



research^{eu}

RESULTS MAGAZINE

N°73
JUNE 2018

SPECIAL FEATURE

TO MARS AND BEYOND: EUROPE'S PUSH TO THE FINAL FRONTIER



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Published

on behalf of the European Commission
by the Community Research and
Development Information Service (CORDIS) at
the Publications Office of the European Union
2, rue Mercier
2985 Luxembourg
LUXEMBOURG
cordis@publications.europa.eu

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ISSN 1831-9947 (printed version)
ISSN 1977-4028 (PDF)
Catalogue n° ZZ-AC-18-005-EN-C
(printed version)
Catalogue n° ZZ-AC-18-005-EN-N (PDF)

Luxembourg: Publications Office of the
European Union, 2018

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EDITORIAL

by the editorial team

MARS EXPLORATION: ALL FOR ONE AND ONE FOR ALL?

Headlines over the past few years have made future human missions to the Moon and Mars more tangible than they've ever been. From the unbridled ambitions of a certain Elon Musk to Donald Trump's recent directive shifting NASA's focus on going back to the Moon, along with the constant discoveries of Earth-like exoplanets, anyone can feel the general excitement for space exploration like it's 1969 all over again.

Channeling all this positive energy, however, is no mean feat. This can be seen with the multiple exchanges of ideas between the US, Russia, Europe and other leading space powers on post-ISS human spaceflight and space exploration: so far, they've all failed to lead to a common vision. The truth is that there are about as many different approaches to, and plans for, space exploration right now as there are challenges to overcome before any of them can become a reality.

'The ESA continues to envision a potential international human mission to Mars to be on the cards by 2025, be it using the Moon as a takeoff station or being planned from Earth directly.'

Once it's been decided if all resources should be focused on a future mission to Mars, to the Moon, or whether a future moonbase could be used to get to Mars more easily, investors might want to make sure that they are betting on the right horse (after all, until not so long ago, experts were talking of a 'Mars curse' when comparing the list of successful missions with those that failed miserably). And last but not least, remaining knowledge and technological gaps should be overcome to increase the odds of a happy ending.

On the European side of things, the European Space Agency (ESA) continues to envision a potential international human mission to Mars to be on the cards by 2025, be it using the Moon as a takeoff station or being planned from Earth directly. Until then, multiple robotic missions will be required to make sure that we know everything there is to know about Mars and how to get there safely. And various EU-funded projects are working hard to get us there.

In this 73rd edition of the research*eu Results Magazine, we shed light on efforts preparing the ground for the Exomars mission; the next-generation of space farming technologies; novel telecommunications for outer space; the relatively new notion of 'planetary protection' from outer solar system bodies; a new rover concept for Moon exploration; a new facility to host space samples; and, last but not least, efforts to reduce the environmental impact of (what we hope) will be an increasing number of space launches. And because Mars is only the beginning of a new era, we close the section with a recap of the achievements of ETAEARTH – the EU project responsible for identifying the closest-to-Earth exoplanets observed by the Kepler mission.

The magazine continues with our usual thematic sections, as well as 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:
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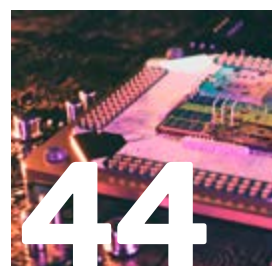
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TO MARS AND BEYOND: EUROPE'S PUSH TO THE FINAL FRONTIER

DETECTING MARS' ANCIENT LIFE FORMS IS POSSIBLE ALTHOUGH MORE DIFFICULT THAN FIRST THOUGHT, RESEARCH FINDS

We may now know much more about Mars and its environment, but whether or not the red planet did host life in the past is still an open question. Should such life forms ever have existed, work conducted under the MASE project could help future missions identify them.

It is a common mistake to associate life with the presence of oxygen. If we go by that principle, and knowing that there is no oxygen in Mars' atmosphere, we could easily conclude that Mars is not suitable for hosting life. A few organisms on Earth, however, have proved that life can exist without oxygen. Some of these life forms, called anaerobic microorganisms, actually stand out through their capacity to survive in extreme environments comparable to those found on Mars.

The question at the heart of the MASE (Mars Analogues for Space Exploration) project was, did such anaerobic microorganisms ever exist on Mars, and if so, how could we detect them even after they died and fossilised? "We know that the planet used to host much more liquid than it does today and that water has been on its surface long enough to support life. Now, we have to find out whether there were any life forms to take advantage of this, or whether there were any particular barriers to life that may have affected the ability of the planet to support life," says Charles Cockell, Professor of Astrobiology at the University of Edinburgh and coordinator of MASE.

To do that, the project team went to several places on Earth where anaerobic life forms can be found, including Rio Tinto in Spain, Iceland, and deep underground environments. They collected samples and brought them to the lab to test their ability to tolerate different types of extremes.

"We wanted to test the limits of life in the presence of oxidants, perchlorates, and other chemicals and conditions that are quite unusual on Earth but really define the conditions on the surface of Mars," Prof. Cockell explains. "But beyond that, we also tried to understand how fossilised organisms are preserved under these conditions, which was a long-standing knowledge gap."

Two main methods were used by the team. One uses antibodies to detect life in rocks and fossilised environments, while the other uses a new type of laser-induced breakdown spectrometer where laser is fired at samples to give off all the

elements they include. "For example, we took permafrost samples and radiated them before looking at whether we could detect signatures of life in those rocks after they'd been processed in Mars-like conditions. We were able to show that our new instrument could detect biosignatures in these ancient permafrost samples," says Prof. Cockell.

The outcomes of these experiments offered a wealth of learning opportunities. First, the team could identify a core set of anaerobic microbes that can be found regardless of the environment, which means that there is some kind of 'core set of capabilities' necessary to survive in extreme environments that could potentially be the same on Mars. Then, the team could show how microbes can use the same adaptation mechanisms to live on Mars as they would on Earth. Finally, they assembled new data showing how anaerobic microbes fossilise under anaerobic conditions, and how this fossilisation process might influence the ability to find these microbes.

"We actually found that the remains of anaerobic microbes can be detected. But what was particularly interesting was that as these organisms fossilise, their biosignatures can disappear within minerals, making it much more difficult to find them. Whilst our work allows for chasing microbes, we now know that it's a lot more complicated than we previously thought," Prof. Cockell explains.

Whilst the project research wasn't targeting a specific mission, Prof. Cockell says that future missions like Exomars, Mars 2020 and even future human explorations of the planet could benefit from the data gathered under MASE.

MASE

- ★ Coordinated by the European Science Foundation in France.
- ★ Funded under FP7-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/188851>
- ★ Project website:
<http://mase.esf.org/>



UNLOCKING MARTIAN DATA REVEALS MYSTERIES OF RED PLANET

Cross-border and cross-disciplinary cooperation have enabled EU-funded researchers to build up one of the most comprehensive pictures of Mars to date, preparing future missions with new analytical tools and underlining the benefits of integral approaches to planetary exploration.

The UPWARDS (Understanding Planet Mars With Advanced Remote-sensing Datasets and Synergistic Studies) project successfully analysed data from missions like the Mars Express to achieve new insights into the content of the planet's subsoil and dust storms as well as the behaviour of water ice clouds and the exchange of methane between the interior of the planet and the atmosphere. New methods were developed to exploit data from the 2016 ExoMars Trace Gas Orbiter (TGO) mission, and to provide a frame of reference for future missions such as the ExoMars Rover operation.

Climate for cooperation

Project coordinator Dr Miguel Angel López-Valverde from the Institute of Astrophysics of Andalusia in Spain believes that the results clearly demonstrate the vital role of scientific cooperation in understanding complex systems like a planet's climate and give scientists a truly coupled view. "Over the past 20 years or so of Mars exploration we've found the climate to be far more complex than first thought," he says. "The climate should be seen as an integral system, much like the Earth's, where the surface, volcanoes, oceans, atmosphere and clouds etc. all interact."

Bringing together experts from across a range of fields, as UPWARDS has done, has been instrumental in this. "One of the strengths of this project has been to enable teams to work together from the beginning," says Dr López-Valverde. "Usually how it works is researchers receive funding for their own specific area, and only collaborate with other experts later on. We have shown that putting in place collaborative teams, before new mission data arrives, can be hugely beneficial for mission preparation, and I think this is a clear lesson for the future."

Discovering Mars

The key objective from the start was to develop new mathematical retrieval methods for obtaining more data about Mars. "Some of these

techniques can combine data from different instruments, which can be a lot more efficient," says López-Valverde. "This sort of thing has been done for collecting data from Earth survey satellites but this is the first time such techniques have been applied for Mars."

New methods for retrieving data in special observing geometries have been pioneered. Vertical profiles of water vapour and carbon dioxide can be recorded even in dusty atmospheric conditions or in direct solar illumination, something that only five years ago would have been impossible to obtain. The project also managed to peek inside dust storms. "This was especially challenging", says López-Valverde. "We found an inverse correlation between the amount of dust and the amount of water vapour inside a storm; again, this sort of finding is a first for Mars."

Another exciting development has been a complete map of Martian water ice clouds, which suggests they play an important part in the planet's water cycle. "These are amazing, bizarre objects that until now we knew very little about," says López-Valverde. "We now suspect there is an active exchange of water vapour between the

subsurface and the atmosphere, and that water ice clouds are much more abundant than previously thought. All this data was available from the Mars Express mission; we just developed the methods to extract it." The project has even been able to measure and compare puzzling emissions of hydrogen at the top of the atmosphere, escaping to space, perhaps confirming that large amounts of water vapour can reach high altitudes during dust storms.

Following completion of the project in February 2018, López-Valverde is confident that dissemination of the data and tools will help to put Europe at the forefront of Mars research and encourage stronger links between European teams. "Large collaborative consortia are key for future planetary research," he underlines. "This project has set an example which I hope others will follow."

UPWARDS

- ★ Coordinated by the Spanish National Research Council in Spain.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/193164>
- ★ Project website: <http://upwards-mars.eu/content/project>



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"This is the first time such techniques have been applied for Mars."



WHEN SPACE LAUNCHERS COME CLEAN

In the quest for constantly reducing the costs of space missions and maximising their chances of success, any information we can get about the launcher's environment and how to best protect it is invaluable. Research under the MaMMoTH-Up project aims to introduce a modular system that can provide such insights.



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The upper stages of space launchers are typically loaded with sensors that could theoretically tell engineers everything they need to know about the launcher's status and possible vulnerabilities. Yet, limited on-board computing capabilities and bandwidth to ground have so far made it impossible to compute most of this data.

This is the context in which the MaMMoTH-Up (Massively extended Modular Monitoring for Upper Stages) project came to life. In 42 months, the project consortium set for itself the objective of increasing the amount of monitored data by a factor of over 2 500.

Jan-Gerd Mess, coordinator of the project on behalf of the German Aerospace Centre, discusses the project's achievements ahead of its completion in August 2018.

★ Why is it important to gather more data from the upper stages of launch vehicles?

Jan-Gerd Mess: One of our main objectives is to provide more insights into the launcher's environment. This is important for better understanding the conditions it is subjected to, but most importantly the resulting mechanical stress that the whole system has to cope with.

The acquired data comes from thermal, pressure, vibration, shock and acceleration sensors as well as strain gauges. It will help optimise the system itself and also enable future developments in terms of stability, weight reduction and safety. This is especially important for newly introduced materials such as carbon fibre, as we can only exploit their full potential if we fully understand their behaviour under operational conditions.

★ What makes gathering this data so difficult to achieve?

The existing launcher hardware and its telemetry chain, although well-proven and reliable, are limited in their performance in terms of computational power and bandwidth.

Updates to either of these are very expensive as they involve costly and protracted requalification of the entire launcher, as well as substantial investments in ground infrastructure.

★ How do you suggest overcoming this problem and what would you say makes your approach particularly innovative?

Our approach is to introduce a modular system that can easily be adapted and extended to comply with specific mission requirements. It is minimally invasive, and at the same time minimises risks for the nominal mission of the launcher.

By using commercial-off-the-shelf (COTS) components in a protected environment, the computational power of the on-board hardware can be increased significantly. This allows us to introduce intelligent data selection and compression algorithms that optimise the amount of useful information for the existing telemetry link. By further introducing widely-used serial interfaces like RS422 and CAN-bus, we also ensure that future developments and modules (cameras, wireless sensors, etc.) can make use of the developed system.

★ Did the demonstrator live up to your initial expectations?

To this point, the demonstrator has survived the necessary qualification testing to be applicable for use on an ARIANE 5 launcher in terms of thermal-vacuum, rapid depressurisation and EMC. Vibration testing is still pending, but the tests will be conducted over the next months, before the end of the project.

From a functional point of view, the whole system has been assembled, and mission simulations based on ARIANE 5 flight profiles have successfully been conducted. Whilst data selection is still an ongoing topic in both research and implementation, data compression as well as all mechanisms for sensor data allocation and transmission are in place and have successfully been tested.

★ How far do you think you'll be able to go? Have you made it to the demo flight stage yet?

A qualification model is now readily integrated and is undergoing representative qualification testing like an actual piece of flight hardware. We are, therefore, confident that we can reach TRL 5/6 by the end of the project.

★ What are your plans for commercialisation, and what would you say will be your main selling points against potential competitors?

To the best of our knowledge, there is currently no other system that can both modularly increase the launcher's capabilities in terms of data acquisition while also introducing a completely new use case to the launcher.



★ What are your follow-up plans, if any?

We are planning to apply for further Horizon 2020 funding within the framework of an in-orbit verification and demonstration, so as to prove the applicability of our approach.

Additionally, an adaption to ARIANE 6 might be feasible, which would include not only a future flight but also the application of the MaMMoTH-Up system during ground-based system and subsystem tests. This would increase the data acquisition capabilities of the qualification facilities.



© Jan-Gerd Mess

JAN-GERD MESS

MaMMoTH-Up

★ Coordinated by the German Aerospace Centre in Germany.

★ Funded under H2020-LEIT-SPACE.

★ <https://cordis.europa.eu/project/rcn/193510>

3D CATALYSTS FOR IMPROVED HYDRAZINE-FREE PROPELLANTS

Hydrazine, one of the most widely used liquid propellants for space propulsion systems, is also extremely toxic. EU researchers have developed 3D catalysts for igniting alternative propellants.

Hydrazine is highly toxic, corrosive and carcinogenic to living organisms. In 2011, the European Commission included hydrazine amongst the candidates for the list of substances of very high concern, which is regulated by the Registration of Evaluation Authorisation and Restriction of Chemicals (REACH) framework. Since then, universities, research institutes and industries all over Europe have been actively exploring and testing non-toxic propellants as a possible replacement for hydrazine-based propellants.

One of the projects that have focused on alternative propellants for space

propulsion systems was the Rheform (Replacement of hydrazine for orbital and launcher propulsion systems) project. Funded by the EU, researchers worked on improving propellants based on ammonium dinitramide (ADN). Replacing hydrazine with new propellants will make space propulsion more sustainable for future missions.

Overcoming current challenges

Although alternative propellants possess characteristics that make them highly desirable for use in launchers and spacecraft, these benefits come with constraints. The combustion temperature of LMP-103S – a blend of ADN, water, methanol and ammonia – is 1600 °C, much higher than that of hydrazine, which is about 900 °C. To withstand such temperatures, combustion chambers utilise special materials that comply with certain criteria of the International Traffic in Arms Regulations (ITAR) in the United States.

Another big problem is that the catalyst used to decompose and ignite the alternative propellant needs to be heated before ignition. The catalyst is currently electrically pre-heated to a temperature of about 350 °C, which takes around 30 minutes before firing, to ensure decomposition of the propellant. Such a

long pre-ignition time is problematic in emergency situations, where a prompt ignition is required.

“The Rheform team has therefore focused on synthesising catalysts that require lower temperatures for pre-heating and adapting the currently existing ADN-based propellants so that the materials used in the combustion chamber are compatible with existing materials available in Europe,” points out Dr Michele Negri. To achieve this goal, development activities were conducted on both catalyst development and catalytic ignition.

Feasibility of lowering ignition temperature

The researchers’ goal was to build a decomposition chamber for the propellant that is capable of ‘cold start’. Soon enough, after testing 40 different catalysts in a batch reactor, the team realised that the water content of the propellants had to be vaporised before coming into contact with the ignition source. The vaporisation was achieved by placing a heat bed at the entrance of the combustion chamber. Some of the catalysts had ignition temperatures just above 100 °C. As Dr Negri states, “The plan of developing a catalytic system capable of a completely cold-start was not deemed feasible.”



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Stronger catalysts with 3D printing

Researchers have explored two different kinds of catalysts: catalyst pellets made from large grains and monolithic structures patterned with internal channels that allow the propellant to flow. Monolith structures are built from ceramic materials. The project team performed several simulations to properly understand the impact of material properties on the catalyst structure performance to ultimately build an efficient decomposition chamber.

Amongst the several types of ceramics tested, researchers selected hexaaluminate structures for their excellent resistance to high temperatures and thermal shocks. Another

novelty introduced by Rheform is 3D printing of these ceramic structures. 3D printing allowed them to produce monoliths with a very complex geometry. "This is the first time that 3D-printed ceramics such as hexaaluminate structures are being used for propellants," states Dr Negri.

The true potential of alternative propellants

Both European and American space agencies have rated green propellants for propulsion systems as a high-priority technology. The main goal of Rheform was to improve performance, reduce costs and minimise exposure to harmful substances with new environmentally friendly liquid propellants.

As Dr Negri explains, "One of the big advantages of alternative propellants to hydrazine is that they are safer, while also decreasing the complexity and cost of testing, shipping, handling and launching." Altogether, 13 SkySat satellites were launched from four different locations which clearly demonstrates that such hydrazine-free propellants allow operational flexibility and permit the launch of spacecraft from different sites.

Rheform

- ★ Coordinated by the German Aerospace Centre in Germany.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <http://cordis.europa.eu/project/rcn/193718>

NEXT GENERATION SPACE FARMING IS ON ITS WAY

Life support systems such as the ISS's European Modular Cultivation System (EMCS) will be key to any viable human exploration missions in space. The TIME SCALE project picks up where the development of the EMCS left off, by preparing the ground for a new generation of life support systems able to sustain future missions to the Moon and Mars.



It's been 12 years since the ESA launched the EMCS, an experimental facility dedicated to studying plant biology in reduced gravity environments. In all those years, scientists could learn about how plants sense the direction of gravity even at very low levels, how gravity impacts the molecular processes regulating plant growth, or how light affects cell proliferation and plant development in the absence of gravity.

But the EMCS isn't perfect, as Dr Ann-Iren Kittang Jost, Research Manager at CIRIS, points out. "The ISS payloads that allow experiments and technology demonstrations under simulated Moon or Mars gravity using a centrifuge have limited volume for crop cultivation. Besides, water is either injected or flows through liquid systems in which nutrients are delivered using slow release in the medium. The main problem is that this only allows for very limited control of the nutrient available for the plants and makes it difficult to study nutrient dynamics during the growth period."

In 2015, Dr Kittang Jost began coordinating the TIME SCALE (Technology and Innovation for Development of Modular Equipment in Scalable Advanced Life Support

Systems for Space Exploration) project to overcome that issue. The project consortium developed larger plant cultivation chambers with a recycling water and nutrient management (WNM) subsystem with a pure liquid substrate.

Despite its potential, the WNM is one of the most challenging subsystems to operate under reduced gravity conditions. "This is an area where much knowledge and technology demonstrations are needed in order to develop reliable knowledge and experience that will benefit future closed regenerative life support systems (CRLSS) for human space exploration," Dr Kittang Jost says.

