinated by the University of Iceland in Iceland.
- ★ Funded under H2020-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/194085>
- ★ Project website: <https://soundofvision.net/>

A BRACELET TO RESTORE THE SENSE OF SPACE

Building a sense of space can be overwhelming for blind children. A new set of devices providing audio feedback on their body movements should soon enable better posture control, motor coordination and spatial orientation.

Kicked off in 2014, the ABBI (Audio Bracelet for Blind Interaction: a new technology based on sensory-motor rehabilitation for visually impaired children) project set itself the ambitious goal of surpassing existing technologies for visually-impaired people. It builds on the observation that early intervention is fundamental, that current devices are not widely accepted by adults and are ill-adapted for children, and that they are often not meant for rehabilitation purposes.

'These devices are too complex because they imply the need to learn a new language following long training programmes and the integration of multiple sensory signals,' Dr Monica Gori, coordinator of the project for the Italian Institute of Technology (IIT), points out.

The ABBI does not require new languages to be learnt and can be used during the early years of life. Once worn, it starts sensing body motion, triggers a sound and provides the user with spatial information on where and how the movement is taking place. When placed on different people in a household for example, it provides a better sense of events and improves the social skills of the visually-impaired. The ABBI can store motion data for off-line analysis and even broadcast beacon messages that can be picked by nearby smartphones. The ABBI is all about stimulating the other senses.

Different prototypes were tested in children from 3 to 17 years old, by conducting longitudinal three-month rehabilitation training. Over this period, half the children (the experimental group) completed the training with the ABBI,

whilst the other group (the control group) followed the typical rehabilitation process without any backup.

'Results suggest that the use of the audio-motor training helps rehabilitate the sense of space and motor skills, and that this improvement is maintained even one year after the training,' Dr Gori says. 'Meanwhile, the control group showed no sign of improvement.'

Social interaction training courses were also run to assess the capacity of many ABBI users to communicate together. 'In this experiment, several people were wearing an ABBI, which provides feedback on their position in the room and their activity. Special games have been developed to encourage playful activity in small groups of children. We found that it is possible to alleviate problems that might derive from having an impaired sense of space, such as a lack of mobility, poor navigation skills and limited interaction with others,' Dr Gori explains.

Commercialisation within a year

Thanks to the active involvement of children with visual impairment, rehabilitators and therapists, the ABBI was shown to improve spatial, mobility and social skills after just three months of use.

An IIT survey with stakeholders and opinion leaders suggests that there is a strong, unmet medical need for new technologies and services to integrate existing methods used to help visually-impaired people. With this in mind, the ABBI could be used as a complement to existing tools and techniques both at home and in public spaces.

The team has already developed an ABBI kit for commercialisation. They also wrote a book containing all the audio games developed during the project. Dr Gori expects commercialisation within a year: 'The device has been patented and we are now working for the CE mark. We are





© Monica Gori

DR MONICA GORI

“The ABBI was shown to improve spatial, mobility and social skills after just three months of use.”

ready to make the ABBI a product, obviously by involving those technological partners that are interested in investing in it. We think that it would be an important step forward if this new technology could reach visually-impaired children and adults across Europe.’

ABBI

- ★ Coordinated by the Italian Institute of Technology in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/189033>
- ★ Project website: <https://www.abbiproject.eu/>
- ★  <http://bit.ly/2j1W0Xn>

INTERVIEW

ONE STEP CLOSER TO A LICENSED DRUG FOR AK

Acanthamoeba keratitis (AK) is a relatively unknown disease affecting less than 0.1 in 10 000 EU citizens. Yet evidence suggests that its incidence is increasing. Whilst the market is too small for pharmaceutical companies, an EU-funded consortium has successfully conducted a Phase I clinical trial on PHMB as a treatment for AK, potentially preventing permanent visual impairment or blindness in patients.

A *canthamoeba spp* are microbial protozoa with a life cycle consisting of two main stages: trophozoite and cyst. Whilst the former is sensitive to most available chemotherapeutic agents, the latter is a dormant form that can survive in extreme adverse environmental conditions. People wearing contact lenses are particularly concerned with this threat: they make up 85% of AK cases and often present increased infection levels.

Yet there is hope. In 2007, SIFI (Società Industria Farmaceutica Italiana) received an orphan drug designation for PHMB, an antimicrobial polymer, to treat AK. Whilst drug development was delayed due to a cost/benefit analysis that made pre-clinical and clinical research activities difficult to sustain, EC funding under the ODAK (Orphan Drug for *Acanthamoeba* Keratitis) project has allowed the company and five other organisations from across Europe to invest in clinical trials.

★ **What is ODAK about?**

Antonino Asero: ODAK is a project led by SIFI, mobilising the critical mass of industrial and academic expertise needed to develop and optimise a therapeutic approach using PHMB to alleviate the severe negative impacts of AK on the health and quality of life of patients.

★ **What is PHMB and how can it cure this disease?**

Polyhexamethylene biguanide hydrochloride (PHMB) has been used for over 60 years as an antimicrobial agent. Commercially, it is used as a general disinfectant and

antiseptic in swimming pools, in the cosmetics industry, in contact lens and eye drop solutions, in surgical and non-surgical wound dressings and in the food industry, due to its broad spectrum of antimicrobial activity.

PHMB works by binding to the cell membrane, causing complex reactions to alter the integrity of the wall. This interaction with the cytoplasmic membrane results in loss of cellular components and inhibition of respiratory enzymes. This allows entry of the PHMB, reducing wall strength and, hence, death of the organism.

In the early 1990s, Moorfields Eye Hospital and the Institute of Ophthalmology conducted a groundbreaking study on the use of PHMB to treat AK. It has since been used worldwide, off label, in the treatment of AK. Data suggest that PHMB used as monotherapy has a good risk-to-benefit ratio and is a valid candidate for a new drug licensing application.

★ **What were the main challenges you faced in moving this project forward and how did you overcome them?**

We have encountered several technical obstacles during the project development path. The most critical ones have been a constant and continuous supply of PHMB. Additionally, developing an appropriate analytical method to investigate PHMB pharmacokinetics in biological matrices was a difficult barrier to overcome.

However, negotiation with the manufacturer was the key to resolving the PHMB supply issue. The pharmacokinetics



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were approached through different analytical studies. A recent scientific publication has been very helpful in demonstrating the intrinsic difficulties in the PHMB molecule being detected at low doses in animal tissues.

★ **What would you say have been the most notable results of the project so far? Did it meet your initial expectations?**

After resolving the main technical issues, the positive results of preclinical work allowed us to initiate and successfully complete a Phase I clinical study with three dose levels (0.04%, 0.06% and 0.08%) of PHMB ophthalmic solution.

The double-masked, placebo-controlled, parallel-group multi-centre Phase I study was performed in 90 healthy volunteers. The study concluded that 0.08% PHMB eye drops are safe and could be investigated in a Phase III study in patients with AK. These results met our expectations of selecting a safe PHMB concentration to be used in humans.

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

The Phase 3 clinical study started in August 2017 at the first clinical trial site in Moorfields Eye Hospital – London. This study will evaluate the efficacy, safety and tolerability of a 0.08% PHMB ophthalmic solution in 130 subjects affected by AK. Additional UK sites in Manchester and Southampton are expected to follow shortly and trial sites in Italy (Milan and Venice) and Poland (Katowice) are expected to open for recruitment in September 2017. Following the completion of the study, SIFI will apply to the EMA for marketing authorisation and once granted bring the drug to market. The project is also providing guidelines and information on the prevention, diagnosis and treatment of the disease. Currently, AK is easily misdiagnosed in contact lens wearers, but early diagnosis is crucial to ensure the correct treatment. Often, topical corticosteroids are initiated following misdiagnosis of AK as herpetic keratitis. Unfortunately, this can make the symptoms worse and treatment more difficult.

★ **If all goes according to plan, when do you expect the new treatment to be commercialised?**

Overall, our ambition is to improve clinical resolution rates through early, accurate diagnosis and an effective drug regimen. We want to achieve this as quickly as possible.

The current timelines suggest that the Marketing Authorisation Application dossier will be ready for submission in Q1 2020 and commercialisation will rapidly follow once approval is received. In the short term, our approaches to providing guidelines on disease diagnosis and prevention will be completed in the coming months.

ODAK

- ★ Coordinated by the University of Rouen Normandy in France.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/106735>
- ★ Project website: <http://www.odak-project.eu/>



© Antonino Asero

ANTONINO ASERO



A POSITIONING KIT FOR VISUALLY-IMPAIRED SMARTPHONE OWNERS

If you have ever had to rely on web mapping services to walk around a city, you probably noticed how positioning often lacks the precision required to do the job. Navocap, a French SME specialising in electronics, has developed an app/positioning unit combo that should be of particular help to those suffering the most from this unreliability.

For people with visual or cognitive impairment, getting reliable information in an environment as hostile and frightening as a crowded city is vital.

Navocap realised this in 2008, when it launched its subsidiary Angeo Technology. Since then, the company has received support from the likes of venture capital company Wiseed and CNES subsidiary Telespace Participation. It commercialised its Angeo-Mobile kit in 2012 to provide visually-impaired people with reliable positioning in dense urban areas. In 2015, it secured EU support under the ANGE02 (For cognitively-impaired or visually-impaired persons suffering from spatial disorientation, a smartphone-based navigation aid that is both reliable and safe for urban pedestrian mobility) project, the objective being to improve the ANGE0 kit and bring it to smartphones.

Navocap's main achievement was to overcome the limitations of GPS positioning with a technology of its own. 'The low performance of other systems finds its source in the lack of reliability of GPS in urban environments,' explains Edgard Antoine, CEO of Navocap. 'In such environments, street canyons often block or divert satellite signals. Besides, the algorithms calculating itineraries rely on a modelling of streets based on their axis. In other words, if you stand, let's say, on an avenue that's 40 metres wide, the 5-metre precision you would usually get with a standard device requires you to wander in the middle of that avenue. I've tried it personally and wouldn't recommend it to anyone...'

ANGE02 – which was recently renamed ANGE0-S to better reflect its nature – comes in the form of a module that can be connected to any smartphone application requiring reliable positioning. The module comprises a reliable positioning unit (RPU), as well as a navigation app of its own, available on the App Store and called Angeo-NAV.

Edgard Antoine explains how the system works: 'The RPU connects to the



smartphone via Bluetooth, and it can be attached to the user's belt. A remote control pinned to the shirt collar allows for keeping the hand of the user free from any burden, and an earphone or bone conduction headphones can complete the kit in particularly noisy environments. The user can communicate with the device by using Apple's "Voice Over" speech synthesis and recognition application dedicated to visually-impaired users.'

To resolve GPS-related issues, the device multiplies satellite-based information sources by using data from the world's three biggest global navigation services: GPS, GALILEO and GLONASS. It then cross-checks this data with that of an inertial unit capable of determining the existence or non-existence of multiple pathways, and compensates for any loss of satellite signal.

'When it comes to calculating itineraries, ANGE0-S uses a specific algorithm that takes into account street width, the need for multimodal routes (pedestrian, bus, tram, metro, etc.) and the personal preferences of visually-impaired people wanting to avoid major roads,' says Edgard Antoine.

Navocap plans for tests to take place at the Vision Institute in Paris at the end of September 2017. If all goes according to plan, Antoine expects a

"If all goes according to plan, Antoine expects a commercial launch in June 2018."

commercial launch in June 2018. In the meantime, the first-generation of the ANGE0 kit including GPS receiver, inertial unit and cellular modem can already be purchased.

'We foresee two main vehicles for commercialisation: associations working with blind and visually-impaired people, and door-to-door sales following a business model similar to that of companies like Tupperware,' says Antoine. 'ANGE0-S is a major step towards answering the needs of these users, and we couldn't have gotten that far without support from the SME-Instrument,' he adds.

ANGE02

- ★ Coordinated by Navocap in France.
- ★ Funded under H2020-SME.
- ★ <http://cordis.europa.eu/project/rcn/198908>



INTERVIEW

FROM PIXELS TO TAXELS: A NEW WORLD OF OPPORTUNITIES FOR THE BLIND

Digital technologies have never evolved at such an incredible pace. Yet, they are still leaving people behind: visually-impaired people, for example, are completely locked out from the use of touchscreen devices. An EU-funded consortium has therefore created the BlindPAD to exploit and enhance their remaining senses.

At the heart of the BLINDPAD (Personal Assistive Device for BLIND and visually impaired people) project was a single question: How can graphical contents be made accessible through touch? With current technologies essentially relying on visual user interfaces and graphical information, the sense of touch has been neglected, and the need for tactile technologies to facilitate the inclusion of visually-impaired people in modern society has never been so important.

As Dr Luca Brayda, researcher at the Robotics, Brain and Cognitive Sciences Department of the Italian Institute of Technology, explains, the BlindPAD aims to become to digital graphical information and communication what Braille is to text.

★ **What are the main problems with current technology and its use of (or lack thereof) the sense of touch?**

Dr Luca Brayda: Blind people need to use the residual sense of touch to understand information – something not at all achieved for graphics. Overcoming that issue would require the fabrication of a tactile tablet for blind persons, which has been a challenge for decades. This is the concept of ‘sensory substitution’: Much like pixels, one digital image can be formed by a grid of small tactile pins (‘taxels’) that can be programmed to be ‘up’ or ‘down’, therefore forming a bas-relief that can be sensed and understood with the hands.

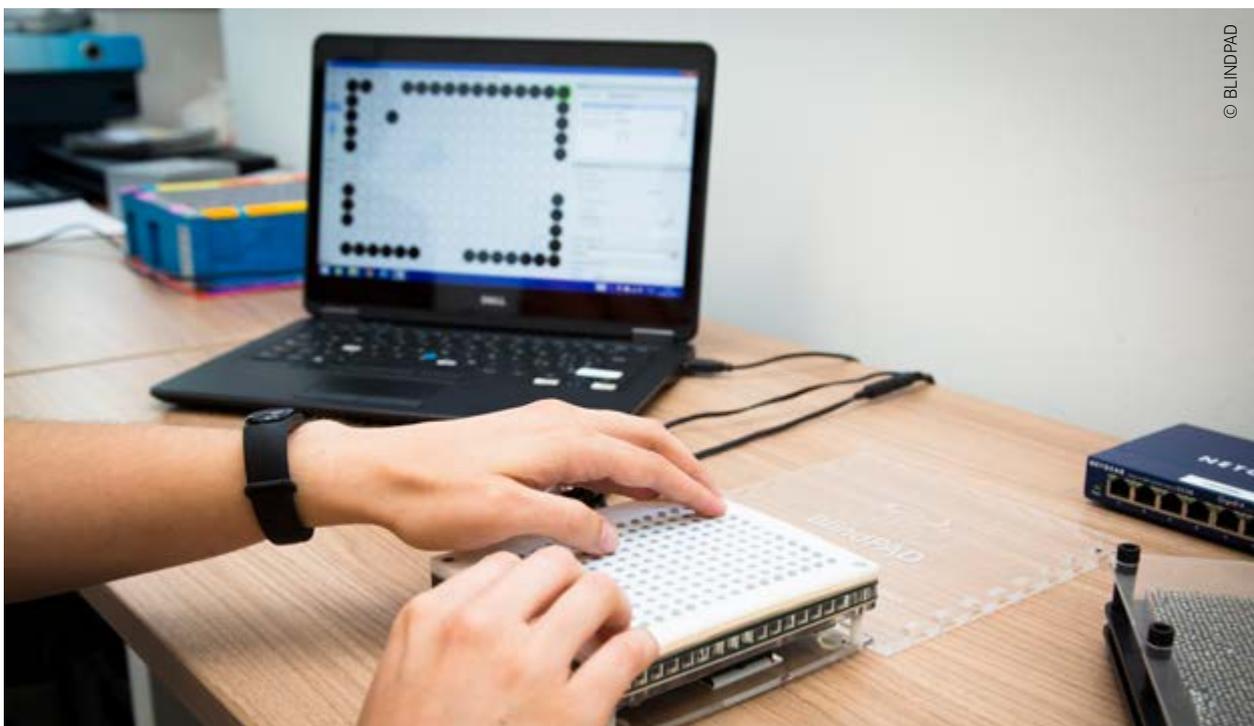
However, making a dense array of taxels with sufficient force and displacement to be easily felt by any user – that is also low power, fast and compact – is a major technological challenge. Due to the complexity of drive electronics or the lack of performance of actuators, none of the previous technological solutions was shown to be scalable, have sufficient performance and be portable.

★ **How does the BlindPAD represent a breakthrough in this regard?**

The BlindPAD has successfully been built and field-tested. It is a system comprising a new tactile tablet, software translating images into tactile representations and a series of exercises that together make digital graphical information accessible to blind and visually-impaired persons.

We have verified the effectiveness of this system especially at the developmental age. Our results contribute to various fields of research. First, to the research field of material engineering – as we have shown that it is possible to build arrangements of small elements able to deliver high forces but with small components. Then, to the field of experimental psychology and cognitive neuroscience, in which the potential abilities of persons with sensory deficits are still debated and to a certain extent underestimated or at least unexploited.

It doesn’t stop there. The project advanced the field of computer-human interaction: since Tactile feedback on





SPECIAL FEATURE

non-flat screens had received attention before BlindPAD, but produced very few solutions going beyond academic experimental setups. More generally, it advanced the field of computer-assisted rehabilitation where no standards exist. The access to digital information can be a breakthrough in making rehabilitation practices semi-autonomous.

★ **What can you tell us about BlindPAD components and the way it works?**

Our tactile display is 12 cm x 15 cm in size, consisting of 192 electromagnetic, independent taxels. Each taxel is very fast in changing state (up/down), allowing static and moving patterns to be displayed.

Together, the taxels can form arbitrary simple sketches: graphs, symbols, emoticons, conventional signs. Conventional visual contents can therefore be learnt through both vision and touch.

★ **What use cases did you aim to assess with your serious games and why?**

We considered two paramount use cases: learning mathematics and learning unknown spaces from maps. We have shown that the BlindPAD successfully trains visual-spatial working memory, complex mental operations and mathematical concepts and helps picture maps of unknown rooms, helping people to find their own position in a real environment.

We believe that learning mathematics is crucial at developmental age: poor knowledge of scientific content undermines skills such as logical reasoning and spatial awareness. A bigger issue is mobility, since tactile maps available in public places are rare, often too complex, costly and sometimes not accessible. An instrument used to display maps dynamically, even lightly like what is being done with Google Maps, does not exist and blind persons are locked out from modern society.

Almost no blind persons specialise in scientific-oriented high schools because of this issue. However, it is known that blind people can develop quite accurate spatial skills. The problem is not how to develop knowledge about space, but rather how to access information about it.

★ **Did the results live up to your initial expectations?**

Yes. We expected to make spatial knowledge better with the BlindPAD, and our experiments confirmed that. Although resolution can be improved, a lot of spatial tasks with about 200 taxels can be efficiently performed. The prototype as it is can be used within rehabilitation contexts.



© Luca Brayda

DR LUCA BRAYDA

★ **What can you tell us of your commercial strategy? When can the BlindPAD be expected on the market?**

The BlindPAD system was built in three years, from scratch: It now comprises a hardware tactile device, software running on most PCs and tablets, and a series of exercises that stimulate abilities linked to spatial working memory, spatial processing, logics and mathematical reasoning.