To stack all the odds in their favour, the project team developed concepts and a breadboard for the cultivation of crops and algae. They created a multi-ion sensor system that allows for monitoring nutrient ions and a camera system combined with a compact gas chromatographer for early stress detection in plants. These tools not only provide real time scientific data, they also allow for regulation systems to be implemented or for early correction measures in a cultivation system.

"The crop cultivation system breadboard is the main outcome of the project, but we also: found an optimal recipe for plant growth; observed the effects of nutrient solution nitrate concentrations on lettuce transpiration; developed a health monitoring system combining cameras and gas analysers; and came up with novel technologies such as multi-sensor ion systems and compact GCs analysing liquids and gas for both earth and space applications," Dr Kittang Jost notes.

Three of these products have already or should soon be launched on the market: upgrades for a Compact Gas Chromatography (GC) system; a one-of-a-kind, automated multi-ion analyser with EC and pH; and the camera system for plant health monitoring that is currently being followed up for a licensing agreement.



Although the project is now completed, TIME SCALE partners will continue to develop crop and algae cultivation systems for the ISS and future space exploration missions. “A spin-off company focusing on water and nutrient management systems as well as the plant health imaging system will be created,” Dr Kittang Jost concludes. “The new knowledge and innovative technologies produced under TIME SCALE open up new potential R&D projects aiming for sustainable food production on Earth and for space applications.”

TIME SCALE

- ★ Coordinated by NTNU Social Research in Norway.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/193705>
- ★ Project website: <http://timescale.eu/>

THE GREENING OF SOLID ROCKET PROPELLANTS?

Members of the EU-funded GRAIL project have spent the past three years investigating the creation of a green solid propellant for space launchers. Their unexpected findings could make alternate, liquid propellants the only viable route to green space launches.

The case for using solid propellants in space propulsion technology is easily pleaded: they are the most cost effective, competitive and reliable solution out there, period. However, there is one element in those propellants that increasingly receives bad press: ammonium perchlorate (AP).

Besides its negative impact on the environment – it notably causes ozone depletion and acid rain formation – AP has also been linked to thyroid gland interference. As many as 270 tonnes of concentrated hydrochloric acid end up in the atmosphere with each launch of Ariane 5. This is deemed to have a negligible environmental impact at the global scale, but so is also the case for every polluting industry, and this argument is thus not a good example of a responsible environmental commitment. The fact that ammonium perchlorate also has been found in European vegetables certainly raises some questions.

There are, unfortunately, very few alternatives to AP. Other oxidisers like ammonium dinitramide (ADN) and the oxidizer ammonium nitrate (AN) have the potential to be greener, but they cannot replace AP on their own.

“Perchlorate has many good properties. It has a high density, burns in a suitable manner and is relatively safe to handle. ADN has very high performance but burns too fast to be used in a large rocket motor, whilst AN burns too slowly and has a very poor performance,” says Dr Niklas Wingborg, Deputy Research Director at the Swedish Defence Research Agency and coordinator of GRAIL (Green Advanced High Energy Propellants for Launchers).

The idea behind the GRAIL project was to use a combination of ADN and AN, hoping that finding the right mixture would create a green oxidiser with properties similar to ammonium perchlorate. Unfortunately, the combustion properties



of ADN and AN combined turned out to be very poor but this setback did not stop the project team from taking a different track in their research.

“We tried to solve that by using different additives, but without success,” Dr Wingborg recalls. “We also found that ADN was more explosive sensitive than we had expected, so we were not able to use as much in the propellant as we had hoped for. As a consequence, we decided to develop a greener propellant instead of a fully green one. We mixed ADN and AP to obtain a propellant that has a higher performance and is 25% greener than current AP based propellants.”

Does that mean that a truly green solid propellant is out of reach? For the moment, it would seem so. As Dr Wingborg points out, developing a completely green propellant would require to master the combustion properties of ADN and AN, which would require further research.

For the near future, it seems that green space propulsion can only be obtained using liquid propellants. However, some liquid fuels are fearfully toxic as hydrazine and its

derivatives. Dr Wingborg thus would like to dedicate a potential new project to make these liquid fuels less toxic. In the meantime, GRAIL's greener solid propellant might appeal to the defence industry, where it could be useful for future missile propulsion technology.

“If we had been successful, our recommendation for the development of future launchers would be to go for the new green solid propellant. But in the GRAIL project we couldn't make such propellant a reality, so my recommendation for civilian launchers currently using solid propellants would be to keep using them for the time being. If health, environmental concerns or public opinion ever make perchlorate unacceptable, then I would recommend to go for liquid propellants,” Dr Wingborg concludes.

GRAIL

- ★ Coordinated by the Swedish Defence Research Agency in Sweden.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/193595>
- ★ Project website: <http://www.grail-h2020.eu>



RESEARCHERS STRENGTHEN GLOBAL PLANETARY PROTECTION COOPERATION

Exploring our solar system must be conducted in a clean and responsible manner if we are to avoid compromising the search for extraterrestrial life. An EU-funded project is providing an international platform for key stakeholders to exchange knowledge and produce policy recommendations that aim to ensure exactly that.

Planetary protection is aimed at preventing contamination between the Earth and other bodies in the context of space missions. The EU-funded PPOSS (Planetary Protection of Outer Solar System) project is helping to refine regulations on planetary protection that were first put in place by scientists about half a century ago.

Space exploration is changing quickly with an emerging private sector, new countries launching programmes and increasing evidence of the presence of liquid water – a prerequisite for all life – in planets and icy moons beyond Mars,” explains PPOSS project coordinator Patricia Cabezas from the European Science Foundation in France. “This makes the issue of contaminating other planets – as well as preventing Earth contamination from returning space missions – more relevant than ever.”

Planetary protection policy recommendations at the international level are placed by the UN Committee on the Peaceful Uses of Outer Space (COPUOS) under the mandate of the Committee on Space Research (COSPAR). These regulations are vital to ensure that the scientific investment in space exploration is not compromised and to address fundamental questions about the origin and evolution of life. To date, planetary protection has mainly focused on planets close to the Sun, in particular Mars. With major space agencies currently planning a number of exploration missions beyond Mars however, a revision and update of the current policy is timely.

Platform for protection

The PPOSS project began by bringing together scientists, technology experts and policy makers involved in limiting contamination of planetary bodies. During the first two years, workshops were held to develop guidance for this European and international planetary protection community. “These workshops gathered scientific experts from Europe, the USA, China and Japan along with representatives of their respective national space agencies and other key stakeholders,” says Cabezas.

The PPOSS International Planetary Protection Handbook was developed out of these sessions. This will serve as a reference guide to educate and train new generations of researchers and engineers that have to deal with planetary protection requirements long after the present project has finished. In addition, a preliminary version of a ‘Research Whitebook’, which identifies key scientific challenges in the exploration of icy moons within the framework of planetary protection, is also being made available. “This is something that has been warmly welcomed by the scientific community,” says Cabezas.

Another example of the project’s long-term perspective is the development of a European roadmap to identify critical technologies that will be required over the next 15 to 20 years to address planetary protection of outer solar

system bodies. In the final stages of the project, a review of the current planetary protection regulation process, as well as planetary protection guidelines related to outer solar system bodies, will be produced. These will go a considerable way towards redefining current international regulations on planetary protection.

Global space community

Another key objective of the PPOSS project has been to build a sustainable and solid international planetary protection community involving the USA, Europe, China and Japan. In the final year of the project, efforts will be made to establish links with space communities in Russia, India and the United Arab Emirates. “Already, a series of international training sessions on the basics of planetary protection have been provided to engineers, agency managers, scientists and students,” says Cabezas. “The first one took place at the Japan Aerospace Exploration Agency and three further sessions will take place in 2018 in the USA, China and Germany respectively.”

While the PPOSS project will end in December 2018, the consortium will continue to assist COSPAR in updating its planetary protection policy.

PPOSS

- ★ Coordinated by the European Science Foundation in France.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/199270>
- ★ Project website: <http://pposs.org/>



EU PROJECT PIONEERS ROBUST NETWORKING FOR SPACE

EU-funded researchers are striving to put Europe at the forefront of next-generation space communication technologies by developing components capable of withstanding the stresses and strains of space exploration.

Ethernet, the dominant technology for wired networks, is widely used in numerous terrestrial applications. Its relative low cost however has also led to its use in applications for which it was not originally designed – such as in space – but which present a whole range of new challenges.

To address this, the EU-funded SEPHY (Space Ethernet Physical Layer Transceiver) project has sought to develop Ethernet components capable of withstanding the hostile environment of space, which would make them ideal for future space communication applications. SEPHY will help make Europe a pioneer in developing this critical space component, since there are currently no such space-graded Ethernet transceivers available on the global market.

“The market has really been pushing for the development of Ethernet components for space,” explains SEPHY project coordinator Daniel González Gutiérrez from Arquimea in Spain. “While this adds a certain amount of pressure, it means that all partners in this consortium are committed to working towards developing a product that is currently unavailable but already in demand. This should also help to reduce dependence on export-controlled technologies coming in from outside Europe.”

Networking in space

The growing complexity of space technology has made the development of next-generation high-speed networking capabilities a priority. Networking systems

must not only ensure smooth communication between all devices onboard but also guarantee service in an incredibly challenging environment.

“The requirements for integrated circuits in space are very different to terrestrial applications,” explains González. “In particular, intense radiation can compromise reliability. Integrated circuits for space applications require great care during design and manufacturing in order to operate in such a harsh environment.”

One solution, built upon by the SEPHY project, has been to design radiation-hardened (rad-hard) Ethernet components. The process of radiation hardening – involves making electronic components and systems resistant to damage or malfunctions caused by radiation. The SEPHY project is developing rad-hard transceivers that enable space systems to use Ethernet, while maintaining interoperability with existing technical standards.

To achieve radiation hardening, the SEPHY project used a special manufacturing process to reduce the impact of radiation on integrated circuits. This was achieved in part through the use of insulation materials. In addition, new circuit design techniques were introduced to achieve rad-hard design.

Tests on prototypes started at the beginning of January 2017, with preliminary results showing strong performances. Tests on second-stage integrated circuits will begin at the end of the summer of 2018 and continue until project completion at the end of the year. The aim during this time will be to get the prototype as market-ready as possible. “Impressions so far from both consortium partners and potential end users have been good, and we’re confident of delivering positive results,” says González.



New frontiers

The long-term impact of the SEPHY project, González believes, will be to put Europe at the forefront of rad-hard Ethernet adoption in space. This will create new high tech commercial opportunities and put researchers and academics at the cutting edge. “The Ethernet commercial and industrial integrated circuit market is dominated by non-European companies,” says González. “We hope that the success of SEPHY will be to ensure not only independence for European space endeavours, but possibly also market leadership as well.”

The SEPHY consortium also plans to reuse the developed components for other mission critical applications, including automotive, avionics and industrial systems in which Ethernet is already or is likely to be the dominant networking technology. This extends the ambition of the proposal beyond space systems, notes González. “Extending the use of SEPHY to terrestrial applications could also help in positioning Europe as a player in the Ethernet integrated circuit market,” he says, “especially for critical applications”.

SEPHY

- ★ Coordinated by Arquimea in Spain.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/193707>
- ★ Project website: <http://www.sephy.eu/>

ROVER CONCEPT OPENS NEW ERA FOR MOON EXPLORATION

EU-funded researchers are developing a lightweight rover that could make missions to the Moon more feasible, help untap sources of extraterrestrial water and open up new possibilities for fuelling future space missions and satellites.

The EU-funded LUVMI (Lunar Volatiles Mobile Instrument) project has developed a prototype lightweight rover – together with a compact payload – that can be sent to the Moon to search for water, minerals and other vital resources. Deputy project coordinator Diego Urbina from Space Applications Services in Belgium

believes that the concept will make manned missions to the Moon more likely, as well as significantly improve our understanding of the universe. Without an atmosphere the Moon has no weather system to blow away billions of years of physical evidence, making it an excellent place to study the history of the solar system itself.



SPECIAL FEATURE

Scientists have also recently discovered evidence of the presence of water on the Moon, located in the permanently shadowed regions in the lunar poles,” says Urbina. “Our vision is that our rover could be sent to confirm the presence of this water and establish its exact distribution, physical form and variability.”

There is huge commercial potential in this. Water sourced from the Moon could be used to fuel communication satellites moving from Low Earth Orbit to Geostationary Orbit for example. “The idea is that satellites could be propelled from one orbit to another with hydrogen and oxygen extracted from the water,” explains Urbina.

Sustainable space sector

The LUVMI project comes at an exciting time for space exploration, with increasing investment coming from the private sector and new business opportunities emerging. There is also growing recognition however that industry must adapt and change if it is to take advantage of these opportunities. “We know from experience that space exploration is a very expensive endeavour,” says Urbina. “Stakeholders realise that the space sector must become more sustainable if it is to have a long-term future.”

There are examples of this happening. The company Space X for example has begun to launch rockets that return to Earth and can be reused, while the concept of ‘*in situ* resource utilisation’ is growing in popularity. “*In situ* resource utilisation is basically about making use of

resources already out there, rather than having to launch everything you need for human space missions, satellites or deep space probes,” explains Urbina. “This means lower mass and ultimately lower costs.”

Mission to the Moon

This is exactly what the LUVMI project aims to achieve. Exploratory missions to the Moon would usually have to send up heavy payloads including a rover vehicle and excavators to dig through the surface, as well as large chambers to heat up material and complex sensors to test for water or other compounds. The advantage of the lightweight LUVMI rover and payload is that it can perform all necessary operations much more efficiently, with a compact rover and a volatiles sampler that extracts the volatiles by penetrating the regolith, heating it up directly on site, and using a state-of-the-art miniature volatiles analyser based on the one used in the Rosetta mission.

“The main innovation is *in situ* sampling technology that can extract and analyse volatiles itself,” says Urbina. “The rover can be used to explore large areas of the Moon and map them with a novel light-field camera, providing information to oncoming missions on where the best places to extract water will be.”

The rover prototype will now be tested on Earth in regions similar to the Moon, while the payload itself will be further refined to be capable of operating in conditions found on the Moon. After this, the consortium will develop a roadmap towards building a flight version of the rover that will one day fly to the Moon, carrying small commercial payloads. The LUVMI project runs until September 2018.

“We would hope to have this available by the early 2020s,” says Urbina. “People are beginning to realise that we have the technology; what is needed really is investment at these early stages.”



LUVMI

- ★ Coordinated by Space Applications Services in Belgium.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/205949>
- ★ Project website: <https://www.luvmi.space/>

STATE-OF-THE-ART FACILITY TO HOUSE SPACE SAMPLES IN EUROPE COMES ONE STEP CLOSER

Europe has a very strong legacy in the curation and research of precious extra terrestrial materials. But as our exploration continues to gather pace, a dedicated European Sample Curation Facility (ESCF), to receive and curate returned samples, is necessary.

Sample return space missions are those that are designed to visit a solar system body, such as the Moon, Mars or asteroids, and then collect and return samples to Earth for scientific study. These missions are seen as important strategic steps in our continuing

exploration of space, leading to human missions to the Moon and Mars.

Even though Europe has a strong heritage in both the study and curation of extra terrestrial samples (in the form of meteorites), and in space exploration, there is no appropriate facility in Europe to be able to properly curate these precious samples. The EU-funded EURO-CARES (European Curation of Astromaterials Returned from the Exploration of Space) project set out to design a roadmap towards the creation of a European facility.

“The lack of such a facility,” says Dr Caroline Smith, joint project coordinator based at the UK’s Natural History

Museum, “means we are missing out on opportunities to collaborate with international partners such as NASA, China and Japan on exciting missions.”

The project hopes that by developing a roadmap outlining the required functions and possible design of such a facility, they will give decision-makers the confidence that Europe can, and should, have such a facility.

Gathering expert insight from a range of disciplines

The site’s structure, the security measures needed to prevent accidental contamination, how to foster the political will, what



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should actually be stored: all these various strands required input from experts in a wide variety of fields. “EURO-CARES is a rather unusual project in that it is extremely multi-disciplinary – our team was comprised of scientists (earth and life), engineers and technologists,” explains Dr Smith.

A key issue the project addressed was the curation of samples returned from Mars. This type of material poses some unique challenges – our current understanding of the history of the red planet suggests that it had the right environment and chemical conditions perhaps for life to develop. Some scientists think that there may even be life occurring on Mars today. Missions to the planet are very carefully designed to avoid contaminating Mars with possible Earth life and, for missions designed to collect and then return Mars samples to Earth, the missions are designed to

prevent any accidental contamination of Earth's biosphere by materials from the planet.

“This issue is taken extremely seriously and is covered by international treaties and policies. A facility designed and built to curate Mars samples must protect both the samples and the Earth. Such a facility would be something similar to a biohazard level 4 lab, a number of which exist in different European countries, where biologists study some of the most hazardous diseases known.”

Secure but open

Security featured prominently in the team's analyses, but they were also passionate about designing a facility that would inspire the public, “We wanted to produce materials that could be used by students of different ages, in a formal or informal learning environment,” says Dr Smith.

She points out that many of the sample return missions that are planned will not be returning materials until the early to mid 2020s at the earliest. “It is the young people of today who will be the scientists and engineers of the future and will be involved in this work when the samples start returning.”

Timely research

While samples may be arriving within the next 10 years, the last time the planetary

protection protocols were published, and then only in draft form, was in the early 2000s. “We have attempted in our work to both review this (and other related documents) and point out technological advances which could also be applied to provide more accurate techniques and so on.”

But, as Prof. Smith says, redeveloping the planetary protection policies will require an international project of its own, probably lasting two-three years with a diverse range of life sciences and earth sciences experts as well as instrument specialists. In the meantime, the project has established it will take a minimum of seven years to design and build a facility to curate samples returned from asteroids and the Moon, and longer for a facility to curate samples from Mars.

EURO-CARES, says Prof. Smith, has developed an excellent network of experts from diverse domains. “Our work is being used by colleagues in Japan and America to aid their work, and so our project has both confirmed European expertise and leadership in this area and given a much higher visibility to this expertise.”

EURO-CARES

- ★ Coordinated by the Natural History Museum in the United Kingdom.
- ★ Funded under H2020-LEIT-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/193697>

INTERVIEW

HOW CHANGES IN STARS' SPEED GAVE AWAY THE MOST EARTH-LIKE PLANETS EVER OBSERVED

When thinking about Earth-like exoplanet discoveries, the Kepler space telescope immediately comes to mind. Yet, it is not only Kepler, but also ground-based information from the HARPS-N spectrograph, that allowed the ETAEARTH consortium to obtain information on these planets with a degree of precision never reached before.

A joint initiative between Europe and the US, ETAEARTH (Measuring Eta_Earth: Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N, and Gaia), was tasked with measuring the dynamical masses of terrestrial planet candidates discovered by the Kepler mission. The project delivered beyond expectations, being responsible for most of the Earth-like planet discoveries made over the past five years.

Dr Alessandro Sozzetti, coordinator of the project and researcher at the National Institute for Astrophysics in Italy, discusses the project's outcomes.

★ **There is much ongoing research dedicated to Earth analogues. What makes ETAEARTH stand out?**

Over the five years of the project, ETAEARTH has combined the fantastic photometric precision of NASA's Kepler and K2 missions and the unrivalled quality of ground-based



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DR ALESSANDRO SOZZETTI

radial velocity measurements with the HARPS-N spectrograph on the Italian Telescopio Nazionale Galileo (TNG) in the Canary Islands. The point was to determine the physical properties of terrestrial extrasolar planets in orbit around stars similar in size to or smaller in size than the Sun, with unprecedented accuracy.

ETA-EARTH scientists had a considerable advantage over other research teams because we had access to a conspicuous Guaranteed Time Observations (GTO) program with HARPS-N@TNG, for a total of 400 observing nights over five years. Such a large telescope time investment was key to the spectacular successes of the project.

★ What's the added value of combining KEPLER and HARPS-N data?

Kepler and K2 exploit the technique of planetary transits: They measure the dip in the light from a star as a planet crosses it, revealing the planet's size. HARPS-N, on the other hand, measures changes in the star's speed due to the gravitational pull from an orbiting planet, allowing us to determine its mass.

From the combination of these two observations, we can calculate the planet's density and determine its bulk composition (e.g., rocky, water-rich, gas-rich, etc.) with high accuracy.

★ Can you tell us more about your methodology?

ETA-EARTH carefully selected Kepler and K2 small-radius exoplanet candidates based on their chances of having their masses measured accurately with HARPS-N. We then designed adaptive observing strategies tailored to each system, depending for example on the magnitude of the signal sought with HARPS-N and on the orbital period of the candidate.

Once an observing campaign for a given target was completed, we accurately determined the fundamental physical parameters of the central star – that is, its mass and radius – as only precise knowledge of these quantities allows us to derive accurate estimates of the planetary parameters.

The next step in our methodology entailed a sophisticated combined analysis of the available Kepler/K2 and HARPS-N data to derive all the system's orbital and physical parameters (for both single and multiple transiting planets). Finally, our measurements of planetary densities were compared with predictions from theory to underpin the actual composition of the planet(s).

★ What were the main difficulties you faced in this process and how did you overcome them?

The biggest challenge we had to face arose from dealing with stellar activity. This phenomenon, produced primarily by spots on the surface of the star that come in and out of view as the star rotates (just like our Sun), introduces complications in the interpretation of the data – particularly those gathered with HARPS-N. It can sometimes mask entirely or even mimic a planetary signal. So you think you

are seeing a planet, but you are instead accurately measuring the star acting up!

Our learning curve was steep, but ultimately we succeeded, using a twofold approach: First, we adapted our observing strategies with HARPS-N to make sure we could sample both stellar and planetary signals well enough. With the best-possible temporal distribution of our observations, we then developed sophisticated analysis tools that allowed us to effectively disentangle planetary signals and those produced by stellar activity.

★ What would you say were your most important findings?

We could learn for the first time about the physics of these objects' interiors. We have notably determined with high precision (20% or better) the composition of 70% of currently known planets with masses between one and six times that of the Earth and with a rocky composition similar to that of Earth.

Among these, we discovered Kepler-78b, the first planetary object that has a similar mass, radius and density to Earth. We have also found the two closest transiting rocky planets, orbiting the solar-type star HD219134 only 21 light years away. This golden sample of planets with well-constrained parameters allowed us to infer that all dense planets with masses below six Earth masses (including Earth and Venus) are well-described by exactly the same rocky composition (in technical terms, the same fixed ratio of iron to magnesium silicate).

Most notably, ETA-EARTH provides the first-ever constraints on the density of K2-3d, a planet in a multiple transiting system that is similar to Earth in mass and orbits within the Habitable Zone of the star known to-date to be closest in mass to the Sun. K2-3d appears to belong to the still elusive class of 'water worlds', with a density somewhat lower than Earth's.

Finally, using information from the full sample of objects found by Kepler, we have determined that one in five solar-like stars host an Earth-like planet, i.e. an object with a size similar to Earth orbiting within the Habitable Zone of its solar-type parent star.

★ What are your follow-up plans, if any?

Our post-ETA-EARTH plans will primarily focus on tapping the huge potential that is about to be unleashed by the new important player in the exoplanet arena, NASA's TESS mission which was successfully launched just a few weeks ago.

TESS will find transiting planets over most of the observable sky with radii not much bigger than Earth's, and around stars typically five to ten times brighter than those observed by Kepler. Some of these small planets will orbit at Habitable Zone distances from their central stars (typically of lower mass than the Sun).

We plan to invest large amounts of observing resources from both hemispheres whilst continuing to use HARPS-N and the new ultra-high-precision European planet hunter ESPRESSO on the Very Large Telescope in the Chilean Andes in order to measure masses and densities of the best candidates provided by TESS. Doing this could dramatically increase the sample of optimal targets amenable for investigations of their atmospheres.



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ETA-EARTH

- ★ Coordinated by the National Institute for Astrophysics in Italy.
- ★ Funded under FP7-SPACE.
- ★ <https://cordis.europa.eu/project/rcn/106562>

HEALTH

REGENERATION OF THE DAMAGED HEART

Cardiovascular disease (CVD) is one of the leading causes of morbidity and mortality worldwide, responsible for millions of deaths every year. Using stem cells to repair the cardiac tissue after myocardial infarction (MI) may help avoid the fatal consequences of heart malfunction.

Acute MI occurs when some of the coronary vessels are blocked, restricting blood flow and causing ischaemia in the myocardium. Currently, MI is treated with coronary artery revascularisation, which effectively restores blood flow to the heart. However, residual myocardial scarring is not eliminated, often hampering cardiac function and eventually leading to heart failure.

Regenerative therapy using cardiac stem cells is a promising new approach for repairing the underlying myocardium damage and restoring heart function. However, outcomes of clinical trials have not been satisfactory so far, possibly due to poor cell survival, engraftment and retention in the infarcted heart.

To increase the efficacy of cell-based therapy, the EU-funded AMCARE (Advanced Materials for Cardiac Regeneration) project aimed to increase the retention of stem cells in the damaged myocardium or heart tissue following delivery. Towards this goal, the consortium integrated expertise in materials science and stem cell biology with leaders in the field of medical devices, biomaterials and cardiovascular regeneration.

The idea behind the AMCARE strategy was to employ hyaluronan (HA)-based biomaterials as a supporting scaffold for the implanted cells. HA hydrogels are widely used as scaffolds for tissue engineering purposes to provide an extracellular matrix (ECM) and enhance cohesion of administered cells as well as retention at the damaged site after delivery. At the same time, hydrogels offer protection from the harsh environment of the ischaemic myocardium.

The ECM is a highly complex network of proteins such as collagen and proteoglycans where cells bind via specific receptors. Despite its tissue-dependent composition, the ECM has a fundamental role in regulating central cellular responses such as migration, proliferation and differentiation. Therefore, it can be used for transplantation purposes to support implanted cells and facilitate their integration into the host tissue.

Novel biomaterials and delivery devices

Project coordinator Dr Duffy explains, "Our industrial partner has developed a platform that can produce hydrogels with tuneable mechanical and viscoelastic properties from viscous gel-like

materials. This means they can withstand elastic changes in the cardiac tissue following injection into the myocardium."

For homogeneous incorporation of cells into the hydrogel while maintaining cell viability, AMCARE partners developed a prototype applicator. Moreover, in the event of acute MI alongside an endocardial catheter, the researchers devised a proprietary cell delivery system for delivery within the ventricle.

Another project innovation was the cardiac patch, a sheet of HA-derivative materials that provide optimum geometrical and mechanical properties such as porosity, swelling and biodegradation. The patch is loaded with therapeutic agents to ensure durable and sustainable contact with the infarcted area and is delivered on the epicardial surface.

The impact of heart regeneration after MI

Overall, the new therapeutic modality generated during the AMCARE project will help restore cardiac function in patients after an ischaemic episode. "The combination of AMCARE's novel medical devices and advanced biomaterial

formulations allows for a tailored approach to meet a patient-specific clinical need,” states Dr Duffy. The idea is that depending on the infarcted area, researchers can use a different therapeutic approach to ensure minimally invasive delivery and fixation that is safe and effective.

AMCARE partners are confident that their novel biomaterial technologies and devices will prove successful commercially. Importantly, repairing the damaged myocardium in post-MI patients can potentially decrease morbidity and mortality, improving long-term healthcare of EU citizens.

AMCARE

- ★ Coordinated by the Royal College of Surgeons in Ireland.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/110863>
- ★ Project website: <http://www.amcare.eu>

NEW SOFTWARE DETECTS ABNORMAL BRAIN PATTERNS IN PATIENTS WITH EPILEPSY

Drug-resistant epilepsy affects a quarter of all epileptic patients. Surgical removal of the area responsible for generating the seizure is a viable alternative, but the affected brain region must be clearly identified for the surgeon.

Presurgical examination is based on identifying the epileptogenic zone (EZ), the area of the brain that needs to be removed for patients to be seizure-free. Until EU research in the EPINET (Detection of brain patterns for the characterisation of epileptic networks) project, there were significant limitations in identifying functional markers to clearly identify the EZ.

EPINET researchers have developed a semi-automated strategy for analysing intracranial electroencephalography (iEEG) and magnetoencephalography (MEG) signals in patients with epilepsy. This aspect of the project was conducted by Dr Lucia Quitadamo, the Marie Skłodowska-Curie senior research fellow who translated these efforts into freely available software EPINETLAB. Able to detect high-frequency field oscillations (HFOs), and to quantify their presence in different brain regions, EPINETLAB can delineate the seizure-onset zone.

A fully documented, user-friendly platform, EPINETLAB analyses spatio-temporal and frequency characteristics of brain electromagnetic signal outside and during epileptic seizures. “As such, the software can support clinicians in the presurgical workup for the identification of the brain area that needs to be removed in the case of patients affected by refractory or drug-resistant epilepsy,” says Professor Stefano Seri from Aston University, project coordinator.

Software development – a two-pronged approach

Another aim of the project was to validate the software with both invasive and non-invasive data – iEEG and MEG, respectively. Together, the signals enabled a robust validation of the algorithms involved.

Often necessary to identify the source of epileptic activity before surgery, the invasive method, iEEG provided a fundamental means to inspect brain behaviour as pathological HFOs, an EZ biomarker. “iEEG is frequently used when non-invasive diagnostic techniques such as scalp EEG give non-concordant information on epileptic source localisation,” explains Prof. Seri.

For the not-so-experienced end user, EPINETLAB was fully integrated into EEGLAB, a software platform widely used for the analysis of brain electromagnetic data in the neuroscience community. Technicians don’t need high-level programming skills and can easily interact with the

software to exploit the general functionalities of EEGLAB and the more specific EPINETLAB ones.

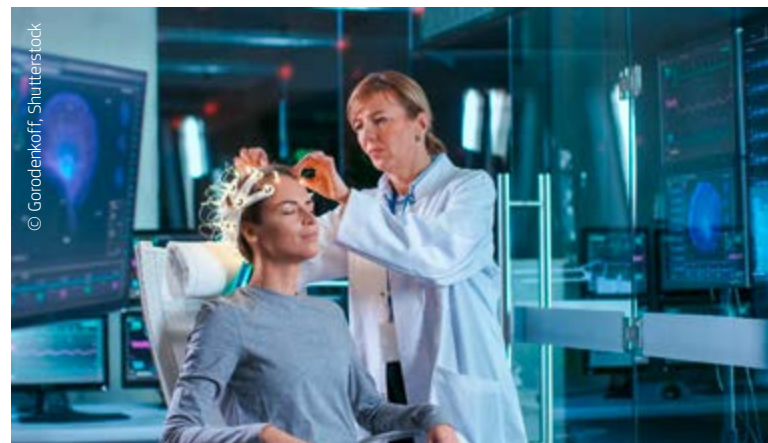
Continued data collection

“Initially, a database was compiled of iEEG data from 60 patients, collected over three different European centres,” outlines Prof. Seri. These were collected as part of trans-national efforts from Niguarda Hospital and Bambino Gesù Hospitals in Italy and the Birmingham Women’s and Children’s Hospital in the United Kingdom. Furthermore, MEG data from 13 paediatric patients was collected during the pre-surgical evaluation at Aston University in children from the Birmingham Children’s Hospital’s Epilepsy Surgery Service. This information enabled the implementation and final validation of EPINETLAB within the project period.

“Validation is still an ongoing process as we are gathering a large-scale dataset from international epilepsy centres and adding new functionalities to the EPINETLAB software, as we are aware they are required by end-users,” continues Prof. Seri.

Future for EPINETLAB

Thanks to the publication in the International Journal of Neural Systems, a highly ranked peer-reviewed journal, and dissemination during the International Epilepsy Conference, Barcelona in September 2017, EPINET has gained international visibility. Prof. Seri points out, “EPINET work has led to many collaborations with international institutions to exploit the know-how achieved in the project and to improve the knowledge we have on epilepsy-related issues.”



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Work with an industrial partner (Micromed S.p.A., Italy), a world leader in the production of systems for neurophysiology, has paved the way to a cross-fertilisation between academia and industry. Together, they explored the possibility of integrating the implemented tools in their diagnostic software package. A strategic objective across the EU, such collaboration will allow consolidation of European leadership in the field.

Summarising the importance of project research to the quality of life for the epileptic patient, which is strictly dependent on the level of post-surgery seizure freedom,

Prof. Seri concludes, “EPINET has provided epilepsy research for the drug-resistant phenotype with an invaluable means to improve the delineation of the area responsible for the generation of the seizure.”

EPINET

- ★ Coordinated by Aston University in the United Kingdom.
- ★ Funded under H2020-MSCA-IF.
- ★ <http://cordis.europa.eu/project/rcn/195032>
- ★ Project website: <https://github.com/quitadal/EPINETLAB>

EXERCISE THROUGH TRANSPORTATION

Most people still aren't getting enough exercise while cities are struggling with transport-related problems. Promoting active mobility (AM) offers a realistic way for people to get enough exercise for health and makes cities more liveable.



Governments are acutely aware of the growing public health threats from obesity and related medical conditions. Authorities often respond by encouraging physical activity, through sport and leisure activities, yet such approaches have proven inadequate. Not everyone is willing or able to participate in such forms of exercise.

Promoting AM (walking, cycling solely or in combination with public transport) is an alternative solution to increase physical activity that, by the way, helps to reach goals on transport planning. Compared to sport, AM requires less time and motivation, and appeals to a wider group of people. AM is also easily integrated into daily life.

The European picture

Cities in Europe are widely seen as walking and cycling-friendly. Yet, the continent actually displays considerable variation, with some areas having very low walking and cycling rates.

The EU-funded PASTA (Physical Activity through Sustainable Transport Approaches) project studied measures to promote AM as well as AM's health

benefits and effectiveness through comparison of seven cities (Antwerp, Barcelona, London, Orebro, Rome, Vienna and Zurich). The study also examined associated dangers such as pollution and traffic.

Results indicated that even in cities having good cycling or walking rates, AM remains incompletely implemented. According to project leader, Elisabeth Raser, policies and goals alone do not guarantee results. “We found that change needs political will, courage and cooperation among different stakeholders,” she says.

New solutions

To help improve matters, the team surveyed 61 stakeholders across the seven cities, and collated 138 AM-promoting suggestions. Most involved the development of infrastructure or the social environment. Other categories included strategic policy and also regulation and legislation. The PASTA team also highlighted eight European examples of good practice that have been implemented successfully.

Over two years, researchers conducted a longitudinal study involving over 10 000 participants. They concluded that AM increases levels of physical activity and reduces transport-associated emissions. Positive benefits of increased exercise, via walking and cycling, also outweighed the potential harm from air pollution or risk of crashing.

Modelling indicated a relationship between the extent of cycling networks and the amount of cycling activity. In health terms, the ideal case would be for all streets to have some cycling infrastructure. The PASTA team showed that a 10% expansion of existing cycling

networks would offer governments the best spending-benefit ratio.

Project work further showed that regular cyclists generally have lower body mass indexes than motorists. Additionally, 90% of cyclists achieve the recommended levels of daily physical activity compared with only 29% for non-cyclists. If all 167 European cities achieved a cycling rate of around 25%, approximately 15 000 premature deaths could be avoided annually.

Lastly, the team also contributed a revision to the World Health Organisation's software tool that assesses the health and economic benefits of exercise. The PASTA team's new modules address air pollution, crashes and carbon.

Ongoing research to further active mobility

“We were able to collect one of the biggest data sets in the field of transport and health,” notes Raser. However, not all could be analysed during the project. So, although PASTA has concluded, team members will continue analysing the data and presenting project results.

The PASTA project confirmed that AM is an effective and popular way to increase population exercise rates. In future, we may see green pathways and bicycle racks supplementing more traditional elements of health infrastructure.

PASTA

- ★ Coordinated by the University of Natural Resources and Life Sciences, Vienna in Austria.
- ★ Funded under FP7-HEALTH.
- ★ <https://cordis.europa.eu/project/rcn/110446>
- ★ Project website: <http://www.pastaproject.eu/home/>
- ★ <https://bit.ly/2FSqJY5>

‘HEARING LOSS IN A DISH’ MODEL TESTS NEW TREATMENTS

Hearing loss to the point of disability affects millions with enormous socio-economic costs. Human inner ear models based on stem cell technology have tested new therapies.

The inner ear is extremely sensitive and can be functionally impaired by noise trauma, toxic drugs, infections, genetic causes and age-related degeneration. Hearing impairment – the most frequent human sensory deficit – is mainly caused by damage or loss of sensory hair cells in the cochlea of the inner ear (in the organ of Corti) that send ‘sound’ signals to the brain.

Scientists of the EU-funded OTOSTEM (Human stem cell applications for the treatment of hearing loss) project coordinated by Prof. Löwenheim in Tübingen, wished to address this urgent medical issue by developing drug and cell-based therapies. “Our focus was set on stem cell technology to generate human inner ear models,” explains deputy project coordinator Dr Hasan Avci.

OTOSTEM tested two therapeutic approaches to treat hearing loss: A cell-based treatment introducing stem/otic progenitor cells into the cochlea, and a drug-based treatment to protect or regenerate sensory hair cells.

Sources of stem cells to treat hearing loss

Researchers utilised various stem cell sources to obtain otic progenitor cells (OPCs). These included native stem cells from foetal and adult human otic tissues, and embryonic or induced pluripotent stem cells. The generated OPCs had to fulfil certain criteria such as *in vitro* expansion and differentiation into sensory hair cells, supporting cells or otic neuronal cell types.

OTOSTEM developed protocols with morphogens or small molecule compounds that induce and determine otic cell fate. OPCs were tested for biological function and absence of tumorigenicity in various *ex vivo* and *in vivo* assays. Through comparison of OPC phenotype and gene expression, OTOSTEM partners identified native human stem cells as the stem cell source with the highest otic differentiation potential.

Functionality of the generated otic or neuronal cell types was validated in *in vitro* experiments. Electrophysiological monitoring demonstrated that transplanted cells resembled those of mouse cochlear hair cells. Human otic neuronal progenitors were tested in preclinical animal models of auditory neuropathy. Hearing restoration was achieved and preserved for more than 30 weeks after transplantation with no adverse effects.

Hearing loss in a dish model

Currently, there is no quantitative cell-based assay for testing drugs specifically toxic to the ear (ototoxicity) in humans, thus even approved drugs bear the risk of causing hearing loss. To address this, and facilitate drug safety studies, the OTOSTEM consortium designed drug screening assays. This ‘hearing loss in a dish model’ employed otic progenitor cell-like cells derived from human induced pluripotent stem cells. The human assay was used for medium-throughput testing of more than 2000 pharmacological active compounds

including FDA-approved drugs. Surprisingly, several of these drugs were identified to be ototoxic.

The OTOSTEM consortium has developed novel compounds with otoprotective and otoregenerative activity. Otoprotective compounds prevent death of human ear hair cells. Otoprotective drugs induce replacement of lost sensory cells. The OTOSTEM findings are of utmost commercial significance to the largely unexplored but growing market of otoprotective and regenerative drugs.