The system, as it is, can be used in rehabilitation centres, potentially with very high impact on rehabilitation practices. Our prototypes are rather easy to reproduce, therefore the technology can be exploited by transferring it to a start-up. With a relatively low effort in terms of engineering, it can become a product. Further funding could allow us to launch a product on the market within less than two years.

BLINDPAD

- ★ Coordinated by the Italian Institute of Technology in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/189036>
- ★ Project website: <https://www.blindpad.eu>
- ★  <http://bit.ly/2ynK544>

HOW GENOME EDITING COULD HELP CURE XLRP

Thanks to funding under the REGAIN project, Dr Knut Stieger, Professor of Experimental Ophthalmology at the University of Giessen, is well on track to finding a treatment for X-linked *retinitis pigmentosa* (XLRP). His research is set not only to benefit XLRP patients, but also to advance the state-of-the-art in targeted gene correction strategies.

One in every 10 to 15 000 European citizens are affected by XLRP within their first 10 years of life. This genetic disorder causes significant vision impairment

and even sometimes complete blindness – and there is no cure.

'In 80% of XLRP cases, a mutation in the RPGR gene causes the absence of

protein or the production of nonfunctional proteins, with both cases leading to an impaired transport of proteins into the outer segments of photoreceptors. This problem leads to



the absence of function of the photoreceptors and their subsequent degeneration,' Dr Stieger explains.

XLRP needs to be treated on a genetic basis. Classic gene addition therapy – in which a correct copy of the cDNA of the gene is transferred into the photoreceptors in order to produce the functionally active protein – is currently under investigation in several clinical trials. However, the artificial control of transgene expression and the need to produce the protein over a very long time are major limitations inherent to this technique.

Enter genome editing, which can correct the disease-causing mutation within the photoreceptors, thus recreating a normal genetic situation allowing for the production of as much protein as is needed for the rest of the patient's lifetime. This is specifically the technique being investigated in Dr Stieger's REGAIN (Retinal Gene Alteration in XLRP) project, which uses CRISPR-Cas for his new treatment approach.

'In XLRP, a large number of patients have disease-causing mutations in one single exon of a gene, the RPGR-ORF15. Replacement of the entire exon with the correct sequence through homology-directed repair (HDR) could be an effective treatment approach for a large number of patients. It can be done by inducing one or more DNA double strand breaks

(DSB) at the target site, which get repaired by the cells' own repair machinery through one of several mechanisms. Choosing the right mechanism will lead to the repair being exactly how we want it to treat the disease.'

A long, rewarding path

Normally, DSBs are repaired by an error prone repair pathway called non-homologous end-joining (NHEJ). The main challenge for Dr Stieger and his team is to prevent this repair pathway from activating at all cost. To this end, they will try to bias the repair machinery towards the HDR or microhomology mediated end-joining (MMEJ). 'It is difficult, but it can be done by temporal manipulation of the repair machinery,' he says.

The second challenge is to perform this repair *in vivo* in the cells of the retina. Transferring all necessary components into photoreceptors is not easy, but crucial nonetheless. A few months away from the project's ending, the team is still trying to find the best approach by using viral vectors or nanoparticles.

'My initial expectation was that we would develop a new therapeutic strategy, and the initial data lives up to this expectation. We still have a very long and complex journey ahead of us, but I think it is worth the effort,' Dr Stieger says.

To date, the project's most important finding certainly is the fact that DNA repair is cell type-specific within the retina, and most likely in all cell types of the body. Dr Stieger believes that this observation needs to be taken into account for every genome editing strategy, and should also be addressed in current plans to start clinical trials for certain forms of *retinitis pigmentosa*.

Over the next few months, the team will focus on controlling the different repair mechanisms of the cell, as well as finding a way to efficiently promote DNA repair in photoreceptors *in vivo*.

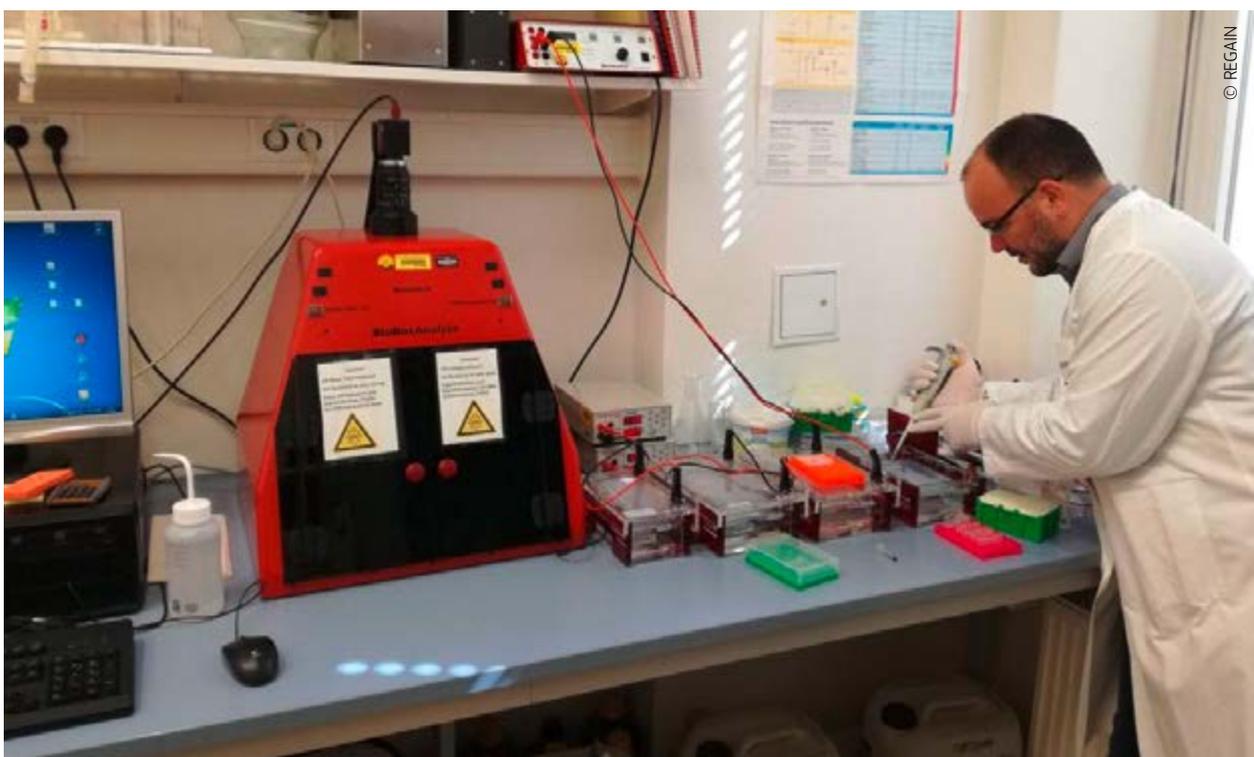
REGAIN

★ Hosted by the University of Giessen in Germany.

★ Funded under FP7-IDEAS-ERC.

★ <http://cordis.europa.eu/project/rcn/105529>

"My initial expectation was that we would develop a new therapeutic strategy, and the initial data lives up to this expectation."



HEALTH

NEW IMAGING TECHNOLOGY COULD PREDICT PATIENT RESPONSE TO NMD TREATMENT

Since not all patients respond to disease or treatment in the same manner, it is of vital importance for physicians to run tests on large cohorts. When facing rare diseases such as Duchenne muscular dystrophy (DMD), however, such cohorts just don't exist and other methods are required. Novel imaging technology developed under the BIOIMAGE-NMD project aims to fill this gap.

The project's purpose was to enable the monitoring of patient response to novel therapies in neuromuscular diseases (NMDs), with DMD being used as a case in point. As Dr Andrew Blamire, Director of Newcastle University's Centre for In Vivo Imaging, explains, there are two major driving factors for developing such monitoring technologies.

The first is the need to identify statistically meaningful differences in response to treatment. 'Many NMDs have a profound impact on muscle strength and function. In trials of new treatments, one will therefore assess, for example, the distance the patient can walk in six minutes as an indication of muscle damage and then see how this changes over time or with treatment,' Dr Blamire explains. 'On the other hand, imaging technology can quantify the degree of muscle damage directly and non-invasively, and provide valuable new outcome measures for trials.'

The second factor is the need to know how the drug interacts with the patient. To achieve this, the project team created imaging technologies which, via drug-labelling approaches, may in the future allow physicians to follow where the drug goes in the body.

New scanning approaches

When it came down to identifying an exemplar disease, the choice of DMD was a no-brainer. Consortium members shared a common interest in the

disease and, at the time of establishing the BIOIMAGE-NMD (BIOIMAGE-Neuromuscular Diseases) project, a number of new treatments for DMD were approaching clinical trial.

The project team started their work with a comprehensive evaluation of several forms of magnetic resonance imaging (MRI). They developed an approach called diffusion imaging, along with new methods to analyse and quantify the scans. In parallel, they developed an approach using positron emission tomography (PET) – a form of imaging which uses radioactively labelled tracer molecules – to label a novel drug called antisense oligonucleotide (AON) which was about to be trialled in DMD patients.

'We developed a way to add a radioactive atom to the drug and make it visible from outside the body using the PET scanner,' Dr Blamire says. 'We have shown in animal models that this new labelling approach does not prevent the drug from acting in the way in which it was designed. This is an important development, as AON is not just being used in patients with DMD but has a wider potential role in diseases with a genetic cause.'

BIOIMAGE-NMD's new diffusion imaging advances have yet to be applied in clinical trials, however, the use of existing quantitative MRI scanning during AON clinical trials allowed for mapping DMD progression by imaging.

'We observed that imaging can clearly detect subtle changes in disease progression and is more sensitive than the routine clinical assessment. We also observed that there is a lot of variation in the rate of disease progression between individual patients, even though they have very similar genetic changes causing their disease, and we identified that we need to further understand the cause of this variation to improve the utility of imaging as an outcome measure.'

Though the project has now been completed, consortium partners are continuing to collaborate on the further evaluation and interpretation of the data collected during BIOIMAGE-NMD and are developing future plans for extension of the research. 'All partners continue with separate (and collaborative) projects and are contributing imaging expertise into NMD trials being led by other commercial partners outside of the original BIOIMAGE-NMD consortium. We are considering all opportunities to obtain further funding for this research, but have yet to secure funding,' Dr Blamire concludes.

BIOIMAGE-NMD

- ★ Coordinated by the University of Newcastle in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/110240>

A NON-INVASIVE WAY TO DIAGNOSE BRAIN TUMOURS

EU-funded researchers working within the HELICOID project are using hyperspectral imaging techniques to achieve better localisation of malignant tumours during surgical procedures.

Brain cancer is one of the most severe and challenging diseases we face. Despite great advancements in aggressive new treatments that combine surgery, radiotherapy and chemotherapy, treatment for persistent or locally recurrent brain tumours remains elusive. This is because traditional diagnoses of internal tumours are based on excisional biopsy, followed by histology or cytology.

The problem with this method is that it is an aggressive and invasive process with potential side-effects and complications. Furthermore, as the diagnostic information is not available in real-time, it requires the tissues to be processed in a lab – a time consuming step for a disease where time is of the essence.

For researchers with the EU-funded HELICOID (HypErspectral Imaging Cancer Detection) project, one way to improve diagnosis is to achieve better localisation of the malignant tumours during surgical procedures by using hyperspectral imaging techniques.

‘The hyperspectral system developed in this project is expected to improve tumour resection during surgery procedures, thereby reducing the risk of disease recurrence and increasing life expectancy,’ explains HELICOID Lead Researcher Gustavo Marrero Callico. ‘Essentially, our system reduces the amount of healthy tissue removed during surgery, thus decreasing morbidity and improving rehabilitation. As a consequence, it has a direct impact on the quality of life of the treated patients.’

Hyperspectral imaging is a non-contact, non-ionising and minimally-invasive sensing technique. Whereas a conventional camera captures images in three colour channels (red, blue and green), a hyperspectral camera captures data

over a large number of contiguous and narrow spectral bands and over a wide spectral range across the electromagnetic spectrum.

Real-time imaging

The main outcome of the project is a non-invasive hyperspectral medical imaging system capable of showing tumour margins of uncovered brain tissue during neurosurgical resection procedures in real-time. The system uses an experimental intraoperative setup based on non-invasive hyperspectral cameras, which is connected to a platform that runs a set of algorithms capable of discriminating between healthy and pathological tissues.

Surgeons receive this information via an array of displays that overlap the conventional images with a simulated colour map indicating the probability of any currently exposed tissue as being cancerous. The end result is the ability to recognise cancer tissues in real-time during the surgical procedure.

Big benefits

This integration of hyperspectral imaging and intraoperative image guided surgery systems is set to have a direct impact on patient outcomes. For example, the HELICOID system allows for confirmation of complete resection during the surgical procedure, thus avoiding complications related to body mass shift. It also provides surgeons – and patients – with confidence that the surgical goals were achieved.

According to Callico, the benefits are many: ‘It is a completely non-invasive technique, we don’t need to inject contrast agents,’ he says. ‘It is also a non-ionising technique, so we don’t change the properties of the brain tissue – and it provides the surgeon with lots of information, in real time, during surgery.’

Based on the experience gained during the evolution of this project, many other types of cancers that affect human beings will be studied and possibly diagnosed via the HELICOID system. ‘The next step is to use this technique with other tumours, including in the lungs, breast and the colon,’ adds Callico. ‘We dream of launching a brand new specialism that we could call hyperspectral medicine.’

HELICOID

- ★ Coordinated by the University of Las Palmas de Gran Canaria in Spain.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/111274>
- ★ Project website: <http://helicoideu/>



LIPOSOME-ENCAPSULATED DRUGS FOR EFFICIENT AND PROLONGED DELIVERY

Drug delivery systems are necessary to distribute the active ingredient to target sites in the body. A European study has developed an innovative method for preparing liposome drug carrier nanocapsules with reduced chance of immune response as well as efficient biodistribution.

In many cases, non-specific delivery of drugs to normal or sensitive tissues causes significant side-effects. In addition, this may mean that the active ingredient is not bioavailable throughout the body and as a result it inefficiently targets the tissue or organ of interest.

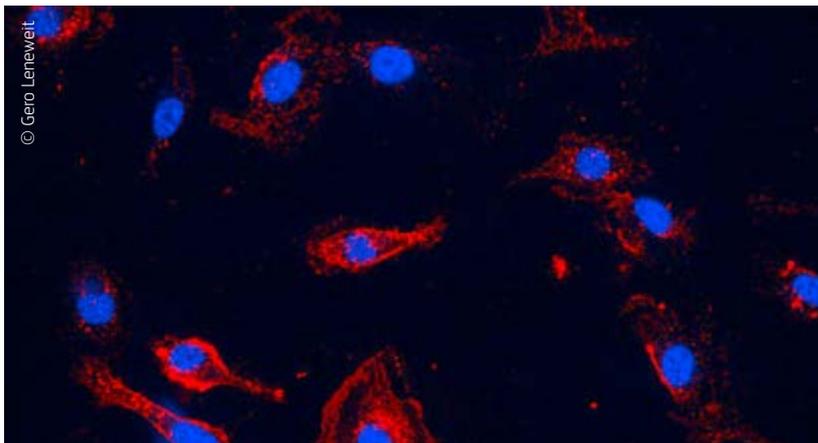
Ideally, a drug delivery system should be safe, non-immunogenic and provide targeted delivery of the compound of interest. Nanocapsules have emerged as suitable carriers of drugs as they provide a cavity for the pharmaceutical surrounded by a natural or synthetic membrane. The development and optimisation of nanocapsule fabrication and functionalisation is a field of intensive research.

Innovative technology for nanocapsule generation

Liposomes are widely used as delivery vehicles of peptides, proteins and other active substances for pharmaceutical and biochemical purposes. However, alongside phospholipids their main drawback is they initiate immune responses mainly by activating the complement system.

To address this, scientists with the EU-funded DECENT AID (Novel drug delivery system produced by centrifugal technologies – composed to minimise adverse immune reactions and designed for optimised therapeutic effects) project developed a new nanocapsule production technology using centrifugation, colloidal and fluid mechanical techniques. ‘These novel nanocapsules should be especially suited for proteins and other sensitive biomolecules which are vulnerable to degradation by existing encapsulation technologies,’ project coordinator Dr Leneweit explains.

The researchers used proteins as active pharmaceutical ingredients in nano-emulsions with phospholipids as emulsifiers. These were then centrifuged to produce asymmetric nanocapsules through a specialised technique that combines an *in situ* optical system.



Characterisation with respect to size, polydispersity, encapsulation efficiency for hydrophilic drugs and asymmetry of the nanocapsule shell produced an unexpected find. The consortium discovered that the density and organisation of phospholipids into monolayers or multilayers depended on the interaction between water and the organic solvent used. The newly discovered mode of interaction is likely to play a role in fat transport in blood circulation and the early stages of arteriosclerosis, as published in the research journal ‘Langmuir’.

Given the capacity of liposomes to activate the complement, researchers tested the immunogenicity of empty liposome nanocapsules *in vitro* and *in vivo*, and investigated the mechanism of immune reactivity. To minimise immune attacks by the complement, coagulation and the phagocytic systems, as well as prolong circulation in the blood, the nanocapsules were coated with heparin, a polymer cover also found naturally in the human body. Being biodegradable and non-immunogenic, the cover avoids accelerated blood clearance upon repeated administration of nanocapsules. The novel protective system proved to be stable in buffer, plasma and whole human blood.

The polymer-coated liposome nanocapsules were also tested against non-coated nanocapsules for *in vivo* immunogenicity. Drug distribution and efficiency were screened in various

mouse models including one for cancer. Results showed a novel mechanism of complement-mediated clearance of unprotected nanocapsules, underscoring the importance of natural polymers for conferring immune resistance.

Industrial scale-up

The DECENT AID approach achieved encapsulation efficiencies of up to 95% and bilayer asymmetries of up to 82%. ‘Our results give the perspective to develop an industrial scale-up and to achieve technologies for the encapsulation of sensitive active pharmaceutical ingredients into nanocapsules of unmet quality,’ Dr Leneweit comments. The consortium plans to establish procedures for continuously operating centrifugal devices to enable industrial production of the nanocapsules.

Collectively, the DECENT AID asymmetric nanocapsules and polymer protection system have successfully addressed a gap in the field of drug delivery. The properties of the nanocapsules make them ideal for sensitive active pharmaceutical ingredients such as those used in cancer therapy.

DECENT AID

- ★ Coordinated by Abnoba in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/106366>

EXPLORING ROAD TRAFFIC NOISE POLLUTION AND ASSOCIATED HEALTH RISKS

Too much noise exposure can have adverse effects on our well-being. The EU-funded QUIET project has explored the wide-reaching long-term health risks that road traffic noise can cause us.

More than 30% of the European population lives in areas where the 55 dB WHO traffic noise limit is exceeded and noise pollution continues to increase each year. Although our understanding of the overall harmful effects is limited, there is now growing public concern following research showing that traffic noise increases the risk of cardiovascular disease.