Given the association of hearing impairment with neurodevelopment in young, and dementia in older people, there is an imminent unmet need for clinically validated therapies. Industrial partners envisage that the OTOSTEM models can be incorporated into the drug discovery pipeline to enable the identification of new and better drugs to treat hearing loss. As Dr Avci outlines, “With the support of the Seventh Framework Programme, we significantly advanced the development of novel therapies against hearing loss and we are eager to continue our success within the H2020 programme.”

OTOSTEM

- ★ Coordinated by the University of Tübingen in Germany.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/110640>
- ★ Project website: <http://www.otostem.org/>

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AIR POLLUTION AND COGNITIVE PERFORMANCE IN CHILDREN

Emerging evidence suggests an association between air pollution exposure and cognitive impairment in children. An EU study provides compelling evidence on the impact of specific pollutants on brain structure and function.

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental condition characterised by an inability to focus on tasks and hyperactive behaviour, leading to functional impairment in academic, family and social settings. Although ADHD is considered a familial condition, certain environmental factors are emerging as important contributors to ADHD pathophysiology.

The EU-funded APGAR (Air Pollution, Growing brAin and cognitive disorder in children) project wished to determine the impact of urban air pollution on brain function and cognitive performance in children. The work focused on polycyclic aromatic hydrocarbons (PAHs) mainly emitted into the air from anthropogenic combustion sources such as cigarette smoke, charcoal-broiled food and emissions from combustion of fossil and biomass fuels. PAHs are extremely dangerous as they can cross the blood-brain barrier and cause pathophysiological changes such as loss of neuronal activity and cell death.

APGAR partners performed a longitudinal study in school age children from the general population in different schools in Barcelona, Spain. Psychometric and air pollution

measurements indoor and outdoor were conducted weekly at the beginning of the school year and 9 months later. "Previous studies have focused exclusively on effects based on test scores. Our study interfaced neuroimaging with environmental epidemiology providing a novel approach," explains project coordinator Dr Mortamais.

Increased levels of air pollutants affect brain structure

Firstly, researchers employed statistical methodology and regression models to investigate the relationships between air pollutant levels at the schools and the children's brain structures obtained through three-dimensional and functional magnetic resonance imaging (MRI). Then they assessed the effects of the air pollution-related brain changes on their cognition and behaviour. In the final step, they examined the association between air pollutant levels and cognitive performance in children.

Interestingly, APGAR results demonstrated that a small increase in specific indoor and outdoor PAH levels in the school environment was associated with a reduction corresponding to almost 2% of the mean caudate nucleus volume

(CNV). The caudate nucleus is a component of the basal ganglia located centrally in the brain and is involved in many crucial cognitive and behavioural processes including ADHD symptoms and Alzheimer's Disease.

Intriguingly, PAH levels and specifically those of benzo(alpha)pyrene (BAP) were well below the legislated annual target levels established by the European Council Directive (2004/107/EC). Although the BAP-related CNV alteration could not be directly associated with an increase in ADHD symptoms, it is nonetheless a concern for the neuro development of children.

Need for different legislation on PAH exposure

Given that the mechanisms underlying PAH neurotoxicity are under investigation, the APGAR findings provide important insight towards the link between air pollution and cognitive disorder in children. Researchers propose that PAHs cause oxidative damage in the particularly vulnerable caudate nucleus of the brain.

Importantly, the results of the project suggest that urban air pollution has an impact on brain structures, even in cases where exposure levels are well below those recommended by the European Union. Follow-up MRI monitoring is necessary to confirm the effect of chronic exposure to air pollution.

"Our results should encourage the re-evaluation of the legislative annual target by the European Union," states Dr Mortamais. Undoubtedly, improving air quality is expected to improve public health by directly reducing the burden of disease associated with air pollution in Europe.



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APGAR

- ★ Coordinated by the Barcelona Institute for Global Health in Spain.
- ★ Funded under H2020-MSCA-IF.
- ★ <http://cordis.europa.eu/project/rcn/195242>

SOCIETY

GEOPOLITICS AND FOOD SECURITY – CONTROL AND POWER

Think of power struggles in the Middle East and you may think of oil. But another commodity has a significant role to play in establishing stability and good governance. One EU-funded project has been considering food.

The RUDEFOPOS-IRAQ (Rural Development, Food Security and Political Stability in Iraq) project assessed the role of food security and rural development in the politics of current and former regimes in Iraq. The project was interested in the degree to which prevalent networks of patronage and rent, along with violent conflict, impacted on the country's internal relations.

"By analysing satellite imagery, grey material, leaked ISIS documents and newspaper sources, we were able to show that agriculture played an important role in funding the terror group," says Dr Eckart Woertz, Senior Research Fellow, based at the Centre for International Information and Documentation in Barcelona, Spain.

Gaining valuable insight into just what part patronage and rent distribution play in regional stability and governance was challenging on many levels – not least the inaccessibility of ISIS controlled territory.

The project employed a two-pronged approach, analysing historical documents and getting a clear picture of the current situation through the use of the internet, satellite images and a field trip to the Kurdistan Region of Iraq (KRI).

Access to historical documents brought its own challenges. Over 11 million records are lodged at the Hoover Institution at Stanford University, brought to the US in the wake of its 2003 occupation of Iraq. Along with the difficulty of selecting what to analyse amongst such a large volume

of material, the project also had to deal with time pressures. Records of the Iraqi government and Saddam Hussein's presidential diwan were housed at the National Defence University in Washington. This closed down in 2015 and with his project well under way at the time, Dr Woertz had to get his analysis done before the doors were locked.

To understand what the situation is now, Dr Woertz relied on an online survey among Iraqi academics from all over Iraq and on expert interviews that he conducted during a field trip to the KRI. The shaky security system made it impossible to conduct household interviews elsewhere, but, says Dr Woertz, "I was also able to rely on earlier extensive quantitative surveys of the World Food Programme (WFP), the World Bank and the International Labour Organisation (ILO)."

Working with Hadi Jaafar of the American University of Beirut, he used satellite images to overcome the inaccessibility of ISIS-held territory. This enabled them to show how agricultural production under ISIS had developed in 2014-15.

"All the work showed that food security and agriculture play a major role in the politics of Iraq, past, present and future. During the multilateral UN embargo of 1990-2003, the role of food security and agriculture was paramount in the strategic calculus of Saddam Hussein's regime."

More contemporaneously, the project revealed the importance of agriculture as a funding source of ISIS, after it had conquered vast tracts of the two bread-baskets of Syria and Iraq, specifically the Gezira and Nineveh provinces. "Our work on agriculture as a funding source of ISIS broke new ground and has relevance beyond the existence of the group as a wannabe proto state, which now has come to an end."

When it comes to contemporary Iraqi food security challenges, qualitative and quantitative surveys indicate that the population overwhelmingly identifies political issues as the main concern. "Technocratic approaches alone (e.g. improving irrigation or designing nutrition interventions) will not suffice," Dr Woertz explains.

"I think it would be good if food security issues gained greater priority in European development, security and foreign policies in the Middle East. Whether it is Syrian reconstruction or political stability in Iraq, food security and agriculture will have a major role to play. I hope that RUDEFOPOS-IRAQ has been able to raise some awareness in this regard," he concludes.

RUDEFOPOS-IRAQ

- ★ Coordinated by the Centre for International Information and Documentation in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <https://cordis.europa.eu/project/rcn/111114>

THE EFFECT OF CULTURE ON INFANTS' DEVELOPMENT OF COMMUNICATION

EU-funded research has broadened understanding of the development of communication in hunter-gatherer children – an under-researched area of scientific investigation.



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Tanzania's Hadza represent a particularly interesting cultural community, living in conditions that resemble those of our ancestors. The Hadza communication (Communication Development in Infants: the Case of the Hadza Hunter-Gatherers of Tanzania) project took an interdisciplinary approach to study infants' verbal and non-verbal interactions with their social environment.

Innovating for modern anthropological studies

"We developed a miniaturised data collection device, the multi-modal interaction recorder for children (MIRC), which was used to collect physiological data (heart rate), audio recordings and the distance of important caregivers from the infant," notes Dr Monika Abels, project research fellow. Infants wore the device for extended periods of time, without it interfering in their everyday activities.

"To our knowledge, this is the first device combining these data streams," says Dr Abels. Its innovation lies in its immunity to observer bias and fatigue. The automatic measurement of distances offers an interesting alternative to the traditional observation of distances approach frequently employed by anthropologists.

Common thread in development of communication through the ages

Research revealed that Hadza infants have similar interaction experiences as infants in other communities that have previously been described more extensively. Dr Abels cites an example: "The most frequent gestures they produce are show/offer, point, request and pick me up gestures. This key finding seems to strengthen the perspective that these gestures may be part of a universal human gestural repertoire."

Other important findings show that an infant's state has a bearing on interactional patterns – "For instance, infants make requesting gestures and pick me up gestures more frequently when they are distressed than when they are not distressed and correspondingly caregivers produce more offering and approach gestures."

Dr Abels further notes that language addressing infants varies according to the livelihood patterns of the camps where they reside – there being marked differences between infants in remote camps and those in transition or relying on tourism. In the latter, infants more frequently hear imperatives rather than being addressed with vocatives. "While imperatives can help infants participate in their interactional partners' activities, they can also be understood as a marker of hierarchical relationships that are uncharacteristic of traditional, egalitarian hunter-gatherer communities."

The project's most important finding is that the Hadza society is changing as the basis for their lifestyle is disappearing – a phenomenon accepted to hold true for hunter-gatherer communities in general. This has far-reaching consequences for children's experiences and development, including communication.

Communicating key findings on communication

The MIRC was presented at the 2017 SRCD Biennial Meeting in Austin, Texas. Results to date were also presented at the '14th International Congress for the Study of Child Language' in Lyon, France and at the workshop 'Many Paths to Language (MPaL)', hosted in Nijmegen, the Netherlands. Another presentation is planned at the Evolang Conference XII in Torun, Poland in April 2018.

Other dissemination activities include presenting project work to the Hadza community, collaboration with a nurse servicing the community, and cooperating with the Tanzanian National Institute for Medical Research, which informs Tanzanian policy decisions. In Europe, Hadza communication presented its work to interested members of the public at a midwife's practice, with similar activities planned for the near future.

Although the project has officially ended, Dr Abels says there are plans to use the MIRC to collect data in other cultural communities so patterns can be compared across cultures. "Archival film material of several communities over a time span of several decades can be utilised to answer the question of whether the pattern observed in the Hadza on livelihood and language addressed at infants is a pattern that can be found in other changing communities as well," Dr Abels concludes.

Hadza communication

- ★ Coordinated by Tilburg University in the Netherlands.
- ★ Funded under H2020-MSCA-IF.
- ★ <http://cordis.europa.eu/project/rcn/195526>

FASHION ACCESSORIES IN THE LATE IRON AGE AND ROMAN PERIOD, EUROPE

Glass bangles were fashionable across Europe from the Late Iron Age to the Roman period. EU research has challenged some common assumptions as to the 'who, what, why, and where and when' of jewellery choice 2 000 years ago.

An important aspect of life in north-west Europe circa 100 BC through to AD 250, as the Late Iron Age gave way to the Roman period, has been investigated by the EU project GLOBALGLASS (Global Glass Adornments Event Horizon in the Late Iron Age and Roman Period Frontiers (100 BC – AD 250)).

Glass bangles break into Iron Age society

GLOBALGLASS brought together evidence from four north-western European countries – Belgium, Germany, the Netherlands and the United Kingdom – and assessed how these artefacts were made, used and deposited on an inter-regional and local level. As project coordinator Dr Tatiana Ivleva comments, "Often forgotten in favour of more studied objects of Later Iron Age metalwork, glass bangles provide a unique glimpse into the craftsmanship, artistic virtuosity and intercultural connectivity across Late Iron Age and Roman period Europe."

Experiments conducted with modern glassmakers and the analysis of around 500 British bangles revealed that British ones were most likely produced in a similar manner as some of the Late Iron Age Continental types. "This suggested that Late Iron Age glass bangle craft and technology continued well into Roman times, contesting the common opinion that the Iron Age production of the seamless glass bracelets was interrupted at the turn of the first century AD," explains Dr Ivleva.

Regional identities

GLOBALGLASS also redated the arrival of the craft into Britain. Previously thought to have made their debut in the late first century AD, project results show this occurred in the early part of the century. Interestingly, these were not copies of their Continental predecessors but were rather selectively adapted from the Continental repertoire. Innovations happened with particular British sheen and were regionally distinct.

"Bangles are not alone," points out Dr Ivleva. "Analysis by a wide range of scholars on items associated with the

body, such as grooming artefacts, toilet instruments, dress adornments and mirrors, point to the changing attitudes towards display and bodily presentation in the early first century AD Britain."

A matter of style and choice as well as availability

Even though a certain style of bangle was available, this was not a limitation due to the available imports from neighbouring areas. For example, people living in the Bavarian region of Germany in the Later Iron Age had a particular preference for the imported bangles from the nearby northern Alpine regions, in spite of the fact they had easy access to bangles produced locally.

"Moreover, we learned that the glass bangles were not high-status or unique items of jewellery worn by the elite, as is sometimes assumed," Dr Ivleva comments. Sometimes a more spectacular piece would be produced, but generally the bangles were mass-produced and took only up to 20 minutes to manufacture.

From a gender point of view and function, these weren't restricted to female adult bracelets. Smaller rings have been found that would only fit the arm of a child or be worn as adornment for a horse forelock secured with ribbons.

An unexpected finding was in relation to manufacture and distribution. On the continent, objects were produced at large industrial areas, but smaller hinterland settlements also participated in the production to satisfy local demand. In contrast, the situation in Britain was that glass bangles were concentrated in small specialised workshops and also produced, perhaps, by itinerant craftspeople.

In the pipeline are two books – 'Global Glass: Bangles of the Late Iron Age and Roman period Europe', which illustrates the globalising nature of this artefact, and 'Romano-British glass bangles: a reappraisal', which will provide practical instructions to the recording, description and study of glass annulars in the United Kingdom. Various videos are available on the website and YouTube, including one where a horse is the main actor!

GLOBALGLASS

- ★ Coordinated by the University of Newcastle upon Tyne in the United Kingdom.
- ★ Funded under H2020-MSCA-IF.
- ★ <https://cordis.europa.eu/project/rcn/195430>
- ★ Project website: <http://www.romanglassbangles.com/project.html>
- ★ <https://bit.ly/2jCxZia>



IMAGINATION DRIVES SCIENTIFIC MODELLING

Philosophers of science have recently suggested a connection between the debate on the nature of scientific models from philosophy of science and the debate on the nature of fiction from aesthetics. An EU-funded project explored this in a novel approach to model-based reasoning.

Research on the SCIMOD (Scientific Models, Fiction and Imagination) project looked to generate new insights into the nature of scientific modelling and model-based reasoning. “In particular, SCIMOD focused on changing our current understanding of the nature of models and how we can learn with them,” explains Dr Fiore Salis, the project’s Marie Curie Fellow.

From imagination to fiction to science and reality

Work included a rigorous study of the analogy between models and fiction, understanding the latter as crucially relying on the imagination. Furthermore, SCIMOD “developed a novel theory of models as fiction that rejects the recurrent equivocation in the philosophy of science between fictionality and non-existence,” says Dr Salis.

Focusing on the crucial role of the imagination in characterising the nature of models as fictions, the team explored imaginative activities that mark the cognitive engagement of scientists with models. SCIMOD also advanced a defence strategy to counter criticisms of the fiction view of models.

Cross-disciplinary approach and outcomes

Project research applied the normative and descriptive methodology of analytical naturalised philosophy of science. This approach relies on using examples and case studies, constructing concepts and building hypotheses on the one hand and collecting and analysing examples to create a focused collection of works on the other.

The Marie Curie Fellow detailed the project’s most important take-away: “Scientific models require propositional imagination, which is an ability to make assumptions and consider alternative possibilities, to use symbols and representations of things.”

In outlining the project’s key final results, Dr Salis noted: “Scientific models are akin to the fictions of literature and the arts to the extent that they crucially rely on



the scientists’ imagination for their construction and development.”

Another finding was that scientists working to construct and develop models deploy a very particular kind of imagination that is propositional imagination of the make-believe variety. This ‘make-believe’ is a special type of imaginative activity involving props that constrain a model’s content.

As to the important role of imagination, Dr Salis explains in simple terms, “that imagination contributes to the generation of hypotheses that are likely true and that can be tested in reality.”

Engaging with scientists for scientists

SCIMOD partners engaged and collaborated with colleagues from philosophy and from the natural and social sciences. This widened the range of considerations in exploring and deciding on precisely-stated questions. The project characterised other deliverables, such as conference presentations and other public-engagement activities involving both specialised and non-specialised audiences in Argentina, Europe and the United States.

The work has resulted in various publications, including book chapters and peer-review articles. The knowledge disseminated in these materials is of value to scientists, including a broader audience of researchers in the humanities and the social sciences.

“Scientific models are akin to the fictions of literature and the arts to the extent that they crucially rely on the scientists’ imagination for their construction and development.”

Aware that some might take issue with the analogy between fiction and models, Dr Salis clarifies that SCIMOD qualified the correct notion of fiction to be used. That is, “a notion of fiction as a counterfactual scenario known by everyone to be at variance with actual facts but that can nevertheless help us to focus on important aspects of reality that would be otherwise difficult to grasp.”

The vision behind this work, continuing beyond the project’s mandate, is to open new lines of research by introducing a novel perspective from aesthetics into the philosophy of science.

SCIMOD

- ★ Coordinated by the London School of Economics and Political Science in the United Kingdom.
- ★ Funded under H2020-MSCA-IF.
- ★ <http://cordis.europa.eu/project/rcn/194924>
- ★ Project website: <http://www.lse.ac.uk/cpnss/research/scientific-models-fiction-and-imagination>

ENERGY

MICROBIAL FUEL CELLS TREAT MICRO-SCALE INDUSTRIAL AND AGRICULTURE WASTE

© H2AD-aFDPI

Micro and small enterprises that generate waste with an organic load beyond that accepted for disposal to sewers can now reduce effluent storage and disposal costs by up to 70%. This EU-developed technology also enables energy recovery from the waste to set against production costs.

Disposal of organic waste streams is a major hurdle to the productivity and profitability of the EU's agri-food and drink processing industries (a-FDPI). To date, there is no feasible micro-scale technology for the safe disposal of organic waste or to recover some of the 288 Terawatt-hours of potential energy that exists in the a-FDPI sector as hydrogen/methane rich biogas.

H2AD-aFDPI (H2AD – Innovative and scalable biotechnology using Microbial Fuel Cell and Anaerobic Digestion for the treatment of micro-scale industrial and agriculture effluents to recover energy from waste), an EU-funded initiative, has answered this challenge by developing a novel micro-scale technology for the rapid and safe disposal of organic effluents – termed H2AD. The technology is based on a highly efficient industrial biotechnology process that reduces the chemical oxygen demand (COD) of the organic content. The energy from the waste is then converted to hydrogen and methane-rich biogas.

"The core technology is an integrated and closed loop microbial fuel cell (MFC), based on a novel hybrid of traditional anaerobic digestion and conventional MFC technology," says engineering project manager, Darren Bacon. However, unlike conventional MFC technology, a microbial reaction with the potential for electrical stimulation is established in a completely anaerobic way. The result is a waste-to-energy process that rapidly reduces the COD and total suspended solids of organic waste streams to safe levels.

Treating waste and providing energy

Researchers built H2AD units for the pre and post treatment of organic waste at five sites across Europe. Each of

the chosen sites offered a wide variety of organic wastes, representing an opportunity for ground-breaking waste treatment whilst obtaining energy rich biogas. "All five trial sites were successfully installed and commissioned, overcoming site-specific challenges to deliver successful trials and solid results that prove the technologies' effectiveness, reliability and adaptability," observes Bacon.

The purpose of the field trials was to confirm the predicted accelerated payback performance of H2AD for the treatment of organic effluents derived from different operational environments within the a-FDPI sector. Researchers measured H2AD performance and modelled predicted payback periods from slurry-fed H2AD for waste streams from fruit drinks processing, dairy processing, microbreweries and mixed agriculture.

Benefits for a large market

Results revealed better than expected reductions in organic pollutants and the excellent composition of the biogas. According to Bacon: "In Valencia, Spain, project partners treated thickened waste from a local ice cream producer. High strength waste was consistently reduced in its COD by over 90%, whilst developing biogas with a methane content of up to 80%. These results far outweighed all expectations for the technology, especially for this challenging form of thickened waste sludge."

The project also showed that there was a large and diverse market that could benefit from H2AD technology, such as within the dairy sector, which includes cheese and ice cream

production. “H2AD will pursue these markets during the first phase of commercialisation before entering into the soft drink, brewery, agriculture and general food production markets within the European arena and eventually into the wider international arena,” observes Bacon. “There are currently trials being organised for H2AD in the UK within the cheese-making, brewing, cider making and food industries to support our commercial activities,” he concludes.

H2AD-aFDPI

- ★ Coordinated by Lindhurst Engineering Limited in the United Kingdom.
- ★ Funded under H2020-SME and H2020-LEIT-BIOTECH.
- ★ <https://cordis.europa.eu/project/rcn/199494>
- ★ Project website: <http://h2ad.org.uk/>
- ★  <https://bit.ly/2FQN1tD>

ENABLING ENERGY EFFICIENCY IN URBAN PLANNING

A training network has enabled young Europeans to develop urban decision-making tools capable of minimising non-renewable energy use in cities.

The EU-funded CI-ENERGY (Smart cities with sustainable energy systems) project – which was trialled in the cities of Geneva and Vienna – successfully created software tools for simulating renewable energy and urban energy efficiency scenarios. The project demonstrated how decision makers can approach this issue at the urban district level rather than for just each individual building, and underlined the importance of equipping scientists of the future with multiple skills.

Planning ahead

At the moment, energy efficiency simulation tools tend to focus on individual buildings rather than whole urban quarters. This makes it difficult for urban planners to take energy efficiency into account and to devise low carbon energy supplies when designing and planning refurbishment actions or new city developments.

The lack of quantitative information to seriously evaluate CO₂ savings, or the cost and impact of retrofitting, renewable energy options, cogeneration or district heating extensions, was a key motivation for the CI-ENERGY project.

“The starting point was the application of geoinformation 3D models to energy planning,” says CI-ENERGY project coordinator Prof. Ursula Eicker from the Stuttgart Technology University of Applied Sciences, Germany. “The cities of Vienna and Geneva were used as case studies to develop prototype applications that could help urban planners prioritise decisions and identify where investment should be made. Many cities have good masterplans about where they want to be in, say, 2050, but what they lack is detailed know-how on how to best get there.”

The first software prototype, designed for a new-build area in Geneva, sought to evaluate the cost and energy efficiency of constructing new buildings across a myriad of configurations. This enabled developers to generate a variety of scenarios to assess energy efficiency at the urban scale.

In Vienna, modelling tools were developed to assess the impact of extending an existing district heating network, providing full cost analyses across a range of scenarios. In both cases, the software tools enable planners to evaluate the cost-benefits of certain strategies and to simulate how best to move forward.

“Work on this has not yet finished,” notes Eicker. “These tools can tell planners what is feasible and at what cost, but now the issue is identifying which actors need to be involved and what issues should be tackled first. But at the very least, we now know what the technical and economic potential is for each scenario.”

Sustainable lessons

The CI-ENERGY project has played an important role in filling the knowledge gap that exists in the urban energy research field. This gap is primarily due to the wide range of fragmented disciplines that this field contains, from building physics and energy supply technologies through to software engineering and information technology. CI-ENERGY helped to bring all these elements together within one common modelling framework, with training carried out through the close collaboration of six research centres and four energy and software companies.

“From an academic perspective this is one of the best graduate experiences that young scientists can get,” says Eicker. “Regular meetings took place

across all the partner countries and feedback came from all supervisors involved. PhD students tend to focus on just one issue, so having this much broader perspective should be good for their careers.”

The next step is to bring this research from the academic prototype stage to the product level. “The interest is clearly there,” says Eicker. “I could imagine providing modelling services to, say, an energy company in Stuttgart, to help them identify which future energy systems are best or how much flexibility and storage might be required to integrate more renewable energies. This work is ongoing, and these tools will now be developed further.”

CI-ENERGY

- ★ Coordinated by Stuttgart Technology University of Applied Sciences in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/109876>



CLOSING THE GAP BETWEEN PREDICTED AND ACTUAL ENERGY SAVINGS

EU-funded researchers have developed a holistic energy monitoring methodology based on performance indicators, information models and simulation tools, to achieve building energy performance targets.



Our built environment is responsible for more than 40% of the EU's energy and CO₂ emissions. Therefore, the European Commission has drawn up a clear 2020 target to reduce energy consumption and CO₂ emissions by 20%, while increasing renewable energy generation by 20%. However, monitoring of actual energy performance consistently shows significant discrepancies between energy design targets and real consumption once a building is occupied.

"Building performance is a major barrier to achieving EU targets for a sustainable future," explains James Sharman, coordinator for the PERFORMER (Portable, Exhaustive, Reliable, Flexible and Optimized appRoach to Monitoring and Evaluation of building eneRgy performance) project. "We addressed this challenge by designing and implementing a software and hardware solution to improve energy management in buildings with the aim of reducing the 'performance gap' typically experienced by buildings. This is when the actual energy consumption of a building in use differs from the energy consumption expected during the design phase. The PERFORMER solution is part product, part service and enables customers to assess, monitor and ensure optimal energy management towards the guarantee of building energy performance."

Testing performance across Europe

Performance of the various components was tested in a range of building types at four pilot sites in Spain, France, Poland and the United Kingdom (Wales). This enabled the energy and environmental benefits of the new methodology and technologies to be assessed under varying climatic

conditions across Europe. "Identification of energy saving opportunities in the pilot buildings offered the possibility of closing the performance gap, thus reducing energy consumption and associated CO₂ emissions," says Sharman.

Project partners created a cloud-based platform for storing and analysing data including a visualisation dashboard for users to interrogate the information. This is complemented by an optional hardware component – the PERFORMER Box – that enables new sensors and meters to be deployed in a building entirely separately from any existing monitoring or BEMS systems while providing a link to the software platform services.

"The PERFORMER tools and methodologies will save customers time and money by identifying cost-optimal solutions that best suit their needs," claims Sharman. He adds: "It will also support designers of sensors, meters and building environmental management systems, as well as installers and consultants through easier access to data for design, purchasing and implementation activities."

Going beyond traditional technology

However, the project goes beyond simple data visualisation by using prediction algorithms and fault reporting to help users target ongoing opportunities for effective improvements. "This is a major improvement over traditional energy visualisation technology, making the level of deviation from predictions apparent," concludes Sharman. "These functions will help users move beyond overall savings in the range of 5% from improved awareness of energy use, to more substantial savings through the identification of numerous ongoing energy management and commissioning opportunities."

PERFORMER's tools and solutions will help building owners and managers to optimise their assets, while also helping energy consultants and energy service providers to assist their own clients with energy management opportunities. The solution will be applicable to any building with an existing building environmental management system that warrants some degree of sub-metering to differentiate between energy uses by zone or service.

Therefore, although it is not likely to be suitable at the level of an individual dwelling, or buildings without a number of zones and services, the majority of commercial, public, leisure and centrally managed multi-residential buildings can all benefit from the use of PERFORMER technologies.

PERFORMER

- ★ Coordinated by SMS Energy Services Limited in the United Kingdom.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/109220>
- ★ Project website: <http://performerproject.eu/>
- ★ <https://bit.ly/2K03oqd>

NEW RELIABILITY CRITERIA FOR POWER SYSTEM MANAGEMENT

An EU-funded consortium of transmission system operators (TSOs) and R&D providers has applied a new approach to the development and operation of the European electricity grid. Major cost savings and benefits for society are anticipated.

Power system reliability management allows the electricity grid to maintain performance at a desired level, while minimising the socio-economic costs of maintaining that performance level. In Europe, network reliability management has traditionally relied on the so-called 'N-1' criterion. This means that if one relevant element fails, the elements remaining in operation must be able to accommodate the new operating conditions without violating the network's operational security limits.

Today, the increasing uncertainty of generation due to intermittent renewable energy sources, combined with the possibilities of demand-side management and energy storage, requires a new reliability criterion. The GARPUR (Generally Accepted Reliability Principle with Uncertainty modelling and through probabilistic Risk assessment) project has responded to this challenge by designing, developing and assessing a new probabilistic reliability criterion for the current pan-European power system and its future development.

Consequences of power system failures evaluated

Researchers evaluated the relevance of the criteria and their practical use, while seeking to maximise social welfare. "The methodology is based on two novel elements," explains project coordinator Oddbjørn Gjerde. "Firstly,

it considers both the probability and the consequences of something going wrong in the power system. Secondly, it takes into account the socio-economic impact of that failure."

This new methodology allows TSOs to evaluate the probability and consequences of failures in their power system, which were expressed as the potential cost of power cuts to consumers. "With this information, TSOs can make decisions and investments that provide the best balance between power supply security and cost," explains Gjerde.

The new criteria were devised with system development, asset management and system operation in mind, ensuring a consistent treatment of reliability across all time horizons. Mathematical and computational models were also used to predict the location, duration and level of interruptions to the power supply. The novel approach was designed to seamlessly fit with existing TSO processes. The TSOs tested the methodology for planning or operating their grids and the results were very promising.

Getting the right balance

The TSO partner in France compared the current N-1 rule with the new approach, and concluded that it would result in similar reliability at a lower

cost. In Belgium the TSO assessed the methodology showing how clustering techniques can be applied to create operating states for a future year. The Icelandic TSO implemented probabilistic reliability assessment in the context of system operation, providing real-time risk visualisation and indicators valuable to the operators in the control room.

In addition, the Norwegian TSO partner employed the methodology to conduct a system expansion planning study, which revealed that for a certain area it would not be socio-economically beneficial to choose the alternative with the highest reliability, since the increased investment costs outweigh the benefits. Major savings of about 25% could be achieved in this case, mainly by lower investment cost.

GARPUR will extend probabilistic reliability management from experts in the TSO organisations, who have the practical responsibility to ensure the security of electricity supply, to all stakeholders dealing with electric power systems reliability management. This also includes regulators and governments whose responsibility it is to ensure the system performs for the benefit of all parts of society.

One of the most important benefits arising from GARPUR is that TSOs can now make better informed decisions. By applying the project's methodology, the risk (defined as probability x consequence) of power cuts is known, allowing different alternatives to be compared, enabling optimal selection. "The aim is to find the optimal balance between the costs of providing reliable electricity supply and the socio-economic costs of power cuts," concludes Gjerde.



GARPUR

- ★ Coordinated by SINTEF Energy Research in Norway.
- ★ Funded under FP7-ENERGY.
- ★ <https://cordis.europa.eu/project/rcn/109832>
- ★ Project website: <https://www.sintef.no/projectweb/garpur/>
- ★  <https://bit.ly/2JBgDI>

NUCLEAR MATERIALS DEVELOPED FOR A SUSTAINABLE FUTURE

An EU-funded project has fostered links between national and European programmes to harmonise and implement scientific and technical research into materials for a safe and sustainable nuclear sector.

The MATISSE (Materials' Innovations for a Safe and Sustainable nuclear in Europe) project provided the foundation for an integrated European research programme, which investigated innovative materials that can be used to ensure a safe and sustainable nuclear sector. The initiative comprised a combination of collaborative projects as well as coordination and support actions by research institutes.

By bringing together 27 organisations from 10 European countries (including an international partner from South Korea), MATISSE allowed researchers to participate in the latest European initiatives, developing advanced materials for nuclear energy production. The aim was to foster links between respective national research programmes by networking and integrating activities on material innovation for advanced nuclear systems, sharing partners' best practices and developing efficient communication tools.

"Under the auspices of the European Energy Research Alliance (EERA), project partners established a Joint Programme on Nuclear Materials (JPNM) to improve coordination of national initiatives, European fundraising programmes and other collaborations," explains project coordinator Dr Pierre-François Giroux. The consortium targeted R&D activities considered priorities by JPNM partners, leading to progress in the fields of conventional materials, advanced materials and predictive capabilities.

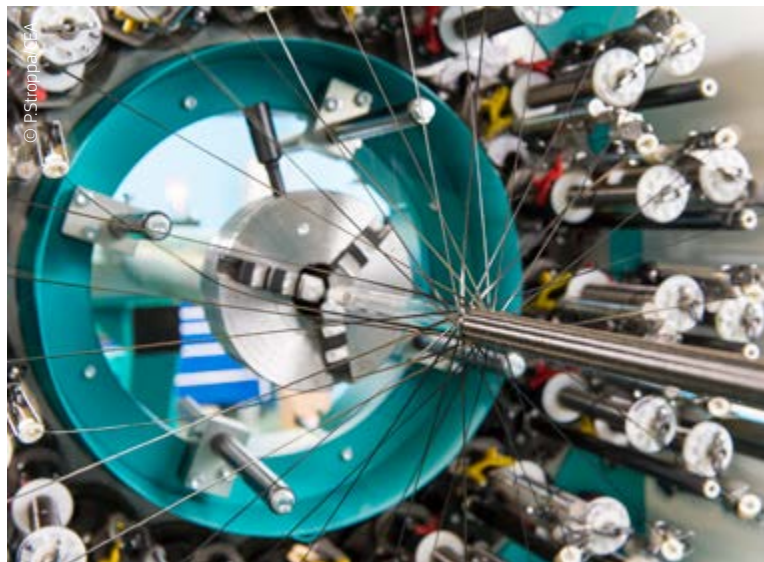
New materials with improved properties

The project furthered three 'Grand Challenges' defined by the EERA-JPNM, including the elaboration of design rules, assessment and test procedures suitable for the expected operating conditions and the materials envisaged. The other challenges involved the development of physical models coupled to advanced microstructural characterisation to achieve high-level understanding of predictive capability, and the development of new materials with superior thermo-mechanical properties and radiation-resistance. "These three Grand Challenges must be addressed and resolved to take full advantage of the nuclear Generation IV technology, with respect to safety, performance and cost," Dr Giroux points out.

Supporting the evolution of the JPNM into an integrated research programme involving Member States, the European Commission and the main European stakeholders was one of the project's main targets. The MATISSE framework was used to implement the JPNM, and a medium to long-term strategy was devised, together with a road-map and access scheme for large-scale research infrastructures.

ODS alloys and ceramic composites investigated

The consortium prepared governance, financial and management structures, while implementing schemes for education and training, networking, dissemination and communication. In addition, project partners identified



priority areas for conducting research, leading to significant results in areas such as assessing the effects of irradiation-induced hardening and creep mechanisms on the performance of ferritic/martensitic alloys. Scientists also selected functional coatings, modified surface layers and classified phenomena such as fuel-cladding interaction and environment assisted degradation of steels in liquid lead alloys.

Researchers also investigated the potential of oxide dispersion strengthened (ODS) alloys and ceramic composites for advanced fuel cladding and novel structural materials for fast neutron reactors. "They studied and enhanced the pre-designs and properties of ODS steels and ceramic composites for cladding applications in order to enlarge the database of commercially available materials to be used for fast neutron reactor prototypes," says Dr Giroux.

MATISSE established key priorities in advanced nuclear materials research, identified funding opportunities and harmonised this scientific and technical domain at the European level by maximising complementary research and synergies with the major actors in this field. Dr Giroux concludes: "The mix of R&D on both conventional and advanced materials is positive for nuclear systems in general. In the short-to-medium-term, prototypes will be built with off-the-shelf materials and the first core fuelled with conventional fuel elements, while in the long term advanced materials will be tested and qualified in order to be implanted in these new nuclear systems."

MATISSE

- ★ Coordinated by the French Alternative Energies and Atomic Energy Commission in France.
- ★ Funded under FP7-EURATOM-FISSION.
- ★ <http://cordis.europa.eu/project/rcn/110016>
- ★ Project website: <http://www.fp7-matisse.eu/>

ENVIRONMENT

URBAN ADAPTATION TO CLIMATE CHANGE

Cities have a key role in addressing global problems such as climate change. A European study has provided a systematic global assessment of the different types of institutional innovation for urban water adaptation.

Are cities around the globe prepared for climate change? The answer to this question involves multiple areas: infrastructure (water supply and flood protection systems), socio-economic factors (behaviours, attitudes), but also, crucially, institutions (policy and legal frameworks, organisational setups, coordination arrangements).

Institutions are comprised of the rights, rules and procedures that influence decision making. They determine to a large extent whether or not cities are adaptive in the face of evolving pressures and shocks under climate change. However, existing institutions are considered to be inadequately prepared for climate change, showing failures in cities across the world exposed to floods, droughts and other climate impacts. Researchers with the INNOVCITIES (Institutional Innovation for Adapting to Climate Change in Water Governance within Cities) study Prof. Huiteima and Dr Patterson point out: "Institutional innovation is needed to enable cities to better prepare for climate change impacts and risks. The single most significant way that climate change will be felt by human society is through impacts on water systems."

Academic research demonstrates that failure to sustainably manage water, despite ongoing efforts over decades, is largely due to weaknesses and gaps in governance rather than a lack of technical knowledge. Under the 2015 Paris Agreement, cities play a key role in global climate change responses. There are many reasons for this: cities are more agile than national governments, able to experiment and advance practical solutions and be more responsive to citizens.

The focus of this study

The study was designed as a web survey with distribution and analysis conducted during 2016–2017. The online format allowed for broad global distribution and targeted cities that are likely to be innovative as well as people likely to be key experts in these cities to provide the best information and experience. The survey was made available in seven languages. Survey replies were received from over 300 experts in 96 cities across all continents. Individual respondents were drawn from multiple sectors (government, research, civil society, industry) to represent a broad spectrum of experts.

Key findings

The project provided a first-of-its-kind assessment of institutional innovation for urban water adaptation in the cities across the globe.

The main finding of this survey is the presence of a relatively vibrant domain of activity regarding the institutional dimensions of urban water adaptation.

Types of institutional innovation taking place include changes in policy and legal frameworks (new policies that support adaptation), changes in policy instruments (adaptation planning and communications), changes in organisations (new departments, staff roles) and changes in coordination arrangements (partnerships, knowledge sharing).

These efforts appear to be achieving modest progress in addressing various climate-related risks such as urban water supply, flooding and sanitation risks. It also demonstrates increasing social preparedness and awareness among decision-makers. Authors believe that "Altogether, the findings give grounds for cautious optimism that progress is being made." However, this conclusion is tentative: more work is needed to analyse the variability between individual cities and regions, and to assess wider effects on urban water governance systems.

Next steps

The main next step is to conduct further in-depth analysis that disaggregates the data and compares cities across different environmental, social, cultural, economic and political contexts for the deep analyses of institutional innovation.

Further key questions to examine are: the extent to which institutional innovation can stimulate not only incremental but more transformative change in urban governance systems; and whether different types of urban governance systems have different potentials to innovate. This will aid in creating urban governance systems that are able to adapt and transform in a changing world.