With this in mind, QUIET (Health consequences of noise exposure from road traffic) set about broadening focus to include other major diseases of high public relevance. 'When I started doing noise research, focus in the field was almost entirely on traffic noise and the risk of cardiovascular disease. I found that given the mechanisms of noise – that is stress and the disturbance of night-time sleep – other major diseases of high public relevance might very well be affected also, including diabetes and cancer,' shares QUIET principal investigator Dr Mette Sørensen.

The project therefore went about investigating if long-term exposure to road traffic noise is detrimental to various health outcomes in susceptible groups as defined by the WHO, i.e. children and the elderly.

Unique registers and the Nordic Prediction Method

On this basis, QUIET closely analysed two large Danish cohorts of 57 000 elderly and 100 000 children, linking them to unique Danish registers. The data helped compile crucial information on socio-economic status and lifestyle, birth weight, weight when seven years old and behavioural problems in children, as well as diabetes, cancer, cancer survival and health behaviour outcomes in the elderly.

In order to estimate noise pollution at each individual's home address, the project team used the Nordic Prediction Method, a calculation method used to estimate noise at the most exposed façades.

Surprising findings

They found that the more one is exposed to specific noises, the higher the risk of developing certain diseases in the long-term. By way of example, for every 10 dB increase in road traffic noise, the risk of diabetes increases by approximately 11%. The study also found that road traffic and railway noise may increase the risk of oestrogen-receptor-negative breast cancer, whilst road traffic noise increases the risk of distal colon cancer.

In addition, researchers discovered a link between traffic noise and physical inactivity. Using data gathered from longitudinal analyses they found that long-term exposure to residential road traffic noise increases the chances of people choosing to cease leisure-time sports and recreational activities, having a detrimental impact on their health and fitness.

Next steps

The project officially ended in February 2017 and was the first to publish studies of noise-induced disease associations beyond the cardiovascular realm through high quality noise assessments and detailed adjustments.

The QUIET team will now embark on a new project (NordSOUND) to try to reproduce these results by studying wider populations across four Nordic countries. The team will also research occupational noise to explore their latest 'lack of silence' hypothesis where no or limited access to a peaceful environment at work or home ultimately may have hazardous effects on people's lives.

Many unresolved issues in the field of noise impact on health remain but the results already point clearly in the direction already suspected by the researchers. Traffic noise pollution is having a hazardous effect on our lives and, as a consequence, there must be increased focus on noise prevention action plans designed by decision makers so that 'the proportion of the population exposed to high levels of noise will go down, instead of, as is presently the case, increasing,' stresses Dr Sørensen.

QUIET

- ★ Hosted by the Danish Cancer Society in Denmark.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/102535>

"For every 10 dB increase in road traffic noise, the risk of diabetes increases by approximately 11%."



THE INTRICATE WEB OF GENE EXPRESSION CONTROL MECHANISMS

Tightly orchestrated gene expression is essential especially in dynamic situations such as rapid immune responses. EU research has taken a new look at how this happens and discovered new control systems.

Lipopolysaccharides (LPSs) on the surface of microbes trigger very strong immune responses through interaction with immune cells, especially antigen presenting cells such as dendritic cells (DCs).

The EXPRESSION DYNAMICS (Orchestrating the Transcriptome and Proteome in Time and Space: Quantitative Modelling of Protein Production, Degradation and Localisation in Mammalian Systems) team investigated control of the immune response of mouse DCs stimulated with the pathogen component LPS. Looking at RNA levels as well as the dynamics of the protein life cycle (production and degradation), they produced a whole picture of the gene expression changes during this immune response. As Marko Jovanovic, principal researcher on the project, outlines, 'We aimed to create a global model, one where we know how much each type of regulatory layer contributes to each gene's expression.'

A new model – the icing on the cake

The result is a model where new cellular functions, necessary for the acute immune response for example, are primarily driven through control at the level of RNA expression. The pre-existing proteome, however, is also modified, in order to adapt to the activated cell state, and this is through

regulation of protein production and/or breakdown, the protein lifecycle.

'We termed this the cupcake model where the attractive part that people very often focus on is the icing and changes in the icing are analogous to the part adjusted by mRNA regulation. The cake part, also essential, but often and unfairly neglected, is analogous to the housekeeping genes which also need to change and, according to our results, involves the protein lifecycle,' explains Marko Jovanovic.

Extending the systems biology model to stimulation of nerve cells, the researchers are now looking at how different classes of genes are regulated in space and time in cell bodies and dendrites of these stimulated neurons. By applying the same proteomics and transcriptomics approach as for the LPS-stimulated DCs, the researchers will find out for thousands of genes in parallel if protein changes are differently regulated in specific cellular compartments, such as cell bodies and dendrites.

Identifying the genes responsible for regulation

Traditionally, gene knock-out screens are used to find the main regulators of a biological process of interest. Although already done in simple model organisms such as yeast for decades, it is much harder in mammalian systems, especially cell lines, and

often involves strong phenotypic readouts such as survival.

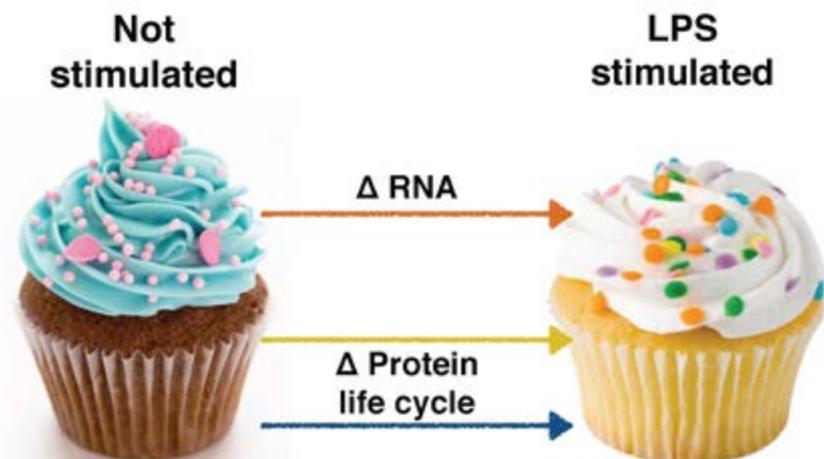
In contrast, EXPRESSION DYNAMICS developed a new marker-based genome-wide screen to identify the regulators of the expression changes of a gene of interest. A more subtle approach, it enables screening for nearly every biological process of interest.

Using the modified CRISPR-based genome-wide screen, again with DCs stimulated by LPS, the team found many unknown regulators of the LPS-induced immune response. They then classified the genes into functional modules with distinct effects on the LPS response.

Gene control mechanism research in the future clinic

The patent application filed for the delivery, use and therapeutic applications of the CRISPR-CAS systems and modelling gives an indication of the enormous scope of this technology. Identification of genes involved in immune system leukocyte responses and modelling of faulty leukocyte action and associated diseases are perhaps the most obvious use. The next step, testing possible chemical and/or gene therapies, stands to be a powerful basis for treatment.

Marko Jovanovic summarises its potential biomedical research power. 'Provided there is a detectable marker, this marker-based genome-wide screen in primary mammalian cells will allow us to apply unbiased genetic screening in nearly every available system and hopefully identify primary targets for disease treatment.'



EXPRESSION DYNAMICS

- ★ Coordinated by the Max Planck Society in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/108222>

SOCIETY

BETTER INVESTING IN EUROPE

Studying the European debt crisis, EU-funded researchers show that the practice of unloading EU or EMU securities during the crisis period was the wrong thing to do and actually helped perpetuate the crisis.

The dominoes started falling in 2008, the year when the largest investment banks in the US either went bankrupt or were sold at fire-sale prices to other banks. This pushed the global financial markets to go into a free fall. Not long after, the crisis hit European shores, where it quickly transformed into a debt crisis. Soon austerity measures became commonplace while, at the same time, national economies struggled to grow.

'The problem with Europe was simple,' says EURO-INVEST (Investing in Europe) Lead Researcher K. Ozgur Demirtas. 'European countries each had their own staggering national debts, there were huge budget deficits, and shrinking economies did not supply enough money to the system.'

According to Demirtas, the answer to this problem was new investments in the Eurozone. Unfortunately, things weren't that easy. 'To pay their national debts, governments must cut spending,' he explains. 'This results in sharp cuts to private sector growth which, in turn, creates a lack of confidence of investors in the Eurozone and instead encourages them to invest in emerging markets.'

It is this vicious loop that motivated Demirtas to investigate the practice of investing in European and emerging

economies for different investment horizons and subsample periods.

A vicious loop

The project first looked at the fact that as European markets tumbled many emerging markets were excelling and how investors penalised companies per the country they operated in. Thus, for example, in theory, if Italy had a budget deficit, high-debt-to-income ratio and growth issues, investment in the country would dry up and Italian companies would be penalised. However, if this was the case, many public companies would not get the necessary investor attention they deserved simply because of the performance of the region they happened to be located in.

'Within this framework, we undertook the task of examining all European public companies against world and emerging market indices,' says Demirtas. 'Our hypothesis was that when state-of-the-art techniques such as Almost Stochastic Dominance (ASD) and Almost Mean-Variance rules are applied, investors' confidence in emerging economies may end up being groundless.'

The wrong thing to do

What Demirtas discovered was that, at short investment horizons, none of the

examined indices were dominant. However, at a five-year investment horizon, emerging market indices dominated all others, making it seem that an index investor would be better off investing in these indices rather than developed market or EMU indices. However, the story doesn't stop there. After examining over 144 million daily observations of 64 051 stocks listed in 51 countries, researchers found that a significant 10.1% of the traded securities dominate the developed market index with 7.8% in the emerging market index.

Based on these findings, the conclusion was that by excessively penalising certain securities in the Eurozone during the crisis period, investor behaviour actually helped fuel the vicious loop. 'Indeed, there are European securities with certain characteristics that continued to dominate alternative investments even after the crisis period,' says Demirtas. 'This may very well show that unloading EU or EMU securities during the crisis period was the wrong thing to do and only helped to self-fulfil the prophecy of the European crisis.'

EURO-INVEST

- ★ Coordinated by Sabanci University in Turkey.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/107282>

TOOLS FOR PUBLIC ENGAGEMENT WILL MAKE EUROPEAN RESEARCH MORE EFFECTIVE

Engaging with the public when developing research strategies is an increasingly important aspect of academic and applied research. EU researchers have developed a toolkit that provides insight and advice to help research organisations integrate public engagement (PE) into their research strategy.

For research to have real impact in modern society, it needs to address real-world needs and answer pertinent questions. Research organisations need tools so they can be aware of public sentiment and public needs.

The recently completed EU-funded PE2020 (Public engagement innovations for Horizon 2020) project delved into more than 250 PE projects across Europe to understand the innovative ways that researchers and organisations can engage with the public to guide their research. The team categorised and scrutinised these projects to come up with mechanisms and best practices.

'The average university or research organisation has very limited capacity to promote and embed PE into their current organisational practices,' says Adjunct Professor Mikko Rask, who headed up the three-year study. 'We found that one of the main challenges in PE is that it is rarely discussed by scientific researchers, heads of HR departments or university leaders.'

To address this, Prof. Rask and his team created resources that provide guidance for those looking to improve PE practice within their organisation. These resources were organised into a freely available digital PE toolkit.

Prof. Rask hopes that the toolkit will encourage organisations and universities to develop PE-centred research policies. 'This toolkit explains why, how and when PE could be useful and highlights the complexity of doing PE well. The toolkit also addresses two issues which usually are neglected – why and how to permanently embed PE in research organisations, and why and how to foster public participation in science.'

The PE2020 team took a methodical approach to developing the resources they have now made widely available. They began by identifying 254 examples of PE in European research projects, and selecting the 50 most innovative processes. Researchers used an 'innovativeness index' based on criteria like new ways of representation, methodological and institutional hybridity, and bearing on political impacts and societal challenges. From this list, they chose 38 projects to use as case studies, which have been published in a free ebook.

"This toolkit explains why, how and when PE could be useful and highlights the complexity of doing PE well."

PE2020 also identified and collected an inventory of 77 mechanisms for PE, grouped into five categories, and published a conceptual model of PE. All these resources are available through the project website.

Following this, the researchers tested their ideas and findings in practice through six pilots. These were undertaken in collaboration with project partners in Italy and Finland, and represented different methods for meaningful PE within real-world research projects. Importantly, these pilots cover all seven societal challenges identified by the EU's Horizon 2020 research programme.

In some of the pilots, PE2020 has encouraged the introduction of 'societal interaction plans'. This is a way to ensure that future research proposals consider the PE elements of their research from the very beginning. In collaboration with the Future Earth research programme, PE2020 has tested out new and improved living lab strategies. This led to research strategies developed through discussions with wide-ranging groups of political, social and academic parties.

'The toolkit was conceived to be read by people who are not experts in this field and who are not informed about PE,' says Prof. Rask. 'We want to help universities and research organisations plan and implement PE initiatives, embed PE in their current strategies and practices, and establish sustained PE policies for science and innovation at local and national level.'

Ultimately, Prof. Rask hopes that the tools developed by PE2020 will initiate a change towards more responsive and responsible research and innovation, for and with society.



PE2020

- ★ Coordinated by the University of Helsinki in Finland.
- ★ Funded under FP7-SIS.
- ★ <http://cordis.europa.eu/project/rcn/110581>
- ★ Project website: <https://pe2020.eu/>

NEW RECOMMENDATIONS FOR COMBATING GLOBAL FOOD AND NUTRITION SECURITY

By 2023, the world's population is due to hit 8 billion according to a recent UN survey. Finding a way to ensure that all those people are well-fed and well-nourished will be a major challenge of the 21st Century. One EU-funded project has been working hard to provide the policy solutions to this challenge, emphasising the need for a robust and stable world food system that can cater for everyone's needs.

One of the biggest challenges facing global society today is the widespread and growing presence of hunger and food insecurity. Global food prices can swing wildly and the EU-funded FOODSECURE (Exploring the Future of Global Food and Nutrition Security) project has sought to address the resulting challenge of food and nutrition security (FNS), being particularly keen to provide concise guidance to EU policymakers on global FNS.

To do this, the FOODSECURE project team has worked with experts from a wide range of policy areas to help them develop their vision for FNS in Europe (and globally) by 2050. These included development aid and disaster relief, the food industry, agriculture, climate change, trade, environmental policy, innovation and renewable energies. 'Overall, the continuation of inequalities in the food system is the main threat for sustained FNS in the long run,' commented Dr Hans Van Meijl, FOODSECURE project coordinator. 'The EU and its international partners need to step up their game to reach the goal of zero hunger [by 2050]. They must implement more coherent policies, assess better the EU's impact on environmental sustainability, address the impact of donor funds, and finally, implement multi-stakeholder knowledge partnerships that can harness all available expertise.'

The project team found that the effectiveness and coherence of EU aid for FNS is severely hampered by donor proliferation, aid fragmentation and the overall lack of coordination. They found that despite great political commitment and a will to increase funds towards guaranteeing FNS, the EU has not made sufficient progress in reducing donor proliferation by concentrating on selected recipient countries and/or by specialising in selected aid sectors. Dr Van Meijl also pointed out the importance of working towards stable political situations in addressing FNS – 'conflict is the number one cause of hunger,' he states.



Another area of interest to FOODSECURE researchers was finding the right balance between agriculture's need to expand (to fulfil the needs of an expanding population) and meet environmental targets. They advocate that increasing agricultural productivity whilst safeguarding sustainability is indeed achievable, with the aid of technological advancements, moderating consumption, nature conservation and the establishment of protected areas, and spatial planning.

They also dug deep into how high and volatile food prices have distinct implications for consumers and producers, with price increases and excessive levels of volatility being recorded from 2007 onwards into the current decade. Among the key factors for this are increased biofuel production, the medium- and long-term effects of climate change, and higher levels of trading in commodity future markets. Armed with these results, the project team has urged policymakers to endorse easier trade in agricultural commodities, drives to guarantee larger food reserves, and more active global financial instruments to positively influence agricultural commodity markets (as well as stricter regulation of such markets).

Finally, Thom Achterbosch of the FOODSECURE coordination team points out the importance of education and innovation to support positive societal outcomes that impact on FNS. 'Along with political stability, basic services for health and development are vital as overall FNS builds on these basic services and helps to lower the food insecurity of vulnerable households,' explains Achterbosch.

Although FOODSECURE has now ended, its legacy will live on through its online navigator website that acts as an interface between the scientific output of the project and policymakers and other stakeholders in the EU and developing countries. The project team will continue to update it, with its main aim being to support decision makers in the formulation of evidence-based food and nutrition policies by presenting key insights on the drivers of global food and nutrition security.

FOODSECURE

- ★ Coordinated by Wageningen Research in the Netherlands.
- ★ Funded under FP7-SSH.
- ★ <http://cordis.europa.eu/project/rcn/102690>
- ★ Project website: <http://www.foodsecure.eu>

HARNESSING THE FULL POTENTIAL OF AN AGEING POPULATION

Europe's population is rapidly ageing. To help societies and economies adapt to this demographic reality, the EU-funded MOPACT project has explored new and innovative policies that will turn Europe's longevity revolution into a major asset for the continent's future social and economic development.

The number of Europeans over 65 will double in the next 50 years, and the number of individuals over 80 will almost triple. Life expectancy will continue to increase, yet unhealthy life years make up around 20% of a person's life. Within this context and considering Horizon 2020's ambitious goals on the demographic challenge, the core mission of MOPACT (Mobilising the potential of active ageing in Europe) has been to produce evidence in the form of both groundbreaking scientific research and policy analyses to allow policymakers to truly understand the complexity of the substantial demographic changes taking place in Europe and, therefore, be in a strong position to frame innovative responses.

In particular, MOPACT has examined both biological and social/economic aspects of how to promote active and healthy ageing. 'Breakthrough biological work on the facilitators of healthy ageing, such as calorific restriction, have the potential to both improve the quality of later life and reduce the public expenditure costs of ageing,' explains MOPACT project coordinator Alan Walker. 'In economic terms, for example, the demonstration that pension costs can be contained if pension ages are linked to increases in longevity, with protection for the disabled, is of critical importance and has the power to defeat the "burden of ageing" fears in one stroke.'

Challenges and opportunities

These challenges remain formidable and will require dedicated and concerted efforts to address. One of MOPACT's key findings is that increases in life expectancy in the EU are not being accompanied by increases in healthy life expectancy. The research team found that the three countries with the largest number of unhealthy life years are Slovakia, Portugal and Germany. 'This means that Europe must re-double its efforts to promote active and healthy ageing,' comments Walker.

With regard to long-term care (LTC), MOPACT has uncovered that there are great variations across the EU, with the Nordic Member States coming top of the class and with Central and Eastern European countries (CEEC) lagging behind. In particular, there is an urgent need for innovation in four key areas: expansion of services, coordination and integration, implementation of community care, and professional training.

However, there are many positives, as Walker elaborates that MOPACT research shows that only 20-25% of healthy life expectancy is genetically predetermined and that it is lifestyle choices and environment that make the crucial difference. 'By encouraging ageing individuals to make lifestyle changes, such as exercising more and adjusting their diets, age-associated

accumulation of molecular and cellular damage can be prevented or greatly delayed,' says Walker.

Encouraging longer workforce and political participation

MOPACT research also focused on innovative ways to allow longer working lives as life expectancy increases. Again, there is a clear fault between pioneering countries at the forefront of these efforts and those lagging behind, again primarily the CEEC countries.

Whilst the project team have studied many different social innovations Walker points to the Finnish model of 'workability' that has been very successful in both alerting employers to workforce ageing and also giving them the tools to adjust their workplaces and practices to enable people to work longer.

In terms of political participation, Walker also pointed out the participation of older people in Senior Citizens' Councils in Denmark rated as a good practice for involvement in decision-making. He also drew attention to the Senior Citizens' Participating Budget in Portugal as being a leading example of co-decision making in public bodies.

Moving forward from MOPACT

The project officially ended in February 2017 but the project team will continue to disseminate its research results. Specifically, MOPACT's legacy will be its vast body of research collected and its stakeholder engagement model. A major book is also in the pipeline and due to be released later in 2017. 'For the rest though, it is up to the policymakers to take the next steps, and they need to do so urgently,' concludes Walker.

MOPACT

- ★ Coordinated by the University of Sheffield in the United Kingdom.
- ★ Funded under FP7-SSH.
- ★ <http://cordis.europa.eu/project/rcn/107822>
- ★ Project website: <http://mopact.group.shef.ac.uk>





TRANSPORT

PUTTING THE INFO INTO URBAN MOBILITY

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The EU-funded PETRA project has developed a service platform for connecting providers and controllers of urban transport with travellers to better align transport offerings with citizen needs.

Infomobility is where big data and everyday travel converge. The concept involves the use and distribution of dynamic and selected multi-modal information to end users – both before and during a trip – with the goal of creating more efficient and higher-quality transport systems. For European cities, the concept has huge potential for helping them achieve their mobility and Smart City objectives. And although both the transport systems and the big data exist, the challenge is bringing the two together.

The aim of the EU-funded PETRA (Personal Transport Advisor: an integrated platform of mobility patterns for Smart Cities to enable demand-adaptive transportation systems) project was to connect these dots by developing a service platform for connecting providers and controllers of urban transport with travellers. The resulting platform fuses different data from various city sources, travel operators and citizens, performs a broad class of predictive analytics, detects real time events and provides information services to transportation service providers and city stakeholders, allowing them to optimise their transport offerings according to citizen needs.

‘With PETRA, cities received an integrated platform to enable the provision of citizen-centric, demand-adaptive city-wide transportation services,’ says project coordinator Sebastiaan Meijer. ‘At the same time, travellers get mobile applications that empower them in making travel priorities and choices for route and modality.’

Clearing up the uncertainty

The PETRA project successfully achieved a handful of important milestones. For example, it made significant technological advances in providing travel advice during times of uncertainty.

‘Capturing urban dynamics requires that data formats are simple yet complete enough to annotate uncertainty in a way that preserves the fine-grained detail required for travel advice,’ explains Meijer. ‘Here we developed a method for obtaining better uncertainty, predominantly for public transport modes, that was robust for the messy data situation that is typical for realistic city contexts.’

Meijer adds that while this method requires further advances to be demonstrated, it is simple enough to be used and applied widely.

Benefiting from the experts

Another important achievement was the development of methodologies and tools to capture city expertise in formal and managerial formats. ‘The involvement of cities and their stakeholders in constructing and managing an infomobility platform opens the door for using their expertise in constructive manners – something that isn’t possible when aiming for a generic solution for all cities,’ says Meijer. ‘It is a well-known fact that city professionals know urban dynamics very well and activate this knowledge when managing disruptions and events, and we wanted to be sure to capture and incorporate this knowledge into our platform.’

In Venice, for example, a simulation model was developed to capture pedestrian dynamics based on the lowest number of modelling assumptions possible. Using the insight of city professionals, this model evolved into a city-wide simulation capturing the city’s busiest tourist hotspots. Parameterisation of the model was done based on available static data, and full validation was done by local experts.

‘Since these experts were well-positioned to predict the dynamics on busy, normal and calm days regarding queuing and crowds at major points of interest, the simulation produced baseline data files for the travel advisory platform,’ says Meijer. ‘With these baselines, and a file that Venice policy makers make every year that predicts which days will be busy, normal or calm, in Venice the PETRA platform can provide dynamic advice based on expert judgement of what the situation will be.’

Bringing tech and management together

With the project now concluded, researchers are working with various European cities to help integrate PETRA’s findings into their infomobility strategies. Furthermore, it is expected that some of the technical infrastructures developed within

the project will form the basis of various spin-off projects – further strengthening the project’s impact.

‘From the start, our goal was to generate new knowledge and methods to further develop the role of cities in infomobility,’ says Meijer. ‘The PETRA platform is the integration object that brings technology and management together into demonstrable synergy.’

PETRA

- ★ Coordinated by the Royal Institute of Technology in Sweden.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/188911>

DEVELOPMENT OF NEW, POWERFUL BATTERY MEANS LONG-RANGE ELECTRIC FERRIES ON THE HORIZON

Reducing emissions and cutting operating costs – just two of the benefits waiting for the first long-range, 100% electrically powered passenger and vehicle ferries. An announcement in May brings the reality closer as the partner of an EU-funded project announces the market launch of a modular, lithium-ion battery system for ferries.

Leclanché, one of the E-FERRY (E-ferry – prototype and full-scale demonstration of next generation 100% electrically powered ferry for passengers and vehicles) project’s partners, has created the first marine battery system of its type approved by international certification. It has recently announced the market launch of its Marine Rack System (MRS) which E-FERRY, supported by the EU, will harness on the voyage between Aeroe (Ærø) island and the mainland. E-FERRY’s design is not the first electric ferry to be put into operation, the Norwegian Ampere currently sails under electrical power, but it is limited to a distance of three nautical miles. Another purely electric ferry is the Ar Vag Tredan that was built in France and is operated by Lorient Agglomération. It uses 128 super capacitors provided by Batscap and is also made of aluminium. It is quite a bit smaller than the Ampere and doesn’t have the ability to transport vehicles.

Fully electric, the E-FERRY project’s boat will be able to cover distances of over 20 nautical miles between charges and will carry both passengers and vehicles. To gain this 20 nautical mile range it needs a large capacity battery. The battery capacity provided by Leclanché’s marine optimised NMC battery modules is 4.3 MWh – making it the biggest battery capacity seen to date.

E-FERRY has now formulated the overall design of the 100% electric ferry that is based on an innovative concept: an optimised hull and propulsion system, a high-energy battery pack and the use of materials and modules that reduce overall weight – the capstan and wheel house will be made from aluminium, for example. The project has also identified the composite materials to be used, and is working on the necessary adaptations at the on-shore facilities in the Søby, Fynshav and Fåborg harbours. The announcement that the project

“The battery capacity provided by Leclanché’s marine optimised NMC battery modules is 4.3 MWh – making it the biggest battery capacity seen to date.”

partners have now launched their MRS comes at the perfect time for E-FERRY to turn their designs into an operational ferry. Construction work on the hull began in June 2016 and is now nearing completion.



The electric ferry, a single-ended, roll-on-roll-off, will be charged by an automated shore connection system to be placed on the onshore ramp in Søby harbour. The charging system will connect automatically, via plugs, when the ferry arrives and charge each side of the vessel separately, up to 2 x 2 MW DC at a time. The charger is the first high power DC charger on the market and will allow the ferry relatively short port-side stays of 15-20 minutes.

The benefits will be great: the electric ferry will reduce the island of Aroe's annual emissions with approximately 2 000 tonnes CO₂, 41 500 kg NO_x, 1 350 kg SO₂ and 2 500 kg particulates.

The groundbreaking design will also reduce operating costs as it will bring down travel times in comparison with existing diesel ferries. Despite the importance of the EU ferry market, the majority of European ferries are more than 20-years-old. The fleet is in need of newer, more energy efficient and less CO₂ emitting vessels. Europe has around 900 ferries for both cargo/cars and passengers, which account for 35% of the world fleet.

The project brings partners from Germany, Switzerland, Finland, Denmark and Greece together to create the most efficient small- to medium-sized ferry hull that has been

built for decades. As E-FERRY explains, their design meets the latest and highest damage stability criterion for ferries, being a two-compartment ship going well beyond the safety requirement for operation in coastal areas.

E-FERRY

- ★ Coordinated by the Ærø Municipality in Denmark.
- ★ Funded under H2020-TRANSPORT.
- ★ <http://cordis.europa.eu/project/rcn/193367>
- ★ Project website: <http://e-ferryproject.eu>

CLEANER ENGINES FOR GREENER AVIATION

An EU-funded project has successfully developed critical aviation engine components for innovative propulsion systems destined for the aircraft of the future.



Components developed by the project team are the so-called transition and aero ducts – also known as barrels because of their shape. The functions of these components include channelling the flow of the stream of the main hot gases to the exhaust, channelling the secondary airstream and channelling cooling air for the lubrication oil.

Particular focus was placed on finding the right design to sustain the functional and failure loads. The development included an analysis of load cases, dynamic analysis, fatigue analysis, assembly analysis, manufacturing analysis and analysis of the right quality plan for the parts.

GREENBARRELS' work forms part of Clean Sky's Sustainable and Green Engine (SAGE) integrated technology demonstrator. This is developing engine technologies for low-noise and lightweight low-pressure systems, high efficiency levels, low nitrogen oxide emissions and low-weight cores and novel configurations such as open rotors and intercoolers. These efforts are aimed at giving the aviation industry more efficient and cleaner aircraft in the future.

“Featuring two sets of uncased blades that rotate in opposite directions, they can cut fuel consumption by 30% compared with current aircraft.”

Whether operators or manufacturers, the entire aviation industry shares the same key goals: to drive down costs by reducing fuel consumption, mitigating harmful emissions and decreasing noise. One of the most amazing new engine architectures promising to make aircraft more eco-friendly and less costly is the contra-rotating open rotor (CROR). It is being developed as a technology demonstrator in the European research programme Clean Sky.

Open rotor engine architectures allow for a high increase in the bypass ratio compared with current engines in use. The bypass ratio of an open rotor can reach 50:1 compared to that of current engines at 14:1. Featuring two sets of uncased blades that rotate in opposite directions, they can cut fuel consumption by 30% compared with current aircraft.

The GREENBARRELS (Contra-rotating open rotor (CROR) propeller barrels) project supported the European Clean Sky initiative by designing, manufacturing and delivering several critical components to be integrated into the CROR engine being developed under the EU initiative.

GREENBARRELS

- ★ Coordinated by Eurecat in Spain.
- ★ Funded under FP7-JTI.
- ★ <http://cordis.europa.eu/project/rcn/104917>



ENVIRONMENT

MODELLING OCEAN FLOWS ADVANCES CLIMATE CHANGE UNDERSTANDING

An EU-funded project has developed new statistical modelling techniques to track the movement of water particles across the world's oceans, contributing to our knowledge about climate change.

With oceans covering more than 70% of the Earth's surface, their flows and movements are key to understanding and predicting the effects of climate change. More and more data is being collected about our oceans and now the challenge is to make sense of it all.

EU-funded project OCEANDATAMODELS (Statistical modelling and estimation for spatiotemporal data with oceanographic applications) has developed new methods to analyse the large amounts of data collected by specialist floating instruments that track the trajectories of ocean water particles.

'Our key innovation was to build new statistical models and analytical tools capable of capturing the swirling rotational oscillations caused by the Earth's rotation – the Coriolis Effect – as well as effects from tides and their counter-currents known as Eddies, and water turbulence,' says Sofia Olhede, OCEANDATAMODELS project coordinator and Professor at University College London (UCL).

The models of ocean water particle pathways now form part of the vast body of statistical techniques used by climate scientists to improve our understanding and ability to predict climate change.

Satellite-tracked drifters

Project researchers used reams of data from the US's National Oceanic and Atmospheric Administration which has gathered hundreds of millions of observations on currents, sea surface temperature, atmospheric pressure, winds and salinity over the past 40 years under its Global Drifter Programme. The data was collected by 'drifters' – or free-floating satellite-tracked buoys that monitor the motion of water particles at the ocean's surface, allowing scientists to closely monitor the ocean's overall circulation.

'The challenge of modelling the motion of drifters is that the data moves in both time and space – something we call a "Lagrangian" perspective – and these types of data required us to develop a new toolkit of statistical and data science methodology,' explains Dr

Adam Sykulski, Lead Research Fellow on the project at Lancaster University.

The project built innovative statistical models, using a cross-disciplinary approach from both statistics and oceanography. Researchers could then map how our oceans vary across time and space, exploring factors like the swirl of currents around the Equator and how water particles from different oceans mix and travel around the world.

One example of the modelling undertaken by researchers is a 'spaghetti plot' diagram of drifters as they travel the world. The different paths drifters can take help scientists to determine how quickly and in what way the ocean is mixing and moving.

The models developed by OCEANDATAMODELS are not only used by climate change scientists, but are also utilised to track and understand the movement of environmental challenges such as oil spills, and the movement of animal species, such as plankton, across the world's oceans.

The project results have now been published in a range of scientific journals and some data is publicly available to download from the Global Drifter Program website. The modelling techniques developed by OCEANDATAMODELS can also be applied to other fields including analysis of seismic signals, neuroscience, glaciology and ecology.

Meanwhile, Olhede says that a possible next step for project researchers could be to extend the current model from its current two-dimensional surface data approach, to develop a model for three-dimensional data covering the ocean's depth.

OCEANDATAMODELS

- ★ Coordinated by University College London in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/186366>

IMPACT OF SHRINKING SEA ICE ON ARCTIC SEABIRDS

The rapid decline of Arctic sea ice is one of the most serious consequences of climate change, profoundly affecting the functioning and biodiversity of the region's marine ecosystems.

Global warming could increase mercury (Hg) concentrations in Arctic marine food webs by releasing pollutants held within the sea ice, permafrost and glaciers. Other sources include the opening up of sea lanes and the development of industry within the Arctic, as well as the modification of pollutant chemistry due to changing conditions.

The EU-funded ARCTOX (Sea-ice shrinking and increasing human activities in the Arctic: What risks for the avian biodiversity?) project was established to monitor the impact of pollutants on the region's seabirds and develop an international network for studying contamination in seabirds and marine food webs at a very large, pan-Arctic scale.

Researchers from the CNRS and the University of La Rochelle (France) investigated the long-term and seasonal variations of Hg in organisms and the extent to which migratory seabirds become contaminated during the wintertime, when they are outside the Arctic. Impacts of Hg on seabird reproduction and survival were also determined.

Seabird populations at risk

'Scientists showed that Hg, which is a powerful neural toxicant, could be a major stress factor in overwintering birds,' explains Dr Jérôme Fort, the scientific coordinator of ARCTOX. 'It may have played a role in the massive seabird mortality of February-March 2014 when 43 000 seabirds originating from the sub-Arctic and northern Europe were found dead along the French Atlantic coasts. Beached emaciated birds showed Hg concentrations above levels associated with sub-lethal effects on kidneys, suggesting Hg toxic effects.'

Hg can also act as an endocrine disruptor, affecting the ability of seabirds to reproduce. By focusing on a breeding population of little auks (*Alle alle*) in East Greenland, ARCTOX found that exposure of females to Hg prior to the breeding season was related to smaller eggs and reduced body mass in hatching chicks. This could have a possible

long-term negative impact, causing a decline in population numbers.

An international sampling network has therefore been established to conduct large-scale studies and provide a fuller understanding of the origin and impact of Hg contamination in the Arctic. This has allowed scientists to map Hg concentration across Arctic marine ecosystems and identify hotspots of Hg contamination that might require specific attention and protection.

'This network can be used to study other pollutants of concern in the future and monitor long-term changes in the contamination of Arctic seabirds and marine food webs at the Arctic scale. Such an approach will give decision-makers a more complete picture of what happens to Hg in the Arctic and the associated toxic risk,' says Dr Jérôme Fort.

Long-term impact on the Arctic

By providing new insights into long-term trends of Hg in some Arctic marine systems, ARCTOX showed that Hg concentrations continue to increase in some Arctic regions and that mitigation strategies need to be discussed in order to understand these trends and how they may be reversed.

Furthermore, project research provides new knowledge about the risks faced by Arctic seabirds, revealing that they are exposed to environmental pollution throughout the year both inside and outside the Arctic. This highlights the importance of concerted international actions to successfully tackle the threat posed by environmental pollution to Arctic wildlife.

Professor Paco Bustamante, the project coordinator of ARCTOX, reflects on the possible environmental effects of a decline in seabird populations: 'They play a key role in Arctic marine food webs, especially in the transfer of organic matter and nutrients in their ecosystems.' He adds, 'Moreover, seabirds have a large, circumpolar distribution in the Arctic. A decline in seabird populations could therefore affect the structure, dynamics and functioning of the entire marine food web.'

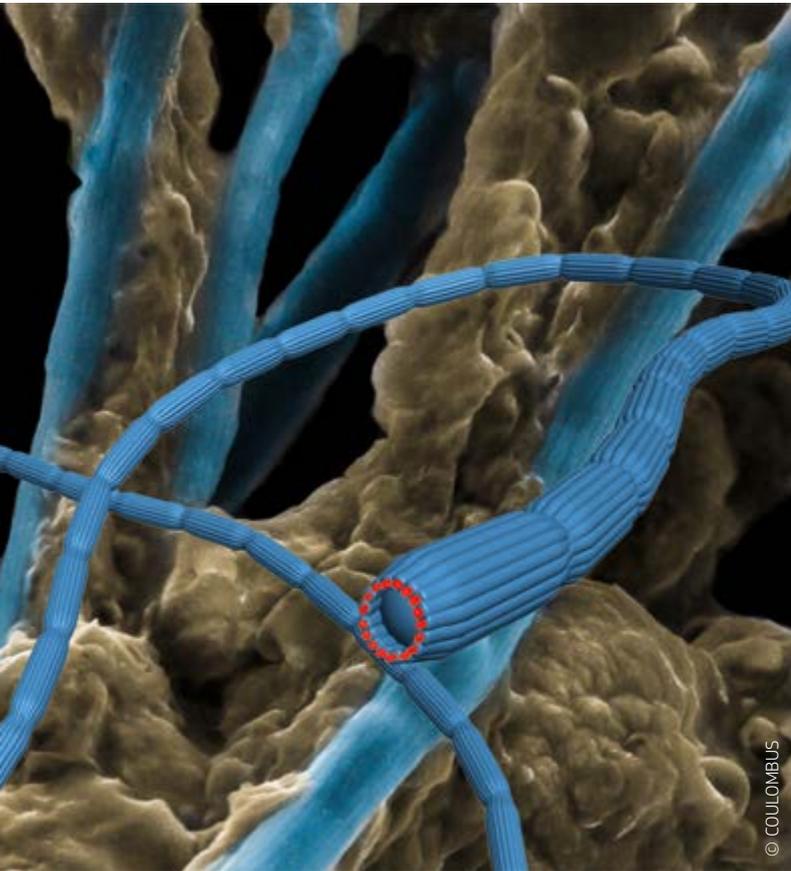
ARCTOX

- ★ Coordinated by the University of La Rochelle in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/186828>



CABLE BACTERIA SHAKING UP OUR UNDERSTANDING OF NATURE

Following its surprise discovery of a new life form capable of transporting electricity over long distances, a Danish-led team of researchers is looking into what makes cable bacteria tick.