INNOVCITIES

- ★ Coordinated by the Institute for Environmental Studies in the Netherlands.
- ★ Funded under H2020-MSCA-IF.
- ★ <http://cordis.europa.eu/project/rcn/195712>
- ★ Project website: <https://www.innovcities.net/>

ECOSYSTEMS' TRUE VALUE IDENTIFIED

Healthily functioning ecosystems produce oxygen and soil, detoxify the water supply and regulate the climate, while contributing to our spiritual and mental wellbeing. EU researchers used these ecosystem services (ES) to determine the natural environment's true value and support its sustainable management.

Ecosystems provide us with a range of resources, goods and services, but overuse and exploitation threaten their ability to continue functioning in ways that support human existence. The ES concept addresses this threat by reframing environmental resource use and explicitly acknowledging humankind's dependence on nature and the need for better protection and management of natural resources.

Despite being adopted in high-level policy frameworks, such as the Convention on Biological Diversity and the EU biodiversity strategy, the use of ES in decision-making still faces challenges. The EU-funded OPERAS (Operational Potential of Ecosystem Research Applications) project explored how and under what conditions the ES concept could be extended beyond academia and implemented in support of sustainable ecosystem management.

Integration of ES into management plans

The consortium comprised 27 academic institutions and consultancies across Europe, who conducted a systematic review of knowledge gaps, user needs and best practice to increase understanding and underpin policy and decision-making. Methods, tools and

instruments for supporting ecosystem management were also developed and optimised, then tested with stakeholders across a range of ecosystems in 12 'exemplar' case-studies.

Researchers created an evidence-based tool for identifying the reliability of ecosystem case studies, using it to quantify the effect of forestry practices on water management. It showed that forest nitrate concentrations were significantly influenced by harvest methods, forest competition, site altitude and time after harvesting. The project also developed a set of 30 indicators of effectiveness and efficiency for the instruments used in ES assessments, linking natural capital with human well-being.

The initiative minimises damage to ecosystems and ensures human well-being through the effective integration of ES across policy sectors. Project coordinator Professor Mark Rounsevell explains: "It is important to understand what people value when developing ecosystem management plans, as traditional economic methods alone are insufficient for determining the full benefits of ES. Socio-cultural valuation, therefore, can ensure a more comprehensive treatment of values."

Development of knowledge marketplace

Decisions concerning land use come with trade-offs over space, time and between stakeholders. Fortunately, OPERAS tools are now available to help decision-makers navigate trade-offs effectively. "There are many methods, approaches and tools to support ecosystem management, but applying them requires sharing real examples from which to learn best practice," says Professor Rounsevell.

Scientists and practitioners developed the OPPLA web-based resource portal, which contains all the tools, instruments and case studies from the OPERAS and OPENNESS projects. The research hub established communities of practice and a knowledge marketplace where the latest ES thinking is brought together. This includes ESCor-Scotland, short for Ecosystem Services Community – Scotland, a community practice that will continue beyond the project's lifetime. Professor Rounsevell states: "OPPLA represents a non-profit organisation with a mission to assist people in making nature work for the benefit of humankind."

The OPERAS initiative combined the efforts of researchers, policy makers and practitioners to support sustainable ecosystem management practices and promote knowledge of ES, leading to a wide range of applications across Europe. Their positive socio-economic benefits include policies that will protect the natural environment, enhance the well-being of citizens and help further the EU's green economy.



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OPERAS

- ★ Coordinated by the University of Edinburgh in the United Kingdom.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/106455>
- ★ <https://bit.ly/2wfdVLY>

TINY PARTICLES HIGH UP IN THE SKY GIVE INSIGHT INTO CLIMATE CHANGE

Scientists have observed extremely high concentrations of aerosol particles at 8- to 14-km altitudes over the Amazon Basin. This finding could have significant implications for climate change.

Aerosols, tiny particles that are suspended in the atmosphere, contribute significantly towards climate change. However, despite their consequential role, aerosol interactions aren't very well understood.

To address this knowledge gap, a team of scientists, some of whom received funding through the EU's A-LIFE (Absorbing aerosol layers in a changing climate: aging, lifetime and dynamics) project, conducted airborne observations of aerosols in the upper troposphere (UT) over the Amazon Basin. Their findings have been published in the journal 'Atmospheric Chemistry and Physics'.

The energy that the sun sends to Earth doesn't all reach the planet's surface. Some of that energy is reflected back into space by aerosols and the clouds they create. Although most aerosols reflect sunlight and have a cooling effect on Earth's atmosphere, some also absorb it. Mineral dust and black carbon are two examples of absorbing aerosols whose action warms the atmosphere.

Prof. Bernadett Weinzierl, the lead researcher for A-LIFE, explains in an interview posted on the European Research Council website: "[B]lack carbon (BC) is the second or third contributor to current global warming after CO₂. Due to the short lifetime of BC – weeks, compared to hundreds of years for CO₂ – controlling BC emissions has been suggested to provide significant climate benefits, but the uncertainties are high and it is even possible that part of the absorption attributed to BC comes from mineral dust, in particular in mixtures."

The observations conducted over the Amazon Basin provided further insight into aerosol interactions in the atmosphere. The scientists discovered high concentrations of aerosol particles in the UT, in some regions numbering in the tens of thousands per cm³. In contrast, the average particle concentration in the lower troposphere (LT) was 1 650 per cm³.

The UT's high aerosol concentrations provide a reservoir of particles that can move downward into the lowest part of

the troposphere known as the planetary boundary layer (PBL). Because these particles have a long lifetime in the UT, they can travel large distances and affect the composition of low-level clouds when they eventually descend into the PBL. The UT may therefore be a major source of tropospheric aerosol particles in regions that aren't strongly affected by man-made or natural aerosols.

The scientists' observations also reveal an enormous difference between today's polluted atmosphere and that of pre-industrial times. Aerosol concentrations in the pristine pre-industrial atmosphere resemble their Amazonian findings: high UT and low LT aerosol levels. However, in polluted continental regions, aerosol concentrations are generally much higher at ground level than in the UT. In an era where humans are the dominant influence on climate and the environment, the aerosol concentration profile has "been turned upside down," say the journal paper authors. The consequences for Earth's climate are significant. "By their radiative and microphysical effects on convection dynamics, aerosols are also able to increase upper tropospheric humidity, which plays an important role in the Earth's radiation budget and may also affect the potential for aerosol nucleation in the UT, thus providing additional feedback," the authors conclude.

During the next two years, A-LIFE will be further investigating the properties of absorbing aerosols to gather new data on their impact on climate change.

A-LIFE

★ Hosted by the University of Vienna in Austria.

★ Funded under H2020-ERC.

★ <https://cordis.europa.eu/project/rcn/193723>

★ Project website:
<http://www.a-life.at/>



GREEN URBAN INFRASTRUCTURE FOR BETTER LIVING

Modern living comes with a host of urban challenges related to land-use conflicts, climate change adaptation, demographic changes, as well as human health and well-being. A team of EU-funded researchers joined forces to address these issues through green infrastructure planning.

“Urban green infrastructure is a strategically planned network of multifunctional green and blue spaces in urban areas,” notes Professor Stephan Pauleit, GREEN SURGE (Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy) project coordinator. These spaces include parks, gardens, woodlands as well as residential and commercial green areas such as green roofs and facades.

Health, environment and economy at the community level

For maximum benefits at the city-regional level, the strategic planning of green infrastructure should consider the entire urban landscape and be based on multifunctionality and connectivity. The GREEN SURGE initiative was established to identify, develop and test different ways of connecting green spaces, biodiversity, people and the green economy.

Specifically, the project worked “to develop innovative approaches and tools for the planning and governance of urban green infrastructure to support uptake and implementation of the EC’s ‘Communication on Green Infrastructure (2013),’” notes Prof. Pauleit.

GREEN SURGE showed that “multifunctional urban green infrastructure can simultaneously promote biodiversity, increase the quality of life for people, and support the economy in intensively used and densely built urban areas,” says Prof. Pauleit. This approach helps to garner political support in decision-making that favours multifunctional urban green infrastructure solutions.

Urban green is crucial for sustainable development

Project findings have important implications for policymaking. Green infrastructure eases heat stress in the summer, reduces air pollution and offsets storm water run-off after heavy rainstorms. Beyond these regulating ecosystem services, it can also provide cultural ecosystem services – recreational spaces, areas where people can experience



natural and cultural assets and enjoy social interaction. GREEN SURGE further showed that residential property values rise the closer they are to green spaces and that well-maintained green spaces attract business.

A survey of over 3 000 people in five cities in Europe showed that people prefer biodiverse environments to grey, species-poor open spaces. There is also sound evidence of the health benefits. “First graders in Berlin living in environments well equipped with green were on average healthier and more advanced in their senso-motoric development than those with poor access to green,” Prof. Pauleit points out.

Good practices for good living

Project work included close interaction with professionals in Urban Learning Labs in Bari, Berlin, Edinburgh, Ljubljana and Malmö. The knowledge gained on good practices can be applied to local strategies for green infrastructure. This particular aspect of the project highlighted practitioners’ real needs and, from a practical viewpoint, the potential and constraints of urban green infrastructure development.

GREEN SURGE has produced a handbook for urban green infrastructure. Freely available on the project’s website, the handbook offers valuable information on how to plan and govern multifunctional green networks in cities to enhance

biodiversity and ecosystem services. It includes policy briefs, factsheets, guidelines, recommendations and main messages, all tailor-made for decision-makers such as planners, policymakers and other practitioners.

Urban green infrastructure to advance biodiversity in local contexts

“Citizens and civil society organisations can be very active to develop and manage green spaces on their own,” explains Prof. Pauleit. “They may be motivated to strengthen their community, create places for nature experience for the kids, do urban gardening, or enhance biodiversity, to name a few.”

GREEN SURGE discovered that some cities ask their residents to propose green space creations and set aside budgets for their realisation. A prime example is the city of Utrecht in the Netherlands. This way, “the local authority develops strong relationships with its citizens and supports citizen involvement and the feeling of responsibility in local issues,” concludes Prof. Pauleit.

GREEN SURGE

- ★ Coordinated by the University of Copenhagen in Denmark.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/110888>
- ★ Project website: <http://greensurge.eu/>
- ★ <https://bit.ly/2wkenIX>

AQUATIC RESOURCES

ENVIRONMENTALLY FRIENDLY AND INNOVATIVE TRAWL DOORS

Conventional trawl doors are heavy, inefficient, damage the seafloor and bear a large carbon footprint. Innovators have created new, lighter trawl doors inspired by the shape of aircraft.

Trawl doors are large steel structures that keep trawls open during trawl fishing; they are traditionally heavy and inefficient to carry around on the boats. Large ships usually carry varied trawl doors for different types of fishing, which increases the down-time needed to change doors between different types of catches.

Heavy, conventional trawl doors are also inconvenient to change as they need to be taken back to land or changed on deck during dangerous sea conditions. Bottom trawling damages the sea bed with conventional trawl doors that dig into the seafloor, and this has put pressure on trawlers to change their fishing practices.

With the EU-funded EKKO (New Generation of Efficient Trawl Doors and Harmless Seafloor Fishing) initiative, project coordinator Smári Jósaftsson set out to create unique trawl doors that reduce fuel consumption with a unique shape and lighter materials. Mr Jósaftsson and the rest of the EKKO team wanted to revolutionise trawl doors and reduce the carbon footprint of trawl fishing.

The team created EKKO trawl doors to suit multiple types of trawl fishing and in this way reduce down-time between catches. They minimised the weight of their mid-water fishing trawl door by using aluminium as well as steel in larger doors, creating a product that is multifunctional, fuel efficient and eco-friendly.

"The captain of a vessel using EKKO trawl doors may want to increase or decrease the weight of the doors," says Mr Jósaftsson. "That is easy to do while the EKKO doors hang in the trawl blocks."

Mr Jósaftsson explains that the weight of the EKKO trawl doors can be changed by adding or removing second-hand chains inside the compartments. The novel design has so many innovations that the team has applied for four different international patents. The four innovations are airfoil-shaped trawl doors, a novel connection for trawl doors, weights for hollow trawl doors and a built-in water/air trap.

The EKKO team conducted a market analysis and reactions from the market showed that their innovative trawl doors would have a significant impact on the industry. Mr Jósaftsson says they have to hurry to conduct more trials before they start to market their product next year.

Mr Jósaftsson and the team ran into some funding issues during the project, which slowed it down significantly. However, they recently attracted three investors to help them get back on track with their plans.

The team used the market analysis to identify additional partners to further develop their innovative design and test it through flume tank tests and fishing trials. EKKO has developed a detailed business plan that includes revenues and costs analysis, a commercialisation plan and a risk assessment.


"As the project funding has finished, our next step has been to apply for a H2020 PH2 grant," Mr Jósaftsson notes.

The team now has two pairs of doors in trials and they want the products to be optimal when they enter the market. They are working with an engineering company to conduct computational fluid dynamics trials and further flume tank tests before they bring the product to market.

"We will start marketing in our home market in Iceland, and then enter the closest markets such as Greenland, Faroe Islands, Norway, Sweden and Denmark," explains Mr Jósaftsson. "Soon after that we will look towards other countries in western Europe, and the east coast of Canada and the US. Then we will go worldwide."

EKKO team members have also already appeared in numerous national newspapers for their innovative design and environmental consciousness. They envision themselves becoming the biggest and most revolutionary trawl door suppliers in the world within 10 years.

EKKO

- ★ Coordinated by NY TOGHLERAHONNUN EHF in Iceland.
- ★ Funded under H2020-SME and H2020-FOOD.
- ★ <https://cordis.europa.eu/project/rcn/211477>
- ★ Project website:
<http://www.ekko.is/>
- ★  <https://bit.ly/2FQSNvj>

THE REAL EFFECTS OF NANOPARTICLES IN THEIR ENVIRONMENT

Most man-made nanomaterials released into the environment will eventually make it into our oceans and seas. The SOS-Nano project has devised tests to predict their toxicity in a marine environment.

Seawater presents a unique situation due to the ions and organic matter present that may interact with nanoparticles (NPs) and interfere with their mode of action. Researchers used an ingenious *in vivo* natural water exposure system to test the effects of metal oxide NPs.

SOS-Nano (Structure – Oxidative Stress relationships of metal oxide nanoparticles in the aquatic environment) used Japanese oyster (*Crassostrea gigas*) larvae. Professor Tamara Galloway, project coordinator outlines the reason for choosing *C. gigas*, “Because oyster larvae filter feed from very early in development, they can be used to model the bioavailability (uptake into an organism) and effects of particles including their ability to induce oxidative stress or to alter development.”

Testing two different models to determine ecotoxic effects

Two structure activity paradigms were investigated – one involved measurement of dissolution and bandgap energies as predictors of oxidative stress. The other gauged oxidative stress generation as a toxicological pathway for predicting health impairment. In addition, the team tested the ions, organic materials and proteins found in seawater to see if they ameliorated the effects of NPs.

Project results verified that, in addition to physico-chemical properties responsible for their mode of action, additional NP properties need to be taken into account when predicting their toxicity in seawater.

Data on NP behaviour, fate and impact in realistic scenarios

A comprehensive project database holds information on the primary physico-chemical properties of the model NPs as well as their secondary properties and oxidation activity in seawater. Using the highest resolution imaging techniques, the ingestion and internalisation of NPs in the larvae were traced. Dissolution tests and abiotic measurement of redox activity enabled assessment of the actual NP mode of action.

Two NPs – zinc oxide (ZnO) and manganese dioxide (MnO₂) – were investigated to represent the target modes of action, dissolution and bandgap. The oyster larvae suffered high toxicity from ZnO as dissolution was not prevented by seawater. Interestingly, this mode of action can be mitigated by organic matter. In contrast, MnO₂ NPs rely on surface redox activity and were not toxic under all exposure scenarios. “Our experiments highlighted how salinity can be

a key factor in the toxicological behaviour of redox related modes of action in marine environments via sorption of ions to reactive sites,” comments Prof. Galloway.

Expansion of the range of ions under test

Throughout the two-year project, SOS-Nano researchers tackled a large and complex series of experiments using a wide range of state-of-the-art technologies. “Meticulous timing of coordination within the time was required and this was very challenging,” points out Prof. Galloway.

Project results show that there is now a firm foundation of paradigm validation on toxicity of two metal oxide NPs in the oyster embryo larvae, an organism remarkably sensitive to the effects of NPs. Future testing would build on this and extend the range of nanomaterials under test, sharing the mode of action but differing in their ability to interact with seawater components.

Based on the observations on internalisation in the larvae, changes in NP physico-chemical properties along their way from marine to biological environments and back would also yield valuable information on NP toxicity.

Lack of a sound human and environmental risk assessment of NPs is now the major limitation to the safe growth of this economic sector, one of the six EU Key Enabling Technologies selected by the European Commission. As such, the SOS-Nano project has addressed one of the most cutting-edge issues of ecotoxicology. “Once the mechanisms behind oxidation potential of NPs are clarified, this can lead to new paradigms or the adjustment of existing models,” Prof. Galloway predicts.

SOS-Nano

- ★ Coordinated by the University of Exeter in the United Kingdom.
- ★ Funded under H2020-MSCA-IF.
- ★ <https://cordis.europa.eu/project/rcn/195051>
- ★ Project website: <https://www.exeter.ac.uk/research/marine/>

“Our experiments highlighted how salinity can be a key factor in the toxicological behaviour of redox related modes of action in marine environments via sorption of ions to reactive sites.”



NEW SENSORS TO TRACK THE HEALTH OF OUR OCEANS

The EU-funded SCHEMA project has developed innovative sensor-based technology to detect harmful chemicals in marine ecosystems in a bid to boost understanding of anthropogenic impacts and marine life sustainability.



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Oceans and seas play a vital role in determining our climate and weather, providing us with an important source of food, supporting the livelihoods of billions of people and ensuring that the economies of many countries stay afloat. However, sea- and land-based human activities are increasingly impacting the health of our marine ecosystems.

The SCHEMA (Integrated in situ Chemical Mapping Probes) project has developed new technology to identify substances that are harming the equilibrium of marine ecosystems, potentially impacting human health, the fishing industry, coastal tourism and the long-term sustainability of our seas and oceans.

“A number of marine ecosystems are underperforming due to the severe environmental stress from human activities but monitoring this is problematic. The commercial availability of deployable sensors and sensing devices is still limited – most of these tools are too large, expensive and power-hungry, hindering their widespread use,” says Mary-Lou Tercier-Waeber, SCHEMA project coordinator.

Easily-deployable mini sensors

To help overcome measuring difficulties and improve ocean monitoring,

SCHEMA partners have developed miniature sensors that can map a range of anthropogenic and natural chemical and biological compounds at a very high resolution. They can detect trace metals; species that play a role in the carbon cycle like carbonate, calcium and the hydrogen ion; nutrients like nitrogen and nitrate; volatile organic compounds; potential harmful algae and biotoxins – all of which may adversely affect the oceans’ health.

Nutrients can cause the development of harmful algal blooms and an increase in oxygen-stifled zones in the oceans. Metal and organic compounds, due to their toxicity, persistence and tendency to accumulate along the food chain, may have a long-term impact on marine biomass composition, activity and health.

The sensors can also help track ocean acidification levels – a process caused by oceans absorbing carbon dioxide from the atmosphere. Ocean acidification is predicted to disrupt food chains and undermine the functioning of marine ecosystems. The sensors will also help to monitor the ability of oceans to carry on absorbing carbon dioxide – a key factor in the fight against climate change.

The project used cutting-edge electrochemical, optical and fluidic techniques

to develop powerful, low-power consumption sensing probes that incorporate the miniature sensors and mini-fluidic systems. It then developed a network controller based on Open Geospatial Consortium – Sensor Web Enablement interfaces and a Global System for Mobile Communication (GSM) transceiver.

“Our integrated modular multifunctional sensing system enables autonomous, high resolution, simultaneous, *in situ* measurements of a broad range of relevant bio-geochemical parameters,” says Tercier-Waeber.

SCHEMA’s new technology was tested in areas of the Atlantic and in Mediterranean coastal zones. Tests were successful in tracking sources of hazardous chemical and biological compounds, and in acting as a system to raise the alarm about these substances. For example, in the bay of Arcachon, South-West France, SCHEMA detected zinc and copper from an industrial origin in their most toxic form. It also found nutrient input from freshwater effluents and a phytoplankton that produces a neurotoxin. This data will help researchers to advance monitoring strategies, boost the ability to predict the impact of toxins on the local ecosystem and help develop ways to sustainably manage the bay’s ecosystem.

SCHEMA partners are now working on bringing their field-validated prototypes to the market, as well as improving the ability of the probes to detect other detrimental chemical compounds, for example volatile organic compounds and saxitoxin – a neurotoxin produced naturally by some species of algae.

SCHEMA

- ★ Coordinated by the University of Geneva in Switzerland.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <https://cordis.europa.eu/project/rcn/110789>

INDUSTRY

A NEW GENERATION OF SCIENTISTS SETS THE STAGE FOR INDUSTRY 4.0

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Industry 4.0 will bring smarter and more connected technologies to factories. But for these technologies to take over the market, sustainability will be required. The SMART-E project has made sure that the new generation of scientists working on future industrial robots is well aware of this requirement.

The fourth industrial revolution is coming soon, and at its core is the full integration of digital and physical technologies enabled by progress in artificial intelligence, cognitive technologies and the Internet of Things. The promise for citizens? Better working conditions, sustainability and product personalisation to a level never seen before.

Getting there, however, requires a new generation of brilliant scientists: notably specialists who will be tasked with creating the advanced robotics technologies at the heart of Industry 4.0. Training these up-and-coming roboticists is precisely what the SMART-E (Sustainable Manufacturing through Advanced Robotics Training in Europe) project was about.

"SMART-E is a world-class doctoral training and research programme," says Prof. Samia Nefti-Meziani, coordinator of the project on behalf of the University of Salford. "It focused on advanced robotics for sustainable manufacturing, and its results will allow European manufacturing companies to adapt their production processes to the trends defining Industry 4.0.

"By doing so, it ensured Europe's competitiveness, creating jobs for high-level skill operators, and increasing productivity. It also provides SMART-E Fellows with complementary business, leadership and interpersonal skills, and exposes them to different working cultures in academic and business sectors internationally."

The SMART-E project involved 13 Early Stage Researchers (ESR) and three Established Researchers (ER). Their objective:

the development of ground-breaking technologies with emphasis on the likes of dexterous, soft and compliant robotics for manufacturing; reconfigurable and logistics robotics; and finally, safety aspects, human-robot interaction and cooperation.

One example of the project's innovative solutions is a Smart-E gripper prototype conceived by the University of Salford. The UK nuclear industry has already recognised the potential of this Smart-E gripper, incorporating it into a recent project awarded by the Nuclear Decommissioning Authority (NDA) in Sellafield, for use in nuclear decommissioning.

Another example is flexible machining using robots instead of expensive CNC machines, which the Advanced Manufacturing Research Centre is currently exploiting with a company that Prof. Nefti-Meziani says, "will save millions of pounds in capital and operational costs over the coming years."

All in all, SMART-E has provided hands-on experience in robotics research to academics and industrial partners. It produced world-class results and provided researchers with an opportunity to collaborate with a number of industrial partners who joined the Network throughout the duration of SMART-E. Results have been disseminated in the form of publications, Shang'AI lecture series in Advanced Robotics for Sustainable Manufacturing, conferences, summer schools, engagement events, industrial presentations and patents.

"The fellows filed two patents and published more than 43 papers – 11 in scientific journals and 33 in proceedings of international conferences (with awards). These papers were published in journals with an impact factor ranging from 0.987 to 8.649," Prof. Nefti-Meziani explains.

"Over one third of our conference papers were presented at leading control and robotics conferences such as the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), the IEEE International Conference on Robotics and Automation (ICRA) and the American Control Conference (ACC)."

Sixteen of the project's research fellows were also recruited by major research organisations and industries.

With the project now over, Prof. Nefti-Meziani says that the next stage will consist in applying for further European funding, "to take all research outputs to commercialisation stage." These efforts will not only benefit current SMART-E industrial partners from the food and aerospace sectors, but also other sectors like Health and Space.

SMART-E

- ★ Coordinated by the University of Salford in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/109367>

A LONG-AWAITED MODERNISATION OF CERAMIC PRODUCTION METHODS

Thousands of years after the ceramic production process was invented, a new solution has finally been developed, with a high potential impact on production cost, percentages of rejects and overall industry sustainability.

Ceramics were one of the first materials our ancestors mastered and transformed into the likes of ceramic tiles, pottery and clay bricks. With all this accumulated know-how – the first human and animal figurines made of clay appeared around 24000 BC – you could be forgiven for thinking that current ceramic producers use well-oiled processes with minimal to no loss or defects.

The truth is, we are far from there. Instead of improving with time and experience, the way ceramics are produced has not changed much. They are still obtained by a process called forming – where inorganic powders, with or without water, are shaped into the desired product – followed by firing at high temperature, typically above 1 000 °C.

"Both steps are crucial for the mechanical properties and quality of the final product, but even today, the ceramic processing and design are essentially based on trial-and-error," says Prof. Andrea Piccolroaz, coordinator of the CERMAT2 (New ceramic technologies and novel multifunctional ceramic devices and structures) project. "The consequence of this approach is an extremely high rate of rejects, which has an impact not only on manufacturing cost but also on the sustainability of the ceramic industry. It's not so surprising

that the ceramics industry is one of the most energy demanding ones, and it is responsible for a large part of greenhouse gas and pollutants emissions."

CERMAT2 aims at no less than a revolution, one that would see the ceramics industry move away from its traditional ways to adopt a more rational and scientific approach. This approach, based on advanced nonlinear mechanical modelling, would involve a mathematical constitutive modelling of ceramic materials, experimental analysis, characterisation and numerical simulation with the finite element method. The purpose? Optimising design through the use of Virtual Prototyping – under which the design is validated *in silico* using computer-aided

engineering software without making use of a physical prototype.

"We successfully developed this method, and we have now delivered the numerical routines and software for the optimal design of ceramic materials to our industrial partners," Prof. Piccolroaz enthuses. "This is not only an advance in our knowledge of ceramic materials, but also a step forward in the mechanical design of ceramics."

To industries wishing to change their ways, Prof. Piccolroaz promises a significant reduction in manufacturing costs thanks to the use of virtual prototyping. Furthermore, software tools developed under the project will allow for predicting the mechanical properties of the final

"CERMAT2 aims at no less than a revolution, one that would see the ceramics industry move away from its traditional ways to adopt a more rational and scientific approach."



pieces, which is expected to have a major impact on the minimisation of defects and therefore the reduction of rejects.

CERMAT2 was completed in October 2017, but work has been continuing since then. One of the project objectives involved training a new generation of young researchers in advanced nonlinear solid mechanics and numerical

implementation, with applications in ceramic production. Some of these researchers have already created a successful start-up with the aim of extending and spreading the CERMAT2 methods across the ceramic industry. "We will continue the collaboration with them to make our new technology the new standard for ceramic production," Prof. Piccolroaz concludes.

CERMAT2

- ★ Coordinated by the University of Trento in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ <https://cordis.europa.eu/project/rcn/109577>
- ★ Project website: <http://cermat2.unitn.it>

CLASSIFICATION FOR NANOMATERIALS OF THE FUTURE

Nanomaterials are present in a dizzying number of diverse applications – including medical, pigment, cosmetics, solar and environmental technologies. End-users, such as material manufacturers, need measurement methods to determine if their product contains nanomaterial, or not.

The EU-funded NANODEFINE (Development of an integrated approach based on validated and standardized methods to support the implementation of the EC recommendation for a definition of nanomaterial) project focused on the development of robust, cost-effective, validated measurement methods and instruments that reliably measure the size of nanoparticles in the EU-defined range of 1-100 nm in a variety of complex industrial materials and products.

An ingenious adaptable e-tool to guide end-users and manufacturers

One main outcome of the project is the NANODEFINE e-tool that supports authorities, industry and researchers. As end-users, they participated in the selection of the most appropriate methods to determine whether a material should be considered, according to the EC definition, a nanomaterial or not. Dr Hans Marvin, project coordinator, outlines, "All these features incorporate the use of materials with different shapes, coatings and for the widest possible range of applications, in various complex media and products."

Implementing the EU definition will include all conventional particulate materials less than 100 nm to be classified accordingly, and the NanoDefiner e-tool comes with a manual containing details of all methodologies developed including many standard operating procedures.

Particle sizer and a decision-making tool for unknown materials as well as multiple components

In addition to the NanoDefiner, the researchers have developed several software solutions including an automated ParticleSizer that supports the e-tool. Using transmission electron microscopy for image analysis, the system automatically measures the distributions of the characteristic size, shape and other properties of potential nanomaterials. The results table can then be uploaded to the NanoDefiner e-tool.

NANODEFINE research has been extended to materials with multiple components. "Nowadays, multi-element nanoparticles represent a substantial portion of manufactured materials and they are used as additives in a variety of common commercial goods such as cosmetics," explains Dr Marvin. Results so far from research with the project INNANOPART have shown that for true multi-element analyses, a time-of-flight mass spectrometer is required.



Dissemination and potential for the future

The tool has been demonstrated to stakeholders at a training course in Wageningen, an outreach event in Brussels, and two technology transfer workshops in Frankfurt, where feedback was very positive. More than 900 users have individually accessed/requested the link to the tool in only four months. Access to the video explains how to use the NanoDefiner e-tool.

Significantly, discussions with the German Chemicals Industry Association have been aired as to how to bring the most promising rapid screening methods into more practical real-life applications. These include volume-specific surface area, which correctly classifies a large set of diversely ranging particles, and field-flow fractionation, a separation technique based on differing mobility.

NANODEFINE has prepared an exploitation plan for commercially usable results now the project has ended. The NanoDefiner e-tool will be taken up by a partner, the Joint Research Centre, and once this is carried out, potential upgrades may become feasible.

NANODEFINE

- ★ Coordinated by Wageningen University and Research in the Netherlands.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/110554>
- ★ Project website: <http://www.nanodefine.eu/>
- ★  <https://bit.ly/2rqXNBD>

MANUFACTURING MATERIALS AND METHODS FOR GREENER, MORE CUSTOMISABLE AND HIGHER QUALITY PRODUCTS

Researchers are developing a novel process for producing cellulose-based electrical insulation components. This method will reduce operating costs and labour time in manufacturing.

Rapid infrastructure growth, increased urbanisation and the expansion of electric power distribution and transmission networks have fuelled the demand for electrical insulation materials. Cellulose, a renewable, non-toxic and abundant natural material, has a wide range of applications, from paper to textile. It's also commonly used in electrical insulation components such as power distribution transformers. However, the technologies involved in the manufacturing of these products are labour intensive and slow.

Enter NOVUM (Pilot line based on novel manufacturing technologies for cellulose-based electrical insulation components), an EU-funded project that aims to make significant improvements in the way in which cellulose is produced. It's an industry-driven initiative that will develop and demonstrate a compact and feasible pilot line concept based on novel processing technologies for rapid, design-driven production of cellulose-based electrical insulation components. The project also seeks to manufacture different types of

electrical insulation components that meet the technical product requirements in the new pilot line.

The researchers say power transformer units using such materials usually have a very specific and individual design, which also influences the design of the insulation components. They note that for each insulation component, an individual metal mould has to be fabricated. This results in hundreds or even thousands of moulds being organised and stored. This process leads to significant material waste.

That's why, they argue, there's a need to improve the manufacturing process of electrical insulation components, in terms of energy consumption, waste generation, duration and automation. In addition, it would be beneficial if the dependency of the process on moulds, especially metal moulds, could be reduced.

The research team hopes to revolutionise the way in which power transformers are designed and produced, and lead to the transition from current manual production to automated production lines.

"Cellulose, a renewable, non-toxic and abundant natural material, has a wide range of applications, from paper to textile."

As it explains in a recent press release, this will result in increased resource efficiency, "including a 40% reduction in labour time and a 60% reduction in waste generation, 20% lower energy consumption and a 4% decrease in operating costs."

In the same press release, NOVUM notes its focus on 3D printing of cellulose-based materials with thermoplastic features and foam forming and thermoforming of cellulose fibres. It says these technologies will be developed in parallel with each other, together with the cellulose materials, to reach an optimal combination for the pilot line concept. "Besides technical feasibility, the decision on the pilot line concept will be based on the end use requirements as well as on economic, social and environmental impacts, including circular economy considerations."

According to the team, the concept will be based on multipliable technologies, which they hope will enable their transition and wide adoption for cellulose-based materials across the process industry and applications in other industrial areas.



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NOVUM

- ★ Coordinated by the VTT Technical Research Centre in Finland.
- ★ Funded under H2020-LEIT-ADVMANU.
- ★ <https://cordis.europa.eu/project/rcn/211276>
- ★ Project website: <http://novumproject.eu/>

INFORMATION AND COMMUNICATION TECHNOLOGY

EXPANDING HPC TO CLOUD COMPUTING AND BIG DATA

Researchers with the EU-funded Bright Beyond HPC project have extended the Bright Cluster Manager programme, making it usable with cloud computing and big data.

An increasing number of high-performance computing (HPC) users are combining HPC with big data and cloud infrastructure and applying common management platforms and paradigms across them. In response to this demand, the EU-funded Bright Beyond HPC (Cluster Management beyond High Performance Computing) project expanded the Bright Computing company's capabilities in managing HPC and big data clusters and OpenStack-based private clouds. Bright Computing, a Dutch company, provides comprehensive software solutions for the provision and management of HPC clusters and OpenStack private clouds.

"We recognise that the deployment and use of these advanced technologies is not only expanding, but converging, and this project allowed Bright Computing to deliver a powerful, integrated, single-pane-of-glass management platform that helps IT organisations gain visibility, control and peace of mind," says Dr Matthijs van Leeuwen, Chief Strategy Officer at Bright Computing.

The project aimed to solve the cluster management problem in HPC, big data/Hadoop and OpenStack cloud computing by developing and bringing Bright Beyond HPC to market readiness. "Bright Computing's Bright Cluster Manager product has a very strong presence in the HPC market," explains van Leeuwen. "The goal of this project was to extend Bright Cluster Manager and make it usable in two important emerging markets, namely, cloud computing and big data."

Cloud computing

As to the first, Bright Cluster Manager was used to manage large clusters of computers that, together, solve complex scientific, technical, engineering or financial problems. However, the product's functionality was limited as the clusters managed by the product consisted of computers physically located inside the company or organisation. With

the emergence of cloud computing, companies were doing more and more of their computing 'in the cloud'.

OpenStack is standard cloud management software that is widely supported by industry for standing up public and private clouds. "Being able to extend an on-premise Bright cluster to an OpenStack cloud, both internal to an organisation and external, is a major achievement of this project," says van Leeuwen. Van Leeuwen says that this capability allows a user to combine clusters of computers inside an organisation with computers available in a cloud. Although the user primarily does this using their own computers, in instances of high computing needs, they also have access to cloud computers, including Amazon Web Services (AWS) and Microsoft Azure Clouds (in addition to private and selected public OpenStack clouds).

Big data

Likewise, with big data, large amounts of data have traditionally been analysed by clusters of computers. However, the management and application software for big data is different from what is used for HPC clusters in that it is geared towards moving large amounts of data and being able to search through this data (as opposed to doing lots of calculations).

The main tool used for managing big data clusters is Apache Hadoop, an Open Source software. By integrating Hadoop into Bright Cluster Manager, organisations can now manage clusters of systems that include both HPC- and big data-oriented computers. This can be used, for instance, by research organisations that analyse experimental data in a Hadoop cluster and compare that to theoretical models calculated on HPC computers. "Industry is often reluctant to use open source software due to a lack of professional support behind it," says van Leeuwen. "Bright Beyond HPC adds industrial strength support to this software, so Bright Cluster Manager can now be used by organisations that

SOCIAL TELEVISION – ENGAGING THE AUDIENCE WITH AN INTERACTIVE APP

With mobile phones and tablets competing with television for audience attention, broadcasters are interested in technology that can combine TV shows with audience interaction using mobile apps. The TELLY project has the solution.



“People are playing games and surfing the web or they are on social media while the TV is on somewhere in the background.”

What is more innovative is that the data gathered from the audience via the second screen app can be relayed back on the TV screen in real time so the audience can, for example, see how voting figures change during popular talent shows.

Audience spikes

“We developed a very robust backend to handle heavy mobile traffic which spikes according to what the audience sees on television at a particular time,” Mr Cercel explains. “We devised our own load-balancing system to be able to scale up automatically. When traffic rises, such as when the audience is voting, the system automatically turns on servers in the cloud to accommodate the spike.”

With a powerful backend, multiple TV shows can be added to the same app, each with separate content, which is more advanced than other apps on the market. Video content sent to the app using an embedded YouTube-like mobile video player, can also be monetised by attracting advertising on the app.

Signing up clients

The EU's funding went towards a feasibility study to test technological and economic viability and to draw up a business plan, identifying potential clients such as broadcasters, media companies, event and conference organisers, for instance, to elicit audience feedback during a panel discussion.

According to the EU funding agreement, “we had to sign six contracts and we signed seven, so we exceeded expectations,” Mr Cercel says. Contracts have been signed with companies in the United Kingdom, the Netherlands, the United States, Lebanon, Romania, Ireland and South Africa.

“They are looking forward to running a pilot test with us so that the product can be fully developed. Discussions are also underway with government agencies interested in real-time polling,” concludes Mr Cercel. “We also plan to apply for a second phase of European funding for the development, launching and marketing of the system.”

An EU-funded company has developed the so-called ‘second screen’ environment as a platform for broadcasters to engage with their audience during a TV show, and prevent viewers migrating away from television, which could ultimately threaten the future of traditional broadcasters.

“People are playing games and surfing the web or they are on social media while the TV is on somewhere in the background. Their focus is on the second screen which is the mobile,” says Dragos Alex Cercel, CEO of Appscend. The company, based in Bucharest, Romania, received a six-month Horizon 2020 grant to develop a system to combine television and audience reaction via a mobile app under the TELLY (A 2nd screen mobile application solution providing interactive multiplayer game and real-time voting capabilities, based on TV content, to better engage TV audiences and sports fans) project.

“TV networks and broadcasters want a tool to maintain user focus on the first screen, which is the TV,” he explains. “This can be with a mobile player versus player application connected and synchronised with the TV show itself, whether it is live or recorded. The producers can use a laptop or tablet to access the app using a dashboard we have devised. A moderator with a tablet can even write and send out questions to poll an audience during a live interview with a presidential candidate.”

The layout of the app changes while the show airs, Mr Cercel explains. “The broadcaster can send different types of interactions like polls, votes and quizzes using gaming concepts to the app based on what is happening in real time on live TV.” They can use a messaging-type system so that viewers can comment on a specific topic. “This creates a lot more engagement for the entire show,” he says.