Not many scientists begin a research project by discovering an entirely new form of life with unheard-of properties. But this is the case for researchers working as part of the EU-funded COULOMBUS (Electric Currents in Sediment and Soil) project which finished last February.

Back in 2012, a student at Aarhus University in Denmark found himself looking down the microscope at cable bacteria, a daisy chain of cells several centimetres long, capable of conducting electricity up through sediments on the sea floor as if it were a living electric cable. Discovering more about this new life form, which has the potential to revolutionise our understanding of the cycling of elements in the eco-system and much more, has kept the team busy ever since.

Mysterious electric currents

At the outset, project coordinator Lars Peter Nielsen, professor of microbial ecology at Aarhus, was keen to explore what could be making the electrical currents he had detected in the Bay of Aarhus. His initial hypothesis – a community of bacteria arranged in some kind of nanowire grid – was quickly discarded when the cable bacteria came into focus under the lens.

‘Suddenly everything fell into place, it was a form of life no one imagined existed – a living organism that can conduct

“Maybe our currents will be able to explain electrical fields that have been measured on land and couldn’t be explained before.”

electricity over a large distance of centimetres. Until now you could only do this at the nano or the microscale,’ he says.

The bacteria, members of the Desulfobulbaceae family, have a ring of electric wires inside. They absorb electrons from hydrogen sulphide in one end of the cable, transport them along thousands of cells up to the surface of the mud, and then deposit them onto oxygen at the other end. In the process, they release the energy they need to survive.

On sea floors and in back gardens

Using robots and a specially developed microsensors, the team measured electric fields from cable bacteria in the Bay of Tokyo and then in a stream, closer to home, in Professor Nielsen’s own back garden. They studied the bacteria’s DNA to find out about its evolution over time and have so far described two genera and six species while several others await further investigation.

COULOMBUS’s more recent work in soil on land means ‘maybe our currents will be able to explain electrical fields that have been measured on land and couldn’t be explained before,’ says Professor Nielsen.

How they conduct

His team is now working on identifying what the conducting electrons inside the bacteria are. ‘Once we have found out what materials are involved, we may be able to start seeing what the possible applications of this conducting mechanism are,’ says Professor Nielsen.

Knowledge about cable bacteria is still in its infancy but the implications of this discovery are likely to be far-reaching. The fact that it constitutes a living link between a conductor and biological processes is likely to be of interest to medical researchers, according to Professor Nielsen. Technologists may wish to explore its potential as a path towards green electronics. It could have applications in cleaning up contaminated groundwater. ‘Cable bacteria already make the sea bed a much better habitat for animals and give them a better chance of surviving oxygen depletion,’ says Professor Nielsen.

He is set to continue exploring the basic questions about cable bacteria at a new Danish-funded Centre for Electromicrobiology being set up at Aarhus University.

COULOMBUS

- ★ Hosted by Aarhus University in Denmark.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/102467>

AGRICULTURE & FORESTRY

FROM BEES TO PEST CONTROL – EVALUATING NATURE’S HIDDEN SERVICES

An EU-funded project has investigated ecosystem services and evaluated the habitats that are essential to maintaining these services, providing useful information to both farmers and policymakers.

Nature is a treasure trove containing many hidden benefits for agriculture, from crop pest control to pollination, known collectively as ecosystem services. While organic farmers are heavily reliant on ecosystem services, on conventional farms there is little active management of the habitats that are needed to support pollinators and predators.

Aiming to improve our understanding of their value, and potentially boost their habitats on conventional farms, EU-funded project QUESSA (Quantification of ecological services for sustainable agriculture) investigated semi-natural habitats and pollinators, pest predators, weed-killing insects and other factors.

‘Based on 16 case studies in eight countries with seven different types of crop we developed a classification system that encompasses most semi-natural habitats in Europe. We created predictive maps of ecosystem services from the local to Europe-wide scale,’ says John Holland, QUESSA project coordinator.

QUESSA studied arable farms, vineyards, vegetable farms and orchards. It found that there is a surprisingly large proportion of semi-natural agricultural landscapes in Europe – about 20% of all agricultural land – but this varies greatly depending on the country.

Italy scored the highest with 89% coverage of semi-natural habitats in olive groves, down to just 1.5% coverage in some areas of the Netherlands.

Project researchers then developed a predictive scoring system for two specific types of ecosystem service – pollinators like honey bees and wild bees; and flying pest natural enemies like parasitic wasps and predatory flies. These were used to generate maps of their location.

The project’s local-scale maps were used by researchers to explore how the configuration of local landscapes effected ecosystem service provision. The Europe-wide map gives policymakers an idea of the overall amount of semi-natural habitats on farm landscapes, as well as the value of the services they provide.

Bee decline

QUESSA found that crops like sunflower and pumpkin can be affected by pollinator decline. Their flowers had an average of 100 visits by a pollinator per flower over the study year. Whereas for oil-seed rape, which is largely wind pollinated, less than 10% of crop flowers were visited by pollinators.

‘Insufficient insect pollination reduced total pollination levels by 3% across all of the crops, but even this small amount, if it occurs across Europe, would equate to an economic loss of EUR 1.8 billion, most of which can be attributed to losses in sunflowers,’ says Holland.

QUESSA also found a total of 854 plant species living in semi-natural landscapes, but the species present varied according to the agro-climatic zone. The maritime and Mediterranean regions were most different from each other.

QUESSA could not identify the ‘best’ habitat for the provision of pollination or pest-control services. However, it did find that some plant species – from the Rose, Asteraceae and legume families – boosted levels of pollinators. Meanwhile, pest predators prefer woody habitats.

The project’s findings have now been incorporated into a free web-based tool that allows farmers and policymakers to estimate the contribution that different habitat types would make to the delivery of ecosystem services in a particular area.

The QUESSA team are now undertaking further analysis of the data they have harvested throughout the project’s lifetime. Holland hopes that in the future, their findings can reach a wider audience who can most benefit from them.

QUESSA

- ★ Coordinated by the Game and Wildlife Conservation Trust in the United Kingdom.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/project/rcn/105334>
- ★ Project website: <http://www.quessa.eu/>

BETTER, FASTER DETECTION OF AFM1 CONTAMINATION IN MILK

A breakthrough in the dairy industry has been achieved with the development of new high-tech devices for improving quality control, particularly regarding contamination by the fungal toxicant aflatoxin M1 (AFM1).

One of the greatest concerns facing the dairy industry is the timely detection of AFM1. This potent carcinogen originates in feed contaminated by a mould (*Aspergillus Flavus*) and may be transferred into the milk of the infected animal. As it is not deactivated by pasteurisation or UHT treatment it can be found in dairy products and concentrated in cheese.

AFM1 thus represents a threat to both human health and the economic success of the dairy industry. The technology currently available for its detection is laboratory based and often requires time-consuming sample preparation. By failing to provide rapid identification of the carcinogen, the industry is unable to deliver cost-effective management of milk quality.

Launched in 2013, the SYMPHONY (Integrated system based on photonic microresonators and microfluidic components for rapid detection of toxins in milk and dairy products) project set out to develop a faster, more efficient approach for detecting AFM1 in milk.

A fresh approach

'The aim is to provide a new method for milk analysis, enabling precise quality control and production management,' explains Dr Leandro Lorenzelli, the coordinator of SYMPHONY. 'The system allows contamination to be detected at an early stage of the milk processing chain, thereby simplifying milk control logistics, minimising hands-on labour and improving product quality,' he adds.

Project partners used biochemistry and novel microfluidic technologies to create a miniaturised device capable of sample purification and pre-concentration by using the selectivity of aptamers and antibodies. Photonic resonators based on a low-cost silicon-based optical sensor were integrated into a smart system in order to achieve the high sensitivity required for detection of the toxicant.

'The main purpose of the sample preparation stage is to clean the milk sample from unwanted components like fats,' states Dr Andrea Adami, project technical manager. 'These may interfere with the following stages and cause clogging of the system; it also concentrates the toxin to allow detection,' he continues.

Improved quality control and food safety

Using the SYMPHONY device as an automated sampling and analysis unit for the Hazard Analysis and Critical Control Points (HACCP) food safety management system will result in better quality control and management of specific risk factors, leading to improved public health safety.

This preventative approach enables contamination to be detected at an early stage by testing each batch entering the production chain more quickly and in larger samples. In addition, farmers are provided with effective feedback, ensuring



"The result will be a considerable reduction in the economic loss to farmers and dairies and an improvement in the quality of the finished product."

timely on-farm management of the contamination by taking rapid action on herds and feed.

'The result will be a considerable reduction in the economic loss to farmers and dairies and an improvement in the quality of the finished product,' claims Dr Adami.

A growing market

Many factors determine the occurrence of AFM1 in milk, such as climate, farm and cow health management, quality of sampling and frequency of sampling. Recently, the effects of climate change such as warmer temperatures and drought-damaged plants are potential candidates for AFM1 outbreaks in temperate regions that are normally toxin free.

Hence, there is a growing need for the SYMPHONY automated system, the production of which will help to make the EU the market leader for AFM1 testing. In addition, the technology can be easily transferred to other sectors of the agro-food industry as well as the environmental sector.

SYMPHONY

- ★ Coordinated by FBK in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/110046>
- ★ Project website: <http://www.symphony-project.eu>
- ★ <http://bit.ly/2xhb4P1>

INNOVATIVE FIWARE-BASED APPS FOR MORE PRODUCTIVE FARMING

The EU-funded FRACTALS project provided EUR 5.52 million in funding to 46 SMEs, who collectively produced a portfolio of disruptive FIWARE-based applications for agriculture.

Introducing state-of-the-art technology into traditional industries can be an effective means of boosting productivity and ensuring competitiveness. With this in mind, the EU-funded FRACTALS (Future Internet Enabled Agricultural Applications) project set out to encourage the development of innovative technologies focused on increasing agricultural productivity. To do so, it provided funding of up to EUR 150 000 to web entrepreneurs developing FIWARE-based applications for the agricultural sector.

FIWARE is an open, public and royalty-free architecture and set of open specifications for digital applications. Applied to the agriculture sector, FIWARE can be used to create crop sensors that tell farmers when they need more nutrients or ground sensors that instruct sprinklers to dispense the exact amount of water needed. 'These types of applications create Smart Fields that have the potential to make food production much more sustainable and help reduce both waste and costs,' says project coordinator Goran Hodoba.

Levelling the playing field

According to Hodoba, FRACTALS focused on agriculture due to a recognised need for technological innovation in the area. 'Less than a quarter of European farmers use ICT in their daily work,' says Hodoba. 'This is significantly lower than in the US, where technologically-enabled American farmers operate more efficiently, increasing communication along the supply chain and thus achieving better margins.'

To help level the playing field, FRACTALS funded and nourished the creation of 43 innovative, market-ready FIWARE-based applications that address concrete problems and agriculture needs in 12 different countries. In addition to the funding, the project also provided developers with ongoing technical and entrepreneurial support and training. The project also established new models of communication and collaboration between ICT industry and agriculture by involving end-users in testing and validating the applications via a Living Lab



environment and by organising demo days and matchmaking opportunities.

One example of the type of applications coming out of the project is AgriSens, a backend system that helps farmers make decisions about their crops by leveraging remote sensing and drone technology. AgriSens products and services are used by large agricultural producers, individual farmers, researchers, seed producers, insurance companies and banks in order to gain valuable insights into the field and, when necessary, take quick corrective action. Today, AgriSens applications are being used by more than 200 users in over 30 countries.

Positioning Europe

In total, FRACTALS invested EUR 5.52 million into 46 SMEs, which produced a portfolio of disruptive FIWARE-based applications for agriculture, all of which are currently benefiting farms in 26 European countries. But the project's impact is much bigger than this immediate benefit.

"In total, FRACTALS invested EUR 5.52 million into 46 SMEs."

For Europe to catch up with global competitors, it is critical to invest in a smart way and to combine priorities in order to maximise impact. 'This combination is what made FRACTALS a smart investment for European taxpayers,' says Hodoba. 'It simultaneously helped the South Eastern Europe/Balkan region to bridge the gap with the rest of Europe through implementing FIWARE technologies whilst, at the same time, contributing to safe and adequate food for future generations of Europeans.'

FRACTALS

- ★ Coordinated by Razvojni fond Vojvodine in Serbia.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/191438>
- ★ Project website: <http://fractals-fp7.com/>

INDUSTRY

BRINGING THE PROMISE OF ADVANCED NANO-MATERIAL PRODUCTS CLOSER, THANKS TO A NEW PROCESS

Nano-technologies and materials are already changing many products, with predictions that the market could grow to an estimated USD 2.6 trillion. With this growth contingent on improved micro-component manufacturing at volume, does the EU-funded MICRO-FAST project point the way forward?

The last decade has witnessed a marked miniaturisation of both manufacturing components and associated equipment, with scales typically ranging from the miniature (< 50.0 mm), to the micro (<1.0 mm) and even the sub-micro (0.1 to 1.0 mm). However, traditional fabrication, machining and forming techniques limit the range of materials which can be processed, holding back the introduction of new tools, new components and ultimately, products for market.

The EU-funded MICRO-FAST (A FAST process and production system for high-throughput, highly flexible and cost-efficient volume production of miniaturised components made of a wide range of materials) project set out to meet this challenge by developing a completely new manufacturing technology for the volume production of high-quality, net-shaped, micro-sized parts using a wide range of powder materials (metallic alloys, composites, ceramics and polymers), at low cost.

Developing a whole new micro-manufacturing process

Finding that it was not practically possible to simply scale down the pre-existing sintering technique known as the field assisted sintering technique (FAST), the MICRO-FAST team successfully developed a completely new micro-component process for the micro-scale (<5.0 mm).

Micro-forming tools underwent advanced surface treatment, and techniques were developed for high-temperature applications. The team developed nanostructured metal and ceramic powders, which, compared to traditional techniques, offered improved quality and properties for bulk parts. As the project leader Professor Yi Qin explains, 'Sintering of a bulk micro-component from powder, was achieved with the FAST technique by simultaneously applying a pressure and a controlled electrical current through a die

filled with powder.' The electrical current through the powder particles resulted in more electro-plasticity, allowing for both more complex shapes and better component density, without the need to apply a high temperature for a lengthy period.

By applying Life-Cycle Assessments, MICRO-FAST found that they had achieved close to full density for the sintered components, with over 98% for titanium and steel powder, and almost 96% for ceramics. Reduced emissions were also observed, largely due to the use of the 'ready to press' new powders that didn't need the addition of binders or solvents. The project also found that compared to traditional sintering – thanks to fewer production steps and the integrated nature of the system – energy consumption was reduced by 20-30%. Reaching sintering temperatures around 20% less than conventional processes, coupled with fast-heating and cooling, enabled shorter production cycles, further producing energy savings.

Savings also look set to be made in the overall cost. As Prof Yi Qin outlines, 'MICRO-FAST enables a single-step production avoiding the lengthy binder mixing and debinding process of current long-chained powder metallurgy production techniques, and this positively affects the overall cost.' Additionally, it is anticipated that direct economic gains for SME participants involved in machine building, tools production and powder manufacturing could see an increase of around 10% in their annual turnover, in the three years after the project end.

Shaping the future of product innovations

Being the first such production system available means that the MICRO-FAST technology is expected to generate significant interest. As Prof. Yi Qin summarises, 'One single manufacturing platform has evident advantages in terms of cost, production time and reduction of manual work; furthermore, the

environmental impact will be consistently reduced.' Added to this, several high-quality powders developed during the project will enable sintering processes with better process control (less wear of tooling, higher yield, reduced emissions) and better product quality (control of dimensions and improved surface finish).

Ultimately, the ability to utilise difficult-to-cut and difficult-to-form materials to manufacture innovative and high quality micro-components, such as those with magnetic properties or

biocompatibility, will prove a real asset for EU manufacturing sectors seeking to gain a competitive technological and business edge.

MICRO-FAST

- ★ Coordinated by Mbn Nanomaterialia in Italy.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/109370>
- ★ Project website: <http://www.micro-fast.eu/>

SOFTWARE INNOVATION LENDS A HAND TO THE DREDGING INDUSTRY

Everywhere land interacts with water, claiming new habitable space or exploiting natural resources can quickly become a major challenge. The MPM-DREDGE project is providing a numerical tool to help engineers rise to such a challenge with a focus on the dredging industry – a sector worth EUR 7 billion.

Without computers, investigating soil-fluid interactions is a real money pit. It requires large-scale experiments where wind, gravity, waves, currents and changing seabed characteristics have to be factored in and change with every new location. Software overcoming the numerical issues associated with large deformations and fluid pressures that occur in the interaction between soils and fluids, on the other hand, could be a real game changer.

'Our goal was to solve problems involving large deformations of soft soil (sand, clay, peat) in interaction with water, which are characteristic of off-shore, near-shore, coastal engineering and flood protection,' says Dr Alexander Rohe, MPM-DREDGE (MPM modelling and simulation of soil-fluid interaction for dredging applications) network coordinator and researcher at Deltares.

The project already benefitted from a head-start in pioneering work from the University of Cambridge and Deltares. The two institutions had identified the so-called Material Point Method (MPM) as a high-potential solution for solving soil-fluid interaction problems, whilst support from the four largest European dredging companies under MPM-DREDGE has enabled them to come up with specific applications for this sector.

The dredging industry is indeed crucial for tackling issues related to the likes of port development, land reclamation, oil and gas exploration and exploitation, offshore wind farms, and a host of



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other initiatives involving soil-fluid interaction.

Appealing to the European dredging industry

MDM-DREDGE applications include: the dredging of soil for sand mining and related risks of liquefaction and breaching, leading to failure of the underwater slopes; installation of geocontainers for construction of breakwaters; as well as erosion modelling for the design of offshore foundations, scour protection, revetments, underwater slopes and dikes/levees.

Now completed, the project has successfully developed a 3D computer code based on MPM which can be used to model large deformation problems for soil-fluid interactions. This numerical tool has been validated, demonstrated and integrated into the joint software Anura3D that combines earlier work from both Cambridge and Deltares.

'We've achieved significant enhancements of MPM towards modelling of two continua, i.e. water and solid, with their mutual interaction. Water can flow into solid soil bodies, flow through them and can also seep out, causing deformation of the soil. The new approach also enables the modelling of state transition, i.e. the fluidisation of solid material, and

solidification or sedimentation of soil-water mixtures or slurries,' says Dr Rohe.

With their new software, the team hope to convince the dredging industry of using advanced numerical modelling techniques to improve the efficiency of their dredging operations and the design of their constructions.

A beta-version was released in January 2017, and the official release is expected for September 2018, as soon as the consortium is done testing and validating new functionalities. From this point onwards, the Anura3D MPM Research Community will pursue development, and new releases will be scheduled every six months. 'The software is currently not open source but it is available upon request. We are working towards a fully open-source release within the next three years,' Dr Rohe says.

New research projects have already started and build upon the results of the project, whilst additional H2020 proposals have been submitted for evaluation.

MDM-DREDGE

- ★ Coordinated by Deltares in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/105988>
- ★ Project website: <http://www.mpm-dredge.eu/>

RECOVERY OF CRITICAL METALS FROM WASTE PROMOTES GREEN TECHNOLOGIES

Recycling plays a vital role in the drive towards a more sustainable society by reducing the amount of waste going to landfill thereby conserving natural resources. An EU-funded initiative has therefore developed innovative processes using powerful solvents to recycle metals from unwanted electrical and electronic material.

Waste electrical and electronic equipment (WEEE) is the fastest growing form of waste in Europe. However, such discarded material contains significant amounts of raw materials described as critical metals that can be profitably recycled. Critical metals' availability is essential for high-technology, green and defence applications, but they are vulnerable to fluctuations in supply.

The EU-funded HYDROWEEE DEMO (Innovative Hydrometallurgical Processes to recover Metals from WEEE including lamps and batteries — Demonstration) project focused on the recovery of base and precious metals from WEEE using innovative hydrometallurgical processes. The initiative built on an earlier EU project that developed processes using sulphuric acid to extract valuable metals from lamps and cathode ray tubes (CRTs), liquid-crystal displays (LCDs), lithium-ion batteries, printed circuit boards (PCBs) and industrial catalysts.

Project partners improved techniques for extracting 11 different metals, including gold and silver, and created new ways to recover a further six metals. The new processes can produce materials with sufficient purity (above 95%) to be put on the market and reused by industry for applications such as for electroplating.

'We built two industrial-scale, real life demonstration plants (one mobile and one stationary) to test the performance and prove the viability of the processes from a technical, economic, operational and social viewpoint,' says Dr Bernd Kopacek, project coordinator.

Making the plant mobile by putting it in a container allows several small and medium-sized enterprises (SMEs) to benefit from the same plant at different times, thereby reducing both waste and the financial investment required. By making the processes universal, different input materials can be treated in the same mobile plant in batches.

'Operating the chemical recycling plants helps SMEs get a better understanding of which critical metals can be recovered and where any difficulties may lie. They also get an insight into the market for critical metals and are able to expand their networks of customers and partners,' Dr Kopacek explains.

A win-win for all

Recyclers will benefit from the initiative as they will have the opportunity to extract more metals. Manufacturers using critical metals will benefit from a steady and reliable supply of raw materials within Europe, rather than depending on China, which currently mines 97% of rare earths. The general public will profit from a cleaner environment as the need to mine new metals is reduced and waste is better managed.

The project will improve efficiency and capacity by encouraging innovation through the introduction of more effective processes and technologies. This will save costs, energy and natural resources and enable Europe to become less dependent on the prices of raw materials.

According to Dr Kopacek: 'The turnover per mobile plant depends on the treated input material, but can reach EUR 3.5 million per mobile plant according to the current size.'

HYDROWEEE DEMO thus supports green technologies such as e-mobility and energy saving lighting, which depend heavily on the use of raw materials like cobalt, indium and rare-earth elements (including yttrium). Studies show global supply of these materials will increasingly lag behind demand if the current situation is not addressed.

Dr Kopacek concludes: 'HYDROWEEE DEMO is in line with the European 2020 strategy and its flagship initiative for a Resource Efficient Europe. It is also expected to create five to seven new jobs per mobile plant, hence the intention is to operate these plants throughout Europe, as well as additional ones in other regions of the world.'



© Bernd Kopacek

HYDROWEEE DEMO

- ★ Coordinated by Kopacek in Austria.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/105213>
- ★ Project website:
<http://www.4980.timewarp.at/sat/hydroWEEE/>

SEND A THIEF TO CATCH A THIEF: LEARNING FROM NATURE FOR MULTI-SCALE TURBULENT FLOWS

Shade under trees has been shown to be better than ‘normal’ shade due to fractal porosity creating efficient convection for coolness. The EU-funded MULTISOLVE project has tapped some of nature’s secrets for a new class of turbulent flows.



Achieving sustainable development urgently requires new techniques to keep our manufacturing products and processes efficient and environmentally friendly. Design plays a vital role in the delivery of these necessary innovations, maximising energy inputs, as well as reducing pollutant outputs. Thankfully, nature shaped by the forces of evolution provides designers with templates from which to work.

The EU-funded MULTISOLVE (Conceptually new, multi-scale solutions to industrial flow problems) project looked precisely to the workings of nature – specifically fractal geometries – for inspiration in the quest to create a new class of multi-scale turbulent flows. What makes the results especially significant is their wide applicability across many industrial sectors such as mixing, aeronautical, automotive, power generation and wind engineering.

The power of the fractal

The scope of harnessing fractal geometries to control turbulence and flow has been demonstrated by research over the last decade. As one of the MULTISOLVE project team, and a key proponent of the approach, Professor Christos Vassilicos explains, ‘Put simply, with turbulent flows being themselves fractal, the underlying principle is to send a thief to catch a thief. Increased understanding of how fractal design influences flow, which we can

observe all around us in nature, allows us to design accordingly, with known benefits in mind.’ Through this methodology, the team has been able to demonstrate both experimentally and computationally (through modelling), that it is possible to generate bespoke turbulence to increase the efficiency and effectiveness of a wide range of processes.

One of the most promising areas for application is for mixing enhancement. This is significant, as Professor Vassilicos points out, because, ‘People don’t realise just how pervasive mixing is in our industries, whether it be in chemical reactors, bio reactors or combustion. Its range of uses, and so the degree to which we depend on it happening efficiently – in terms of power inputs, mix quality, speed and cost – is enormous.’

While MULTISOLVE was principally focused on turbulent flows in air and water, the work led to subsequent developments (in another project) concerned with viscoelastic fluids (e.g. chocolate), showing that mixing blades, designed according to fractal principles, reduce the mixing time by half. With production time equating to money expended, this technological breakthrough has generated considerable interest from industry.

Another exciting application is for the design of blades functioning in air currents, such as wind turbines, which increasingly supply power across Europe.

“One of the most promising areas for application is for mixing enhancement.”

In order to maintain robustness, the blades can’t have zero thickness trailing edges, as this weakens the blade at the point where it interacts with the axis, bending it and so creating more drag. Industry often responds by shortening the blade, which in turn increases wind resistance, reducing efficiency.

The solution MULTISOLVE offered was, as project coordinator Professor George Papadakis explains, ‘To use fractal design to corrugate the trailing edge. This reduces wind resistance, increasing efficiency while still maintaining blade sturdiness.’ The fractal design has also been shown to reduce noise pollution, which is especially promising when applied to aircraft wings. Crucially, the MULTISOLVE approach need only retro-fit the individual parts affected.

To bring the technique to market, the MULTISOLVE team are now concerned with focusing on a limited number of applications for scaled up testing, in a manner relevant for industry. However, bridging the lab-to-market gap comes with its own challenges as Professor Vassilicos elucidates, ‘The time lag from academic research, which is typically more generic, to specific industrial applications can take years because industry operates within many socio-economic constraints. But if we respect each other’s differences, we can work together for real innovations.’

MULTISOLVE

- ★ Coordinated by the Imperial College of Science, Technology and Medicine in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/105080>

COMPUTATIONAL HOMOGENISATION IN MAGNETO-MECHANICS

Researchers with the EU-funded MOCOPOLY project developed a methodology to repeatedly fabricate MSEs for the purpose of experimental testing.

Magneto-sensitive elastomers (MSEs) are a new class of materials that change their mechanical behaviour in response to the application of an external magnetic field. These smart materials have received considerable attention in recent years, thanks to their exciting potential uses in engineering applications such as rapid-response variable stiffness actuators and dampers for mechanical systems with electronic controls and artificial muscles for use in robotic and biomechanical devices.

As a prerequisite for the design of industrial devices using MSEs, numerous challenges related to the fabrication, testing and computer modelling of these materials need to be addressed. To address these needs, the EU-funded MOCOPOLY (Multi-scale, Multi-physics MOdelling and COmputation of magneto-sensitive POLYmeric materials) project contributed over 40 peer-reviewed publications to the scientific literature on a variety of MSE-related topics. 'One major result of the project's intense, multinational efforts was the development of a methodology for repeatedly fabricating MSEs for the purpose of experimental testing,' says MOCOPOLY project coordinator Paul Steinmann.

Exciting experiments

Project researchers procured two devices for experimental testing purposes, namely a rotational rheometer and tensile test machine.

Using these devices, researchers developed experimental protocols for achieving reliable and repeatable results. In addition, auxiliary experimental studies using state-of-the-art technology provided researchers with an in-depth understanding of the internal structure of MSEs and of the complex structure of the MSE at macro- and microscopic levels.

Inspired by the experimental data extracted for the MSE in both uncured and cured states, the project was able to mathematically model the macroscopic deformation characteristics of MSEs at large strains and in the presence of a magnetic field. 'We used a unique approach to encapsulate the mechanics of the imperfect chain-like structures that are developed by the particles when the material is cured under a magnetic field,' explains Steinmann.

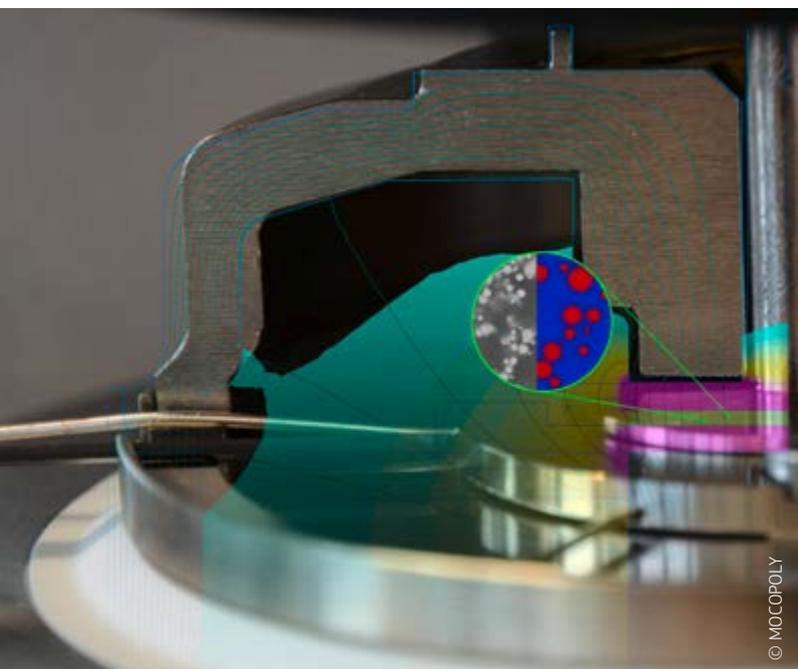
Researchers also developed a computational framework to simulate the curing process of the magneto-viscoelastic MSEs under the influence of a magneto-mechanical load, along with a unified framework for computational analysis of the MSEs using high-performance, open-source software. Some aspects of this framework and the derivative works were then given back to the open-source community.

To complement the work at large length scales, microstructural studies were conducted to determine the influence of the particles within MSEs. 'We produced a computational model that captured both macro and nano-scale effects and, with this enhancement, were able to represent characteristics that can only be observed at this length scale,' says Steinmann.

Furthermore, the process of homogenisation allowed the team to estimate the effective large-scale properties of a heterogeneous material from the response of the underlying micro-structure. Using computational methods, researchers extended the already established methods to encompass phenomena only experienced within MSEs, including the presence and interaction of magnetisable particles. 'As a result, we developed and utilised approaches to perform studies that produced a statistical quantification of uncertainties indicated in experimental data,' says Steinmann. 'To complement and validate these studies, we developed a robust method for the identification of microscopic material parameters using macroscopic experiments.'

Far-reaching results

Thanks to these experiments, the MOCOPOLY project made significant progress towards developing a better understanding of MSEs. More so, due to the fundamental mathematical equations governing magneto-elasticity and the conditions under which the project's studies were conducted, much of the theory developed for magneto-mechanics can also be directly applied to electro-mechanics, and vice-versa. 'Through this interdisciplinary overlap, we were able to extend our findings to other interesting electro-mechanical smart materials,' adds Steinmann.



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MOCOPOLY

- ★ Hosted by the University of Erlangen-Nuremberg in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/102464>



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INFORMATION AND COMMUNICATION TECHNOLOGIES

A STEP CLOSER IN TACKLING ONLINE RUMOURS AND FAKE NEWS

With a recent explosion in fake news online – from propaganda to ‘alternative facts’ – online media desperately needs new systems to check news veracity and validity. A recent EU-funded project may have the answer.

Rumours have been around for millennia, as attested by the ancient (and modern) Greek word ‘pHEME’, which means rumour or inaccurate information. In the age of social media, people are getting most of their news and information from the internet, often making decisions or forming opinions based on false information. The EU-funded PHEME (Computing veracity across media, languages, and social networks) project developed software tools that can identify and verify the veracity of online rumours.

Such efforts couldn’t have come at a better time as the spread of alternative media has motivated journalists and media managers worldwide to intensify their fact-checking and verification efforts. ‘Recent high-profile examples are elections and referenda, where false information and online propaganda may

have misled numerous citizens,’ says project coordinator Kalina Bontcheva from the University of Sheffield in the United Kingdom. ‘Social media platforms such as Facebook are also having to rise to the challenge of limiting the impact of misinformation online,’ she adds.

PHEME developed a sophisticated computational framework for rapid automatic discovery and verification of rumours on a large scale. ‘One key tool we created is an open-source journalism dashboard that helps journalists track emerging rumours and examine key aspects of relevant discussions on social media,’ explains Prof. Bontcheva. ‘Another is an automated fact checking tool that assists journalists in checking the validity of claims made by politicians or in the news media.’ In addition, PHEME developed a dashboard aimed

at identifying and analysing medical misinformation.

To ensure the tools’ efficiency, the project team used past rumours as training data for machine learning algorithms. ‘We trained models to spot the opinions or stances that people are taking about a claim, and based on that picked out how likely a rumour is to be true or false,’ explains Prof. Bontcheva. ‘Once this is completed, the team can assign a value that reflects the veracity of the rumour.’

The work has been challenging, as machines – like people – can also fall for half-truths and propaganda. Nonetheless, machine performance is improving continuously and can cross-reference large amounts of information very quickly from different sources. ‘The PHEME tools can provide the

evidence, but human input is needed for the decision making,' says Prof. Bontcheva, underlining that 'the PHEME rumour analysis tools are intended to assist, not replace, journalists in the decision-making and verification tasks.' The current level of accuracy of around 75-80% has been quite satisfactory for the project's purpose.

Importantly, most of the tools are open source and freely available to scientists, journalists and medical professionals so they can experiment with them. Some news organisations are trialling the tools, and there are ongoing discussions to commercialise the outcomes successfully.

One global challenge in the field is how to eliminate fake news from people's social feeds. 'Although some key players have started developing solutions, they haven't solved the problem, in the

same way that we haven't been fully able to eliminate email spam,' argues Prof. Bontcheva. 'Any tools must also be complemented with raising user awareness and educating social network users about how to identify fake news and unreliable content,' she adds.

In the meantime, project partners are continuing to improve the algorithms in terms of reliability, scalability and efficiency beyond the project's end date. 'The technology is getting better and we've pushed the state of the art from what it was three years ago,' says Prof. Bontcheva.

Overall, PHEME has created and released several human-verified rumour datasets and software tools. These can then be scrutinised and verified independently, avoiding concerns regarding tool-based censorship as well. The findings will be instrumental in making our news more

"Most of the tools are open source and freely available to scientists, journalists and medical professionals so they can experiment with them."

reliable and so our beliefs and decisions more sound.

PHEME

- ★ Coordinated by the University of Sheffield in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/191627>
- ★ Project website: <https://www.pheme.eu/>
- ★  <http://bit.ly/2oCWY92>

ICT SOLUTIONS TO ENHANCE URBAN WATER MANAGEMENT

To save water and energy, it is necessary to involve citizens in meeting actual consumption levels and desired targets. An EU initiative developed an ICT platform that actively engages citizens in improving the management of water demand in urban areas.



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Water is becoming an increasingly scarce commodity. This negatively impacts drinking water resources. At the same time, urbanisation has become a global phenomenon, as more and more people choose to live in cities. Providing diminishing water resources to a growing number of cities is a daunting challenge.

Technology that meets water utility company and consumer needs

'In many situations, water supply cannot be increased at will, either because the infrastructure investment takes years or because it is very expensive, even in terms of the

energy required,' says Professor Andrea Emilio Rizzoli, project coordinator for the EU-funded SMARTH2O (SmartH2O: an ICT Platform to leverage on Social Computing for the efficient management of Water Consumption) project. To tackle the problem of water demand and supply, the project introduced a software platform enabling water utilities, municipalities and citizens to design, develop and implement better water management practices and policies. This will lead to a reduction in water consumption without compromising quality of life.

The software solution takes advantage of recent developments in water metering infrastructures. 'The advent of smart water meters enables us to closely monitor how much water each household is using, and when,' explains Prof. Rizzoli. 'The platform records and processes such data, providing motivational feedback to users in order to reduce

consumption,' he adds. The technological innovation works to understand and model consumers' current behaviour on the basis of historical and real-time water usage data. It predicts how consumer behaviour can

"Project partners successfully deployed the SMARTH2O platform in 400 Swiss households and to over 40 000 customers in Spain."

be influenced by various water demand management policies, from water savings and social awareness campaigns to dynamic water pricing schemes. Customers must subscribe to the platform to reap its benefits.

Project partners successfully deployed the SMARTH2O platform in 400 Swiss households and to over 40 000 customers in Spain. Outcomes showed notable water savings of around 20% in Spain and 10% in Switzerland.

Cooperative awareness tools to make citizens better water consumers

Researchers developed novel algorithms that can attribute a household's total water consumption to single-end uses, such as showering or watering the garden. This allows for more

precise and impactful water reduction recommendations. They also developed algorithms to identify the most common water use profiles. The algorithms are then used in an agent-based simulation platform to simulate and predict water use at the district level.

Another field of research focused on the development of gamification techniques to encourage water savings. A board game with a digital extension aimed at promoting water efficiency among school children was designed and distributed to households in Spain and Switzerland. In addition, a behavioural economics study was carried out on the impact of rewards and incentives on water consumption.

'Thanks to SMARTH2O, water utilities can promote more responsible use, and learn more about how customers behave and how they react to awareness stimuli and to consumption rewards and incentives,' concludes Prof. Rizzoli. 'It also raises consumer awareness on existing water usage habits and lifestyle implications such as environmental consciousness.'

SMARTH2O technology is currently being commercially exploited. Potential customers have SmarterWater at their disposal, a new product that incorporates many of the developed solution's advantages. This digital 2.0 platform connects water systems online, thus providing accurate consumption data in real time.