TELLY

- ★ Coordinated by Vitality Media in Romania.
- ★ Funded under H2020-LEIT-ICT and H2020-SME.
- ★ <https://cordis.europa.eu/project/rcn/210418>
- ★ Project website:
<http://appscend.com/products/social-tv.html>

THE JUWELS IN THE SUPERCOMPUTING CROWN

As part of a ground-breaking supercomputer to meet the growing needs of business and science, researchers have developed a new high-performance module capable of up to 12 quadrillion calculations per second.

The supercomputer JUQUEEN, the one-time reigning power in Europe's high-performance computing industry, is ceding its place to its successor, the Jülich Wizard for European Leadership Science. Called JUWELS for short, the supercomputer is the culmination of the joint efforts of more than 16 European partners in the EU-funded DEEP projects since 2011. Once completed, JUWELS will consist of three fully integrated modules able to carry out demanding simulations and scientific tasks.

JUWELS, part one

The first JUWELS module is being installed at the Jülich Supercomputing Centre (JSC) in the spring of 2018. The general-purpose Cluster Module is based on a French IT services company's Sequana architecture, with software supplied by one of the German partners. It consists of about 2550 compute nodes, each with dual Intel Xeon 24-core processors and at least 96 GB of main memory. Armed with such massive firepower, it can reach a peak performance of 12 petaflops/s, or 12 quadrillion operations per second.

Building on the architecture developed in the predecessor DEEP and DEEP-ER projects, DEEP-EST (DEEP – Extreme Scale

Technologies) aims to deliver another two modules based on the Modular Supercomputer Architecture concept. The innovative concept was first dreamed up years ago by Prof. Thomas Lippert, Director of the JSC. "The JSC is breaking new ground with its modular concept," he said in a Jülich press release.

The modular approach to supercomputing

In today's world of high-performance computing, compute-intensive applications involving simulation and data analysis have become increasingly important, but current supercomputers just cannot keep up. "[A]pplications are becoming significantly more complex and the volumes of data from present-day experiments, for example at CERN, are increasing in size. This means that supercomputers will require drastically larger storage capacities – and they must be located as close to the processors as possible. Only then can the data be processed in a fast and energy-efficient manner," explained JSC scientist Dr Estela Suarez in an earlier press release.

Enter Modular Supercomputer Architecture, which combines diverse modules with different performance features into a single system. The modules are connected

through a high-speed network and are operated by the same software. Heterogeneous applications therefore run concurrently on exactly matching compute and data resources, offering significant reductions in the time and energy needed to calculate a solution. The system's high flexibility also makes it easily adaptable. Designed with big data science needs in mind, modular supercomputing is a novel European approach to information processing technology. It will pave the way for cost-effective and energy-efficient exascale computers – supercomputers a thousand times faster than today's most powerful systems.

Six real-world applications are being used to evaluate the hardware and software technologies developed in DEEP-EST. These are high-energy physics, earth science, space weather, molecular dynamics, neuroscience and radio astronomy. Each field uses different module combinations, proving Modular Supercomputer Architecture's adaptability to the needs of many different users.

Next in line in DEEP-EST is the Extreme Scale Booster module, which will be able to support a wide range of high-performance computing applications. This will be followed by the project's final output, the Data Analytics Module, whose design will be geared towards high-performance data analytics workloads.



DEEP-EST

- ★ Coordinated by Jülich in Germany.
- ★ Funded under H2020-FET.
- ★ <https://cordis.europa.eu/project/rcn/210094>
- ★ Project website: <http://www.deep-projects.eu>

"Compute-intensive applications involving simulation and data analysis have become increasingly important."

FUNDAMENTAL RESEARCH

QUANTUM NETWORKS HOLD KEY TO FUTURE COMMUNICATION

Could quantum mechanics hold the key to the development of superfast, next-generation communication? A Marie Curie-funded project has made important steps towards answering this question.

The EU-funded SiPhoN (Single-Photon Non-Locality) project successfully created on-demand single photons and demonstrated that these particles can outperform natural atoms in experiments related to a specific quantum phenomenon. This achievement could have important implications in the pioneering world of quantum communication.

"Today's society is based on fast access to information," says SiPhoN project coordinator Klaus Jöns from the KTH Royal Institute of Technology in Sweden. "Getting a head-start on information is vital in business, finance, politics and security. Most of our information exchange is now done via the internet of course, but even this medium has capacity limits. Furthermore, data transfer is not secure."

Future networks

Jöns' EU-funded project tapped into the fascinating and mysterious world of quantum mechanics to further determine the feasibility of a future network that can handle massive amounts of data flow. "The idea is that at the quantum level, we can encode information on the smallest quanta of energy, a single light particle called a photon," he explains. "This would not only reduce the amount of energy needed to transfer information, but also allow for totally secure communication due to the principles of quantum mechanics."

The project focused specifically on a quantum phenomenon known as non-locality. This quantum mechanical effect is already well understood, and several experiments have been performed, usually involving two entangled photons. A projective measurement on one photon instantly collapses the state of the other entangled photon at a distant location. However, non-locality of a single particle, in particular of a single-photon, raises some fundamental questions: can a single-photon be simultaneously at different locations?

"Non-locality, which Albert Einstein described as 'spooky actions at a distance', occurs when particles separated in space are instantaneously influenced by an action that takes place in one part of the system and at one location," explains Jöns. "In this project we wanted to see if modern nano-scale semiconductor quantum light sources could demonstrate non-locality in photons."

Artificial atoms

Jöns and his team used nano-scale devices, also called artificial atoms, in their experiments and demonstrated that these are indeed excellent single-photon sources. These artificial atoms also outperformed natural atoms in many cases. "These nano-scale semiconductor quantum light sources exhibited the lowest unwanted multi-photon emissions," says Jöns. "They can also be used to generate deterministic entangled photon pairs."

This new method of generating pairs of entangled photons, on-demand, could help to speed up research. The project also discovered that these quantum emitters ‘blink’, which means that they sometimes do not emit light. This, says, Jöns, should be taken into account when developing future applications in quantum communications.

While it is clear that single and entangled photons are important blocks in building up quantum networks, Jöns stresses that a great deal more fundamental research is needed in order to identify the best quantum light sources that meet the most stringent requirements.

“This Marie Curie project enabled me to build up my own network of collaborators,” he says. “This was an important step in helping me to become more independent and to build up my own research portfolio. It also offered me a unique research environment with excellent supervision and mentoring, which in my case was Professor Val Zwiller at KTH Stockholm.”

SiPhoN

★ Coordinated by the KTH Royal Institute of Technology in Sweden.

★ Funded under H2020-MSCA-IF.

★ <https://cordis.europa.eu/project/rcn/196091>

UNDERSTANDING HOW MICROORGANISMS ADAPT TO THEIR SURROUNDINGS

Researchers with the EU-funded Bio-Strategies project have gained important insights into how microorganisms adapt to the mineral environment where they live and how this affects the plants that depend on these minerals.

It has long been suspected that microorganisms have the ability to adapt to their surrounding environment. This is particularly true for those living in soil, where the microorganism must attack mineral grains to extract metal nutrients. But as different minerals have different metal compositions, and because some are harder to leach than others, it is a very different scenario for a microorganism to live in one type of soil or another.

To learn more about this assumed adaptability, researchers working as part of the EU-funded Bio-Strategies (Bio-strategies of mineral nutrient extraction from silicates by selected microorganisms) project examined whether microorganisms change their strategy of attack based on the minerals they live on. Can a microorganism change from secreting acid to secreting molecules that hold to metals? Can they change the intensity of their attack based on initial successes? These are the questions that the project sought to answer.

Important findings

Following an array of experiments, researchers came to two important conclusions. First, they discovered that microorganisms concentrated on the parts of the mineral grains where they most easily leached. “For the plate-like minerals we used, such as mica, the weakest point was the edge of the plates,” says project researcher Dr Javier Cuadros.

Second, researchers observed that one of the microorganisms used in the experiments, a type of fungus, changed

the intensity of the attack in accordance to the mineral it was attacking. In the extreme case, the surface of the mineral vermiculite was depleted from all the metals except silicon. “We think the reason for this very intense attack was that the fungus was searching for potassium, of which there is very little in vermiculite,” explains Cuadros.

These findings are important in that they show how bacteria and fungi can sense the location of nutrients and respond to this information. It also helps demonstrate the dependency of superior forms of life, such as plants, on microorganisms. In fact, one part of the project was devoted to investigating whether the metal nutrients being leached by the bacterium and fungus were then made available to plants growing in the same soil. With initial results indicating that they are, this means that microorganisms not acting in symbiosis with plants are also providing for a plant’s nutritional needs via their mineral-leaching activity.

“We have reason to believe that the interconnection between mineral soil,

microbial and plant communities is enormous and very complex,” says Cuadros. “Obviously, this interconnection also extends to animals, and includes humans, but we have to work one step at a time to reveal the intricate interdependence in complete ecosystems.”

A rock-solid legacy

According to Cuadros, the legacy of the project will be its contribution to the definition of rock-life coevolution on Earth. “Life shapes rocks and rocks shape biological activity,” he adds. “This project is an example of how the mineral matrix where microorganisms live fosters their biological evolution toward different nutrition strategies.”

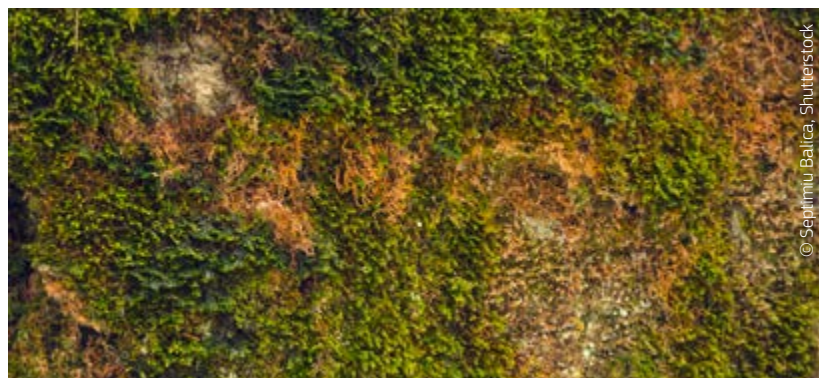
Bio-Strategies

★ Coordinated by the Natural History Museum in the United Kingdom.

★ Funded under H2020-MSCA-IF.

★ <https://cordis.europa.eu/project/rcn/194824>

★ Project website: <http://www.nhm.ac.uk/our-science/our-work/origins-evolution-and-futures/bio-strategies.html>



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THE MECHANISMS OF PLANT AGEING

European researchers investigated the molecular mechanisms that drive stress-related responses that cause ageing and death in plants. The goal is to generate resilient crop varieties.



Unlike animals that can avoid stress, plants have evolved responses for evading factors that can be detrimental for growth and survival, environmental conditions and pathogens. This is often communicated through the production of reactive oxygen species (ROS), by-products of aerobic metabolism.

Low ROS levels mediate the responses towards stress while at higher concentrations they may lead to programmed cell death. ROS also play a pivotal role during several developmental processes, including root hair growth and seed germination.

Scientists of the EU-funded PlantAgeing (Deciphering the regulatory role of reactive oxygen species in plant ageing through an integrative genetics and genomics approach) project wished to determine the role of ROS in plant senescence and ageing and extend existing knowledge on the genetic determinants of the ageing process. This was a collaborative undertaking between scientific groups from Bulgaria and New Zealand.

Biological ageing in plants

Studies over the years have identified genes that accelerate senescence alongside others that delay senescence and thus extend lifespan. However, very little is known about how these genes interact and respond to specific environmental and developmental signals. In addition, the developmental stage of a plant also affects its ability to withstand adverse environmental conditions or initiate senescence.

PlantAgeing researchers employed *Arabidopsis thaliana* mutants with extended or shortened life span as well as plants with extreme tolerance to abiotic stress. Abiotic stress contributors mainly comprise extreme temperatures, high salinity, water deprivation and pollutants including herbicides.

The team performed genome-wide studies including transcriptomics and metabolomics to investigate gene expression and metabolite level changes at different stages of development and under stress. They also examined how ROS-responsive

genes react to oxidative stress. "We worked under the assumption that when a negative regulator of ageing is overexpressed, the transgenic plants will have delayed senescence, while repression of such a gene would accelerate senescence," explains project coordinator Dr Gechev. "The opposite will take place if a gene positively regulates senescence; its overexpression will accelerate biological ageing," he continues.

Novel molecular cues on plant lifespan

Molecular, proteome and metabolome profiling provided important insight on how senescence-related genes regulate lifespan in plants. Genetic comparison between plants tolerant to abiotic stress and other stress-tolerant plants further produced significant information on the mechanism of stress response.

The consortium identified key genes, metabolites and lipid classes that are highly regulated during long-term darkness in the flowering plant *Haberlea rhodopensis*. Additionally, they sequenced the genome of the UV-tolerant plant *Pachycladon cheeseemanii* and characterised its physiological and molecular responses to high doses of UV radiation.

Plant senescence is of considerable interest to agricultural practice as its manipulation has the potential to significantly influence crop tolerance to adverse conditions and improve yield. Project findings successfully uncovered new elements of the ROS regulatory pathway that modulate senescence in *Arabidopsis thaliana*.

Although too early to predict the impact on farming, Dr Gechev envisages, "the enhanced knowledge on the mechanisms that regulate plant ageing and senescence will contribute to more resistant crops and vegetables with extended shelf life."

PlantAgeing

- ★ Coordinated by the Institute of Molecular Biology and Biotechnology in Bulgaria.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/109892>

EVENTS

JULY
01►06

Gothenburg, SWEDEN

SUMMER STUDY

2D MATERIALS FOR ENVIRONMENT AND ENERGY APPLICATIONS

The EU-funded GRAPHENE FLAGSHIP project will be organising a summer study event in Gothenburg (Hindås), Sweden, from 1-6 July, 2018.

Graphene Study is the Graphene Flagship's school for early-career researchers, specifically designed to develop outstanding researchers in graphene. It provides opportunities to discover new insights and acquire high-level expertise from leading experts in the field, present research in the poster session, and enjoy numerous social activities and networking opportunities for career development.

The Graphene Study 2018, summer edition, titled '2D materials for environment and energy applications', will delve into deeper aspects of how things work, exploring experimenters' techniques in studying energy and environmental applications for graphene, mainly filtration and energy storage technologies.

Leading academic and industry experts from around the world, including Rohit Karnik from the Massachusetts Institute of Technology, Aleksandra Radenovic from the École Polytechnique Fédérale de Lausanne, and David A. Pacheco Tanaka from TecNALIA will provide delegates with their insights on topics from nanofluidics and power generation to desalination using graphene.

For further information, please visit:

https://graphene-flagship.eu/graphenestudy/GS_June_2018/Pages/Graphene-Study-Summer-2018.aspx

JULY
02►06

Grugliasco, ITALY

SUMMER SCHOOL

EMPHASIS SUMMER SCHOOL 2018. EMERGING PESTS AND DISEASES IN HORTICULTURAL CROPS: INNOVATIVE SOLUTION

The EU-funded EMPHASIS project will be organising a Summer School in Grugliasco, Italy, from 2-6 July, 2018.

The overall goal of EMPHASIS is to develop and promote the take-up of practical and effective solutions to prevent and protect European crops from native and alien pest threats, improving productivity and resilience of European agriculture, in the context of climate change.

This course aims to train young researchers on epidemiological issues related to emerging pests and pathogens and on innovative management strategies in horticultural systems, and to provide skills on using innovative and effective diagnostic systems.

The course comprises three sections:

- innovative strategies for diagnosis and management in horticultural crops;
- emerging pests in horticultural crops;
- use of LAMP technology.

The purpose of the course is to familiarise trainees with the basic principles of LAMP as a diagnostic tool and to train them on in-field DNA extraction methods and common instruments/reagents of a LAMP assay. The course will provide trainees with the basis for designing, performing and troubleshooting a LAMP assay.

The training will be structured on two levels (Basic and Advanced).

For further information, please visit:

<https://www.eventbrite.com/e/emphasis-summer-school-tickets-34566975755?utm-medium=discovery&utm-campaign=social&utm-content=attendeeshare&aff=escb&utm-source=cp&utm-term=listing>

JULY
04

Dublin, IRELAND

EXHIBITION

ENABLE-S3 EXHIBITION: VALIDATION & TESTING OF COMPLEX AUTOMATED SYSTEMS

The EU-funded ENABLE-S3 project will be organising a public exhibition in Dublin, Ireland, on 4 July, 2018.

ENABLE-S3 aspires to substitute today's cost-intensive verification & validation efforts with more advanced and efficient methods to pave the way for commercialisation of highly automated cyber-physical systems.

At this public exhibition, ENABLE-S3 partners will present the key results after two years of project work. Visitors will have the chance to learn more about the key activities, gain first-hand insights into the prototypes from across six domains and meet the people driving this project.

This event will bring together stakeholders from funding authorities, industry and other EU projects.

What visitors can expect:

- first-hand insights into one of the biggest EU projects about verification & validation testing for automated systems;
- large exhibition presenting around 25 prototypes developed within this project;
- keynote speakers with diverse backgrounds;
- networking opportunities with experts representing funding authorities, industry and academia.

For further information, please visit:

<https://www.enable-s3.eu/news/enable-s3-exhibition-dublin-wednesday-4-july-2018>

EVENTS

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

JULY
04►06

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Kalkscheune Berlin, GERMANY

WORKSHOP

2ND HBP CURRICULUM WORKSHOP SERIES. ENTREPRENEURSHIP IN NEUROSCIENCE - TURNING SCIENCE INTO INVENTION & INNOVATION

The EU-funded The Human Brain Project will be organising a curriculum workshop in Berlin, Germany, on 4-6 July, 2018.

This 'hackathon'-style workshop is a hands-on intensive experience complementing the theoretical aspects of the online course on intellectual property rights, translation and exploitation of research.

Students will work in teams to assemble research proposals in brain science. Experienced entrepreneurs, top executives at the interface between academia and industry, and researchers from academia will present, mentor and advise on the translational aspects of the offered projects, including how to advance their proposal from lab to market, understand problems and define needs, choose or identify target populations, patentability options, and how to build a business model. Finally, students will present their proposals to industry and academia experts.

The workshop is a unique experience of diving into the entrepreneurial world, learning how to incorporate innovation and entrepreneurship mindsets and concepts into day-to-day research work and beyond.

For further information, please visit: <https://www.eventbrite.com/e/2nd-hbp-curriculum-workshop-series-entrepreneurship-in-neuroscience-turning-science-into-invention-tickets-38139610602>



research^{eu} Results Pack

CORDIS brings you the latest results from EU-funded research and innovation projects through our theme-specific Results Packs, including scientific breakthroughs and exciting new products and technologies.



Antimicrobial resistance

CORDIS delivers the latest results from EU-funded research and innovation projects via theme-specific Results Packs, including exciting scientific breakthroughs and fascinating new products, techniques and technologies.

Our latest Pack showcases 13 projects that are spearheading research combating antimicrobial resistance and the growth of 'superbugs'. For further information please go to: https://cordis.europa.eu/article/id/400927-new-weapons-to-combat-antibiotic-resistance_en.html



Construction skills

Our latest Results Pack focuses on five EU-funded projects based across Europe that have driven forward the BUILD UP Skills initiative. This aims to equip the next generation of construction sector workers – from manual labourers to design professionals and senior management – with the skills and knowledge needed to ensure building and renovation projects meet stringent energy efficiency requirements. For further information please go to: https://cordis.europa.eu/article/id/400910-new-skills-for-the-construction-sector-to-achieve-european-energy-targets_en.html



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