SMARTH2O

- ★ Coordinated by SUPSI in Switzerland.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/191632>
- ★ Project website: <http://www.smarth2o-fp7.eu/>

A PUSH TOWARDS DECENTRALISED ONLINE SOCIAL NETWORKS FOR AN ENHANCED FUTURE DIGITAL ECONOMY

Online social networking (OSN) sites are reshaping the internet's structure, design and utility. An EU initiative targeted a push away from centralised services towards totally decentralised systems for positive change in the future provision of online social services.

The EU-funded project ISOCIAL (iSocial: Decentralised online social networks) worked to advance understanding of the requirements for developing decentralised OSN platforms. 'OSN decentralisation can address privacy considerations while assuring service scalability, performance and fault-tolerance in the presence of an expanding base of users and

applications,' notes Associate Professor Girdzijauskas, project coordinator.

However, Europe has a shortage of individuals with the skills needed to build decentralised IT platforms and infrastructures able to host innovative OSN services and applications. To this end, the project's primary goal centred on providing world-class

"We believe that decentralised OSNs create a potentially transformational change in consumer behaviour and will bring a far-reaching impact on traditional industries of content, media and communications."



training for the next generation of researchers, computer scientists and web engineers.

The ISOCIAL training network funded a total of 16 fellows. Their work covered four interconnected research tracks: decentralised infrastructure; big data analytics and machine learning; security and privacy; and simulation and modelling.

Research activities emphasised both theoretical and experimental approaches, methodologies and tools. This supports the development of 'totally decentralised systems that will pervade our environment and seamlessly integrate with future internet and media services,' explains Prof. Girdzijauskas.

ISOCIAL fellows realised a number of important developments, including designing and building a peer-to-peer architecture for distributed notification systems over decentralised OSNs (DOSNs). They developed novel, massively parallel graph-based algorithms that suitably fit DOSNs and eliminate the need for centralised aggregation points. Fellows also worked on the integration of graph analytics with machine learning to analyse autonomous data sources as well as users' interactions in decentralised settings.

Effecting positive change in consumer behaviour

Overall, project efforts, activities and research were aligned with ISOCIAL's vision of supporting future provision

of social applications and services in the absence of central management and control. 'We believe that decentralised OSNs create a potentially transformational change in consumer behaviour and will bring a far-reaching impact on traditional industries of content, media and communications,' says Prof. Girdzijauskas. 'Distributed and scalable overlay networking and distributed storage infrastructures that support open social networks and related innovative applications also help to preserve end-user privacy and information ownership.'

The ISOCIAL consortium held a series of events across Europe, including annual research meetings, two intensive postgraduate summer schools, three thematic workshops and one final comprehensive workshop. Partners also offered seven online courses. Two video challenge programmes were organised, open to students of secondary schools and universities – one on 'Online Social Networks for Health and Well-being' and the other on 'Online Social Networks for Social Good'.

Research done during the project's mandate resulted in 10 journal and 37 conference publications. Groundbreaking research on social networks modelling was published in Nature Physics. At project close, three students had successfully defended their PhD theses, with another seven expected to complete their PhDs in 2017.

New technologies for networking and infrastructures

Some of the technologies developed during ISOCIAL have already been adopted by European SMEs. These include a language technology company driving next-generation text analytics and one providing solutions for media distribution and performance analysis.

ISOCIAL's training network as well as general project work and outcomes have paved the way for improved networking and enhanced infrastructures that support open social networks and applications. As the 'ISOCIAL Final Report' notes, 'it significantly advanced the field of Decentralized Online Social Networks, by making available completely new technologies that will pave the way for more decentralized, sharing-based digital economy of the future.'

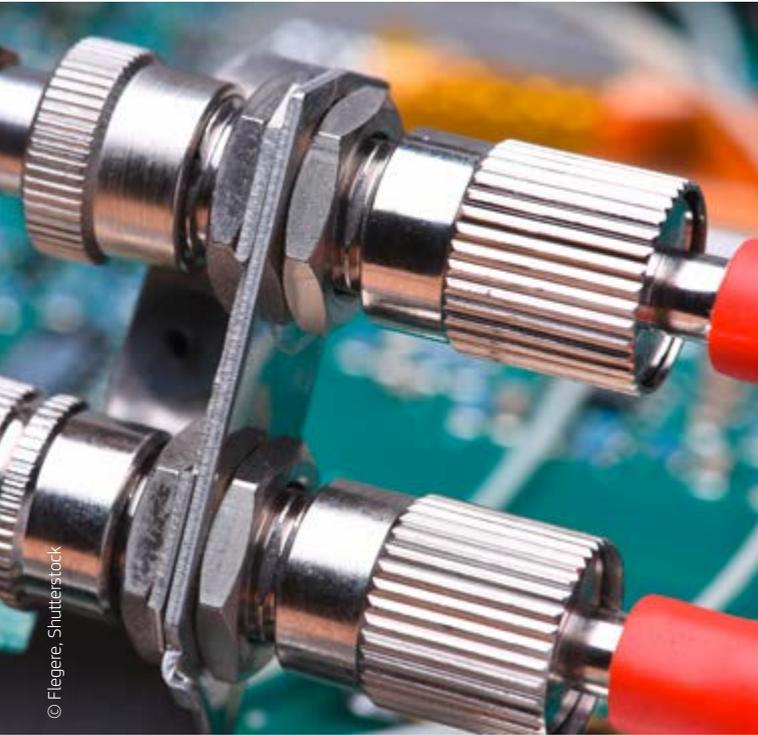
Overall, project developments and deliverables will help to preserve end-user privacy and information ownership, as well as pave the way to the emergence of novel decentralised services thereby addressing issues like energy efficiency and data lock-in.

ISOCIAL

- ★ Coordinated by the Royal Institute of Technology in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/104968>
- ★ Project website: <http://isocial-itn.eu>

TOWARD A PRACTICAL USE OF PHASE-SENSITIVE OPTICAL AMPLIFIERS

Researchers with the EU-funded PSOPA project have helped address some of the barriers to the use of PSAs for telecommunication and other potential applications.



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Optical amplifiers are essential in optical communication systems as they compensate loss induced by transmission fibre, thus ensuring the signal integrity of the information being transmitted. Because phase-sensitive amplifiers (PSA) are coherent, the phase relationship among the optical waves at input plays a key role. PSAs have unique and superior properties compared with all other optical amplifiers, most notably the potential for noiseless amplification, very broad optical bandwidth and enabling a range of ultrafast, all-optical functionalities.

“We made progress toward a new and compact platform for the implementation of PSA using nonlinear silicon-nitride waveguides.”

In communication, there is an urgent need to develop new technologies that can break the ‘nonlinear

Shannon capacity limit’ – a serious barrier to achieving the continued capacity increase needed to meet the growing demand for bandwidth. Although the use of PSAs is expected to be an essential part of this development, before they can be used for telecommunication and other potential applications, several important challenges must first be addressed.

Overcoming challenges

Researchers with the EU-funded PSOPA (Phase-sensitive optical parametric amplifiers) project set out to address these challenges. For example, one challenge is the undesired nonlinear phenomena of Stimulated Brillouin

scattering that limits the amount of optical power that can be launched into an optical fibre.

‘While techniques exist to increase the threshold of this effect, they come with associated performance penalties,’ says project coordinator Peter Andrekson. ‘We developed an approach based on stretching sections of fibre with optical isolators in between, which allowed for more than an order of magnitude threshold increase with no associated penalty.’

Another challenge that PSOPA overcame was the need for a low noise, high power pump wave at each PSA in a transmission system. ‘Here we implemented an all-optical technique to recover a weak pump wave for the PSA by using so-called injection locking, which demonstrates that this is a very promising technique to maintain the PSA performance in a system,’ explains Andrekson.

PSOPA also overcame engineering challenges. ‘We made progress toward a new and compact platform for the implementation of PSA using nonlinear silicon-nitride waveguides,’ says Andrekson. ‘Although nonlinear amplification in these chips still must be demonstrated, this remains a promising platform as it can be implemented in a wide range of operating wavelengths and can facilitate new non-telecom related applications.’

Andrekson adds that the combination of a PSA’s ultralow noise and transmission fibre nonlinearity mitigation capabilities, which were discovered in this project, was experimentally investigated in a long-haul fibre optic transmission system for the first time. ‘These experiments showed a very significant data transmission reach extension of three times what is capable when using conventional amplifiers,’ he says.

Commercial potential

Andrekson also notes that these approaches allowed PSOPA to use PSA in a record-breaking demonstration of high sensitivity in free-space optical links. ‘This was achieved very late in the project and is something we continue to pursue quite intensely,’ says Andrekson. ‘This may be the project’s most promising commercial opportunity, with potential applications including very long reach free-space optical communication – necessary for communication to the moon or Mars.’

The project is currently in discussions with companies and space agencies, including the European Space Agency (ESA).

PSOPA

- ★ Hosted by Chalmers University of Technology in Sweden.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/result/rcn/201860>

SPACE

FIRST SATELLITE ABLE TO RE-ENTER THE ATMOSPHERE IN A CONTROLLED WAY

D-Sat is the first satellite in history that will end its mission by re-entering Earth's atmosphere in a safe and controlled way, burning up instead of becoming new debris. The satellite, which was launched on Friday, 23 June 2017, used a decommissioning and re-entry device created by the EU-funded D3 project.

Space debris is a growing problem. Earth observation, weather forecast, global navigation, disaster prevention, high-precision farming and self-driving cars are all applications that require space-based assets. Our dependence on these technologies is increasing, as is the number of man-made objects, no longer in service, in orbit around Earth. Out of the, approximately, 6 000 satellites launched since the space age began, only 1 300 are operational.

Defunct objects such as decommissioned satellites, the upper stages of rockets and other objects released during a space mission all clutter the immediate space around our planet. According to NASA, there are hundreds of thousands of pieces of debris ranging in size between 1 cm (0.4 inches) and 10 cm (4 inches) travelling around Earth, and this number is likely to increase if we keep leaving nonfunctioning satellites in orbit. Each represents a collision hazard.

D-Orbit, the coordinator of the EU-funded D3 (Smart propulsive device for controlled satellite decommissioning and reentry) project, is harnessing work done by the D3 project to aid the decommissioning manoeuvre of its small test satellite, the D-Sat. D-Sat will run three tests, and the dedicated propulsive device created by D3 will then remove it from orbit in a quick, direct and controlled way at the end of its mission.

The project explains, 'Thanks to D-Orbit's patented D3 independent propulsive system onboard, D-Sat will perform a precise decommissioning manoeuvre that will cause the satellite to re-enter Earth's orbit in just 30 minutes from the moment of ignition, even if the main systems become unresponsive.' The device may be on a small satellite for testing purposes but D-Orbit makes it clear that the same technology can be scaled up to decommission much larger spacecraft in any orbit. The technology, they explain, offers a safe and cost effective way of mitigating the space debris issue while enabling satellite operators to use all propellant onboard to perform their missions. The control offered by D3 enables the re-entry to be manoeuvred accurately, '(...) we can target a precise zone above the ocean, ensuring that possible micro-fragments will be disposed out of harm's way,' says D-Orbit.

But the satellite will not just be testing the decommissioning phase, it will also perform three experiments:

SatAlert, is an in-orbit validation of the Multiple Alert Message Encapsulation (MAMES) protocol, defined by ETSI (European Telecommunications Standards Institute). MAMES is an extensible multiple alert message encapsulation protocol for transporting alert messages of different formats over satellite links. D-Sat will collect MAMES emergency messages sent from a

ground station, store them onboard and re-broadcast them to national public safety entities upon receiving a trigger command. This experiment will validate a typical emergency scenario where civil defence agencies need a means to broadcast instructions in areas affected by natural disasters when the ground telecommunication infrastructures have been damaged.

DeCas, (Debris Collision Alerting System), activates itself during re-entry to broadcast its location and the debris footprint dynamics to civil protection agencies. In a real-world scenario, this information would be processed on ground and then transmitted in real-time to airplanes flying over that zone through the Air Traffic Control Centre, and to the populated areas below through national public safety agencies.

Atmosphere Analyser is a data collection experiment aimed at collecting *in situ* atmospheric data from the lower ionosphere during the re-entry manoeuvre.

D3

- ★ Coordinated by D-Orbit in Italy.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <http://cordis.europa.eu/project/rcn/199599>

CUBESAT TECHNOLOGY VALIDATION

SMEs form the backbone of the European economy, providing a potential source of growth. An EU-funded initiative has demonstrated that SMEs can also be players in the space technology sector.

Large-scale system integrators use nanosatellites (with a mass between 1 and 10 kg) as technology test beds, while SMEs have focused on nanosatellite solutions. Many SMEs already provide components and subsystems as part of their product portfolio.

The SME-SAT (Small and medium enterprise satellite) project brought together one of the largest ever SME-based consortiums to qualify a broad range of technologies for space. Systems and subsystems were integrated into a nanosatellite.

Each SME in the consortium was responsible for contributing a particular spacecraft system, including attitude determination and control systems, star trackers and magnetometers. A commercially available off-the-shelf 3U structure 100 mm x 100 mm x 340.5 mm was used to house them. Solar arrays were mounted on the outside of the structure to provide a renewable energy source to the bespoke systems.

Inside the structure, sensors were connected to common PC-104 boards that interface with the rest of the nanosatellite bus. The majority of the payload is internal, except for the accelerometers and gyroscopes. These were placed on a deployable boom that moves them about 30 cm away from the nanosatellite.

SMEs have always cooperated closely with academics, as this new generation of entrepreneurs is mostly university alumni. The SME-SAT project represented a unique space mission, fostering new alliances between SMEs, universities and large-scale system integrators.

The SME-SAT CubeSat was placed in Sun-synchronous orbit at an altitude of 400 or 600 km above the surface of the Earth using the ISIPOD CubeSat deployer. It was launched 'piggyback', using excess capacity of the launch vehicle as part of a larger satellite mission. Sensor performance was evaluated against measurements collected on the ground.

After the end of the SME-SAT project, a series of sensors manufactured in Europe is expected to be at the top of the technology readiness level scale.

SME-SAT

- ★ Coordinated by the University of Surrey in the United Kingdom.
- ★ Funded under FP7-SPACE.
- ★ <http://cordis.europa.eu/project/rcn/106745>



THE SECRETS OF YOUNG AND DYING STARS

Stars, like interstellar nuclear reactors, create new elements essential for the formation of new stars. Advanced telescopes have now made it possible for EU-funded astronomers to deepen our understanding of their mass-loss process.

Stars spend most of their lifetime in what is called the main sequence. In this state of hydrostatic equilibrium, nuclear fusion inside the stars counterbalances gravitational forces, preventing them from imploding. Once nuclear fuel has been consumed within the core, the stellar structures adjust to maintain equilibrium.

Stars with masses close to the sun grow into giant stars with high mass-loss rates. After they have expelled most of their material, the remnants can ionise the star core. The ionised envelope looks similar to giant gas planets, earning them the name 'planetary nebula'.

The Boomerang nebula was the target of the EU-funded MAGNETIC AGB (Illuminating the role of magnetic fields around dying stars) project. Besides this pre-planetary nebula, astronomers sought to improve our understanding of the massive outflow of R Sculptoris, an asymptotic giant branch (AGB) dying star.

Red giant stars like R Sculptoris are major contributors to the dust and gas that provide raw materials for the formation of future generations of stars. Through observations, the MAGNETIC AGB team showed that magnetic fields have a central role to play in star formation.

Specifically, they found a new molecular probe of energetic outflows that arise at the end of stellar life. Direct detection of synchrotron emission from a stellar jet has also offered evidence that magnetic fields are directly involved in collimating the outflows that shape stellar ejecta.

Synchrotron radiation is commonly detected in relativistic jets emerging from astrophysical sources such as active galactic nuclei and quasars. The mechanism that underlies synchrotron emission involves interaction between relativistic particles moving in a region controlled by a magnetic field.

"They found a new molecular probe of energetic outflows that arise at the end of stellar life."

The observations of a synchrotron jet from beyond the AGB star suggest that magnetic launching and collimation is a common feature. The observational findings were supported by magnetohydrodynamical simulations.

MAGNETIC AGB offered unambiguous proof that magnetic fields are key to explaining the asymmetries observed in protostars and young planetary nebulas. However, the source of stellar magnetic fields remains unclear and will be the subject of further research.

MAGNETIC AGB

- ★ Coordinated by Chalmers University of Technology in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/104836>

FUNDAMENTAL RESEARCH

NOVEL METHODS LIFT THE VEIL ON CHROMATIN'S ROLE IN GENE EXPRESSION

Chromatin can be regarded as the control centre of a cell: It shields DNA to protect its structure and sequence, and controls its expression and replication. An ERC grant has now allowed for a better understanding of how it does so.

For Prof. Bas van Steensel, Chromatin Genomics Group Leader at the Netherlands Cancer Institute, the CHROMATINPRINCIPLES (Principles of Chromatin Organisation) project was all about seeing the bigger picture.

Whilst the scientific community already knows much about interactions between chromatin proteins, how they are organised as a network remains a mystery. 'Chromatin is very complex, because it consists of hundreds of proteins. How these proteins work together to form distinct types of chromatin is poorly understood. Moreover, we need to understand how different chromatin types control gene expression,' says Prof. van Steensel.

In other words, the team had to develop better tools to study chromatin and gene regulation. Their previous studies on *Drosophila* had already shed some light on the principle types of chromatins. One of these, a novel repressive type of chromatin that covers nearly half of the fly genome called BLACK chromatin, was of particular interest. Its

embedded genes are inactive – suggesting that this chromatin type helps to repress gene activity – and it tends to be positioned at the edge of the nucleus (the nuclear lamina), pointing to a role in the spatial organisation of the genome.

By focusing on BLACK chromatin, the team hoped to gain insight into the basic mechanisms that drive the partitioning of the genome into distinct chromatin types. Technical problems in *Drosophila* cells, however, forced the team to shift its attention towards a closely-related type of chromatin in mammalian cells known as lamina associated domains (LADs).

'Like *Drosophila* BLACK chromatin, mammalian LADs are thought to repress gene activity, and they are located at the edge of the nucleus. We developed exciting new methods to visualise and track LADs in living cells, and to map the contacts of LADs genome-wide in single cells,' says Prof. van Steensel.

There were three main methods developed under the project: TRIP, for integrating a reporter gene that can sense local

chromatin effects across the genome; SuRE, which allowed the team to generate a catalogue of all regions in the human genome that can drive gene expression in the absence of a chromatin context; and TIDE, a web-based tool that can help interested researchers to test genome editing by means of the CRISPR technology.

The results were outstanding: 'We found strong evidence that LADs repress gene activity,' Prof. van Steensel says. 'Our different approaches also revealed that the LAD contacts with the lamina are highly dynamic, and that they are subjected to extensive reshuffling each time the cell

"We found strong evidence that LADs repress gene activity."

divides. There is, however, a subset of LADs that are very stably anchored to the lamina in almost every single cell.

They may help organise chromosomes inside the nucleus. Finally, we identified one chromatin modification in LADs that promotes lamina interactions.'

Now that the project is completed, the team hope that all the project's insights will contribute to scientific understanding of gene regulation, and that the new methods they developed will be adopted and further modified by other labs.

In the meantime, Prof. van Steensel has been awarded another ERC Advanced Grant. His new goal is to further explore the interactions of the genome with the nuclear lamina, as well as develop additional tools to manipulate the genome at large scale, so as to find out how DNA sequence drives interactions with the nuclear lamina.

CHROMATIN PRINCIPLES

- ★ Hosted by the Netherlands Cancer Institute in the Netherlands.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/102541/>

SELF-REPLICATING MOLECULES PROVIDE CLUES TO HOW LIFE MAY HAVE BEGUN

A chance discovery of molecules that make copies of themselves could shed light on the age-old question of how life emerged on this planet.

EU-funded scientists under the EUR 1.5 million five-year REPLI (Self-replication in dynamic molecular networks) project have been investigating how self-replicating molecules acquire aspects found in life forms. Such molecules could provide a simple model of the fundamental processes that occur in species formation. It could also mean that ecological diversity in biology may have roots at the molecular level.

'We are able to observe behaviour in not-yet-living systems of self-replicating molecules that start to show strong similarities with what we see in biology,' says project coordinator Sijbren Otto, Professor of Systems Chemistry at the University of Groningen, adding 'one of the fundamental questions our research addresses, at least in part, is how life emerged.'

The REPLI team found that a set of replicator molecules – which they originally discovered by chance – can mutate spontaneously. 'The simplest form of self-replicator is a single molecule which makes exact copies of itself. With evolution you need copies that are somewhat different in structure from the original and are therefore mutations and we were able to achieve this in the lab,' Professor Otto says. 'We observed this in real time at a molecular level – once one set of mutants was formed, a second set branched off from the first a little later which can be compared with how new species would emerge in biology.'

The team found that the two distinct sets of molecules compete for two different building blocks or subcomponents that make up the molecules, which could be similar to the way that animals compete for food.

Environmental impact on molecular structure

Another discovery was that the replicator's environment determines its molecular structure. 'You could draw a parallel with biological adaptation,' says Prof. Otto. 'In biological evolution, organisms adapt to environmental changes and we see something similar at the very

rudimentary level with replicator molecules.'

The team was able to investigate extinction-related theories using flow system experiments – flowing in the building blocks from which the replicators construct themselves, whilst at the same time flowing out the same volume per unit of time so the overall volume stays constant. 'If the replicators in the sample can make more of themselves faster than they are flowed out of the system they'll be sustained. But if they can't, they wither away and become extinct,' Professor Otto observes, adding 'the



harsh reality is that evolution only works if there is life and death.'

Towards rudimentary life forms

Most of the laboratory work was with peptide molecules containing up to 40 amino acids. 'But the principles could extend to other classes of molecules. The only real requirement is the molecules have to be able to stick to one another to assemble into larger structures,' says Professor Otto.

The ERC has provided a follow-up five-year EUR 2.5 million grant from September 2017 to continue this research under the Steps Towards the Novo Life project.

'An ultimate aim would be to push self-replicating molecules towards rudimentary life,' Professor Otto says.

'Life had billions of years of evolution to get to the level of sophistication and complexity we have now. Whatever we are going to produce in the lab in our

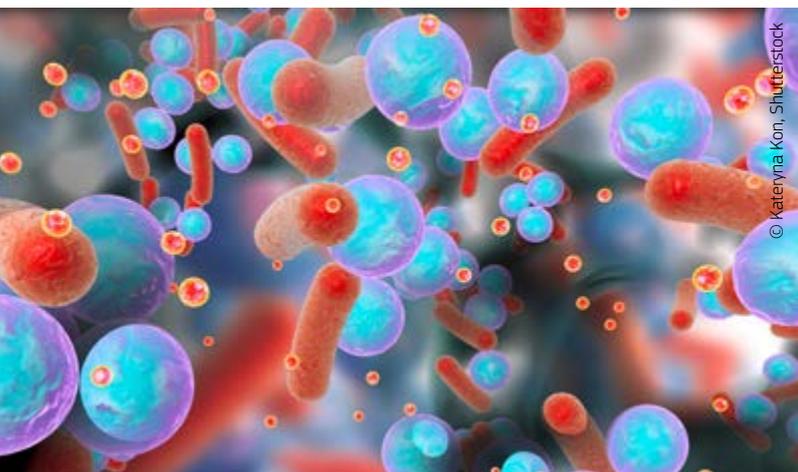
lifetime is not going to be able to rival that. But it will hopefully capture the essence, the bare minimum of what life boils down to or what it started from.'

REPLI

- ★ Hosted by the University of Groningen in the Netherlands.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/100213>

LOW-COST, FLEXIBLE SUBSTRATES FOR NANOPLASMONIC SENSING

EU-funded researchers with the PLASMAQUO project have developed a new way to visualise chemical communication within microbial populations, which could lead to new anti-bacterial therapeutic strategies with relevant biomedical applications.



Thanks to their unprecedented ability to concentrate light at the nanometre scale, plasmonic nanostructures have played a significant role in the field of nanotechnology, particularly as to their use in various sensing applications. 'The adsorption of plasmonic nanoparticles onto substrates in a controlled manner is a crucial process for the fabrication of nanoplasmonic devices where the nanoparticles amplify the electromagnetic fields for enhanced device performance,' says Luis Liz-Marzán, project coordinator of the EU-funded PLASMAQUO (Development of plasmonic quorum sensors for understanding bacterial-eukaryotic cell relations) project.

The PLASMAQUO project aimed to develop nanostructured materials based on plasmonic gold nanoparticles as substrates for ultra-sensitive detection of the communication processes between living cells. 'In particular, we focused on a bacterial cell-to-cell communication phenomenon, termed quorum sensing, which relies on the production, release and sensing of small signalling molecules that allow bacteria to monitor their local environment and population density,' explains Liz-Marzán.

Quorum sensing is known to regulate a wide range of microbial physiological processes, including virulence and the formation of bacterial biofilms, which are the most successful

form of colonisation among microbes. 'As quorum sensing and biofilms are intimately linked with the pathogenesis of various persistent infectious diseases, such as pneumonia in cystic fibrosis, there is a need for the development of new strategies for the non-invasive analysis of quorum sensing in living bacterial populations,' says Liz-Marzán. 'The ability to visualise this form of chemical communication within microbial populations will extend our understanding of its functions and may lead to new anti-bacterial therapeutic strategies with relevant biomedical applications.'

Beyond state-of-the-art

Project researchers used surface enhanced Raman scattering (SERS) spectroscopy, an analytical technique that relies on the generation of high electric fields at the surface of metallic nanoparticles through illumination under surface plasmon resonance conditions. However, owing to the inherent limitations of SERS, reliable sensing in complex biological media is still challenging due to the background noise from interfering species and the non-specific adsorption of biomolecules that could hinder the interaction of target molecules with the SERS-active surface.

To overcome this challenge, PLASMAQUO devised plasmonic nanostructured substrates as platforms for growing bacterial cultures and *in situ*, label-free detection of the secreted signalling molecules toward the plasmonic sensor. In order to avoid contamination of the optical sensor with other biomolecules present in the culture medium, the team fabricated cell-compatible hybrid materials comprised of a plasmonic component within a porous matrix. This functions as a molecular sieve to restrict the diffusion toward the metallic nanoparticles.

"PLASMAQUO went beyond the state-of-the-art in the fields of colloidal nanoparticle synthesis, colloidal phase behaviour studies and understanding of SERS mechanisms for designing new and highly efficient plasmonic nanoparticles."

'PLASMAQUO went beyond the state-of-the-art in the fields of colloidal nanoparticle synthesis, colloidal phase behaviour studies and understanding of SERS mechanisms for designing new and highly efficient plasmonic nanoparticles,' says Liz-Marzán.

Paving the way

This work allowed researchers to demonstrate the performance of various purpose-designed plasmonic materials for detection and imaging of quorum sensing in biofilms of the opportunistic human pathogen *Pseudomonas Aeruginosa*. According to Liz-Marzán, the project paved the way for the application of plasmonic sensors in various fields. For example, they could be

incorporated in implants, catheters or implantable medical devices to monitor a possible infection in a non-invasive manner. 'Given the resistance of bacterial biofilms to chemical cleaning agents, these have a great impact on different industries,' adds Liz-Marzán. 'The application of plasmonic sensors for *in situ* detection by portable Raman devices could allow their early detection and favour their eradication.'

PLASMAQUO

- ★ Hosted by CIC biomaGUNE in Spain.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/98099>

LOOKING TO INSECTS TO UNDERSTAND OUR BIOLOGICAL RHYTHMS

To better understand the biological effect of time on humans, EU-funded researchers within the INSECTIME project took a closer look at insects.

When you set out to research the biological effect time has on humans, you probably wouldn't think about focusing your study on insects. But that's exactly what the EU-funded INSECTIME (Insect Timing) project did.

'Our focus was on the circadian and seasonal rhythms in fruit flies, olive flies, linden bugs and parasitoid wasps, all of which are particularly relevant for understanding temporal aspects of human health and wellbeing,' says project coordinator Charalambos Kyriacou.

The rhythm of bugs

INSECTIME had one goal: to improve the understanding of our biological rhythms by looking at our circadian and seasonal clocks. Circadian clocks are molecular mechanisms that regulate biological processes that display an endogenous oscillation of about 24 hours. These rhythms have been widely observed not only in humans, but also in plants, animals, fungi and bacteria. 'These rhythms allow organisms to predict, instead of merely react to, the daily environmental fluctuations due to the Earth's rotation around its axis,' explains Kyriacou.

Technological advances have permitted society to escape the temporal constraints usually imposed by the natural environment, thus allowing altered and irregular behavioural patterns, meal schedules and lighting regimes. Recently, a wide variety of diseases and health problems have been shown to be mediated or aggravated by chronic disturbance of the circadian clock, for example, in shift

workers that make up about 20% of the working population.

Seasonal clocks, on the other hand, regulate those physiological and behavioural processes that repeat themselves every 12 months. These seasonal changes are caused by the Earth's axial tilt and its rotation around the sun. 'We all experience changes to our appetite, mood, weight, sleep and fertility throughout the year,' says Kyriacou. 'In some cases, especially in extreme environmental conditions, the extent of these cycles can become pathological and lead to depression.'

A fly on the wall

The astonishing similarity between the molecular cogs of the 24-hour clock of flies and mammals means

that studying the mechanism in insects, and the way it adapts to the environment, leads to insights about human clocks. 'Indeed, the fruit fly, *Drosophila melanogaster*, has led the way in the genetic analysis of circadian cycles and much of what we know about mammalian rhythms came initially from this tiny insect,' explains Kyriacou.

According to Kyriacou, *Drosophila* has a life cycle of 10 days, making it much easier to perform genetic analyses than when using a mouse, whose generation time is upwards of three months. Furthermore, nearly 100 years of genetic analysis of the fly means that it has an unparalleled molecular genetic toolbox whereby any gene can be expressed in any



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tissue. For example, a brain neuron can be shut down or made hyperactive or even ablated.

Of flies and men

Using these flies, INSECTIME researchers discovered how light and temperature signals enter the clock and how natural cycling environmental light and temperature conditions engage seasonal winter hibernation. The neurons responsible for these responses have been identified and their role in the neuronal network of ~150 cells that generates rhythmic behaviour has been elucidated. 'In the mammal, ~20 000 neurons determine rhythmic behaviour,

yet the principles by which these clock cells communicate with each other is almost identical to the fly, so it will be interesting to see how the INSECTIME fly research stimulates similar work in mammals,' concludes Kyriacou.

INSECTIME

- ★ Coordinated by the University of Leicester in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/105379>
- ★ Project website: <http://insectime.org>

NEW INSIGHTS INTO THE FUNCTION OF FAST-SPIKING, PARVALBUMIN+ GABAERGIC INTERNEURONS

Researchers within the EU-funded NANOPHYS project create a complete picture of the cellular and subcellular properties of the fast-spiking, parvalbumin-expressing GABAergic basket cell, leading to far-reaching implications for clinical science and medicine.

Cortical neuronal networks are comprised of two types of neurons: Glutamatergic principal neurons and GABAergic interneurons. Although GABAergic interneurons numerically represent only 10-20% of the neuronal population, they serve key functions in the network. However, in contrast to the substantial amount of information available on the subcellular signalling properties of pyramidal neurons, little was known about the properties of GABAergic interneurons.

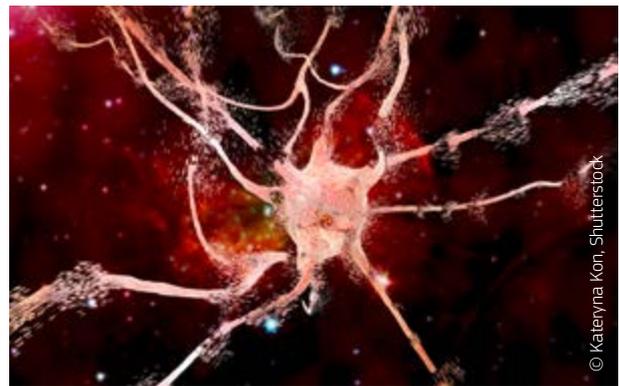
Enter NANOPHYS (Nanophysiology of fast-spiking, parvalbumin-expressing GABAergic interneurons). Using cutting-edge subcellular patch-clamp methods in brain slices, imaging techniques and computational approaches, the EU-funded project created a complete picture of both the cellular and subcellular properties of the fast-spiking, parvalbumin-positive (PV+) GABAergic basket cell.

'By incorporating realistic basket cell models into dentate gyrus network models, we are now able to test the contribution of this important type of GABAergic interneuron to complex functions of the dentate gyrus, such as pattern separation and conversion from grid to place codes,' says NANOPHYS Principal Investigator Peter Jonas. 'Our findings may lay the basis for the development of new therapeutic strategies for treating diseases of the nervous system, targeting interneurons at defined subcellular locations.'

A breakthrough conclusion

Although a minority cell type, GABAergic interneurons are vital for normal brain function because they regulate the activity of principal neurons and generate rhythmic activity in the brain. If interneuron function is affected, higher brain functions can be impaired, resulting, for example, in seizures. Through the extensive work of the NANOPHYS project, PV+ interneurons have become one of the best characterised neuron types in the entire brain. '10 to 20 years ago much more was known about glutamatergic principal neurons than about GABAergic interneurons,' says Jonas. 'Now the situation is almost reverse and research on principal neurons will need to catch up.'

Research has shown that PV+ interneurons can convert an excitatory input signal into an inhibitory output signal within a millisecond or less. However, prior to NANOPHYS, it was



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unclear how these signalling properties were implemented at the molecular and cellular levels, or how they led to complex network functions.

The project's major conclusion is that PV+ interneurons operate as fast signalling devices, and that several molecular and subcellular specialisations generate this property in combination. 'The specific involvement of PV+ interneurons in fast network oscillations demonstrates that these neurons make use of their fast signalling properties in the intact network *in vivo*,' explains Jonas. These results fundamentally change our way of thinking about the function of GABAergic interneurons.

Long-term benefits

According to Jonas, the project's findings may have far-reaching implications for clinical science and medicine. 'Accumulating evidence suggests that PV+ interneurons not only play an important role in the physiological activity of the hippocampal network, they also appear to be involved in several brain diseases, such as schizophrenia, autism, epilepsy and neurodegenerative diseases,' he says. 'Thus, the results obtained in NANOPHYS may, on the long-term scale, help to develop new therapeutic strategies for these brain disorders.'

NANOPHYS

- ★ Hosted by the Institute of Science and Technology in Austria.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/98450>

EVENTS

NOVEMBER
8

Brussels, Belgium

CONFERENCE

TRANSFORMING THE FUTURE OF EUROPEAN PEOPLE THROUGH RESEARCH

The 'Transforming the Future of European People Through Research' conference, will be held at the European Parliament Headquarters, Brussels, Belgium, 8 November 2017.

In this Conference evidence for the social impact achieved by EU-funded projects will be presented by different stakeholders including scientists, policy makers representing different levels of policy implementation – regional and national – as well as end-users who have benefited from the social impact of EU research.

The FP7 IMPACT-EV project was set up to map and evaluate the impact of research in Europe. This project has analysed the impact of EU-funded research projects not only identifying scientific impact but also particularly focusing on the political and social impacts of these research projects.

For further information and to register, please visit:
<http://impact-ev.eu/conference/>

NOVEMBER
13-15

Palma de Mallorca, Spain

CONFERENCE

EUROPEAN CONFERENCE ON XYLELLA FASTIDIOSA

A major scientific conference on Xylella Fastidiosa, will take place, in Palma de Mallorca, Spain, 13-15 November 2017.

The event will provide a platform for in-depth discussion on the results of research into X. fastidiosa and its vectors, in support of ongoing efforts to control the European outbreaks.

As well as speakers and participants from Europe, the conference will be attended by scientific experts from other parts of the world – such as Brazil and the United States – where X. fastidiosa has been present for many years.

The conference is organised jointly by EFSA, the University of the Balearic Islands, the Eupresco network for phytosanitary research coordination and funding, the EU Horizon 2020 projects PONTE and XF-ACTORS, and the European Commission's Directorate-General for Research and Innovation (DG RTD).

For further information, please visit:
<http://www.xfactorsproject.eu/european-conference-xylella-fastidiosa-full-program/>

NOVEMBER
15-17

Barcelona, Spain

SYMPOSIUM

ENABLE PROJECT SYMPOSIUM

The Institute for Research in Biomedicine (IRB) will launch the European Academy for Biomedical Science (ENABLE) project through a symposium that will take place in Barcelona, Spain for young life sciences researchers from 15 to 17 November 2017.

The three-day symposia will include scientific debates, career sessions and outreach activities jointly coordinated by young students from four European centres.

The ENABLE symposia are organised entirely by young scientists from the four research centres and cover three aspects for the careers of these young people, namely the discussion of cutting-edge research, the promotion of career development in science, and science outreach activities for schools and the public. The first symposium will be entitled 'Breaking down complexity: innovative models and techniques in biomedicine.'

The project was awarded EUR 500 000 through the 'Celebrating European Science' section of the EU's Horizon 2020 programme. The event in Barcelona will be the first of four yearly gatherings that seek to train the next generation of leading biomedical scientists in Europe.

For further information, please visit:
<https://enablenetwork.eu/>

EVENTS

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

NOV.
21-23

PLOCAN, GRAN CANARIA

GENERAL ASSEMBLY,

ATLANTOS PROJECT 3RD GENERAL ASSEMBLY MEETING

The 3rd ATLANTOS General Assembly, hosted by PLOCAN, will be held in Gran Canaria, at both the Palacio de Congresos de Canarias and PLOCAN, 21-23 November 2017.

As well as the General Assembly and Executive Board briefings, the event will include a special focus on sensors, innovation of observing technologies and the private sector.

ATLANTOS (Optimizing and Enhancing the Integrated Atlantic Ocean Observing System) is an EU-funded research and innovation project that proposes the integration of ocean observing activities across all disciplines for the Atlantic, considering European as well as non-European partners.

The vision of ATLANTOS is to improve and innovate Atlantic observing by using the Framework of Ocean Observing to obtain an international, more sustainable, more efficient, more integrated and fit-for-purpose system.

For more information and to register, please visit:
<https://www.atlantot-h2020.eu/events/3rd-general-assembly-meeting-21st-23rd-november-2017/>



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More details next issue!



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