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Reform strategy to make
Europe
more innovative and
entrepreneurial

Drones soar up to clouds
to understand ice-formation
effect on climate

A unitary theory of metric
analysis
helps unveil structures within data

SPECIAL FEATURE
A SECURE AND HIGH-QUALITY
FOOD SYSTEM,
FROM FARM, FACTORY,
TO FORK

Editorial

Food for thought and getting primed for the year ahead – welcome to this month's Research*eu magazine

You'll be reading these words in January 2019 but officially this edition of Research*eu magazine is our bumper end-of-year-crossover issue straddling December 2018 and January 2019. So, with that in mind, we hope all our readers had an extremely relaxing and peaceful Christmas and New Year period, filled with fun, family, and of course, food. Which gives us a great hook into introducing this edition's **special feature** – December can be a glutinous month (with January of course being an attempt for many to make up for festive culinary sins), so we have focused our special feature not just on food, but efforts specifically aimed towards ensuring that the food we eat is both high-quality and, crucially, safe to consume.

In previous years, there have been some particularly high-profile cases of poor food safety standards across the world and closer to home. From the powdered milk crisis in China to the 2013 horse meat scandal in Europe, consumer confidence in the food system has been badly shaken. Our special feature highlights 7 EU-funded projects developing and/or utilising the most modern technologies to provide Europe with a safe, robust and high-quality food system.

Elsewhere, **Life After** catches up with Cellply, an innovative Italian SME that spearheaded the EU-funded **ONCOSMART** project that has developed a truly exciting *ex vivo* diagnostic system to help make personalised cancer treatment a reality. In **Project of the Month**, we feature the **OptiNanoPro** project that recently won a prestigious award for its new technology in the field of advanced nano-materials. And finally, check out **EU Agenda** to see which EU-funded project-led events and relevant international days are upcoming.

Looking towards 2019, we have an editorial calendar which we hope will be of immense interest to our readers – we'll be shining a light on topics as diverse as new treatments for rare diseases, the robot revolution, EU-funded efforts to better understand the vast cosmos, Europe's place in an increasingly chaotic international environment, and how tech is taking on terrorism... just to name a few of the exciting special feature topics to come in the months ahead!

As usual, if you'd like to send us your feedback, questions and/or suggestions, please send them to: editorial@cordis.europa.eu

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AGENDA



Pharmawizard: complete healthcare services in one app

There is an overwhelming number of drugs available on the market together with a lot of often unverified information. A mobile app, Pharmawizard, is making it much easier for consumers and medical staff to get accurate information on medication use and healthcare, and to save money when buying pharmaceutical products.

Health and medicine are the second most googled topics worldwide. Health markets are also highly fragmented and are influenced by various lobbies. This, combined with an ageing population putting pressure on already overstretched public health services, means that the need for information on medication use has never been greater.

The PW (Your digital source for medication awareness: "Your health is a choice, choose to know") project has used EU funding to develop a wide range of mobile app solutions to provide information to the public as well as players in the healthcare market. Citizens can 'intelligently' search, compare, purchase and manage medicines. Other end-users ranging from pharmacies and hospitals to pharma producers can assess their patients' needs and promote their products accordingly.

NO NEED FOR WIZARDRY WITH PHARMAWIZARD

Pharmawizard, currently available in Spanish and Italian, provides information on more than 19000 drugs and around 1330000 parapharmaceuticals in Italy alone. "We developed an integrated digital health solution that empowers citizens to better manage their day-to-day health particularly related to medications and preventative care. Users can engage in a reliable and seamless customer journey,"

emphasises Francesco Marcellino, project coordinator as well as founder and CEO of Datawizard SRL.

Data includes drug uses and side effects, interactions and symptoms. Helping to bridge the information gap between public institutions, professionals and patients, the app delivers the required facts in an innovative, user-friendly, personalised way. Possible benefits include decreases in healthcare spending, money savings for families and individuals, increased therapy adherence and preventing medicine-related errors due to lack of access to official medical information.

B2C, B2B AND B2B2C COVERAGE

Since the launch of the app, there have been 197000 downloads, and there are 53000 active users every month. Significantly, 16000 unique users have used the 'Therapy Management' feature for therapy adherence. Following PharmaNow's launch in April 2018, there were 507 purchase orders of medicine in the first month. From a fun/educational point of view, there is PharmaMemory, where gamers can learn about the body, health and common pathologies.

The Pharmawizard White Label provides services for two large insurance companies in Italy, the largest medical consulting firm globally and the biggest network of doctors for



home health assistance in Italy. To increase the scope of their network, partnerships with leading pharmaceutical and healthcare companies worldwide have been signed.

TESTING TIMES DURING PHARMAWIZARD DEVELOPMENT

According to Marcellino, the most challenging part of PW was to sort out how to commercialise the project. He believes the key to success is to design the right business model. "Thanks to this H2020 Innovation Action, we have realised the right business model for DataWizard SRL which will offer us a clear path to market and sustainable commercialisation," Marcellino concludes.

"Identifying the right target players in digital healthcare in Europe proved more complex than we initially thought," says Marcellino. Thanks to their marketplace awareness, PW concluded that insurance companies offering wellness and health insurance were well-positioned to lead in the digital healthcare revolution.

A TRULY GLOBAL FUTURE FOR PHARMAWIZARD

Presently active in Spain and Italy, the company foresees launching into Germany, France, Portugal and other EU countries. New features are in the pipeline and will help citizens travelling abroad find their medications in foreign countries. For example, an Italian travelling in China would be able to visualise the active ingredient of their drug in Standard Mandarin characters and show this to the pharmacist.

197 000 downloads



and 53 000 active users every month

Summing up the success of Pharmawizard, Marcellino emphasises, "What makes Pharmawizard truly unique is that our digital services are scalable at an exponential level without incremental costs, a significant benefit to large companies that serve millions of clients. We provide a way for technology to make existing systems more efficient, therefore cutting costs for patients and companies."

PW

- Coordinated by DataWizard SRL in Italy.
 - Funded under H2020-SME and H2020-SOCIETY.
 - cordis.europa.eu/project/rcn/201673
 - Project website: pharmawizard.es
- ▶ bit.ly/2zalP70

HEALTH

Bone-eating giant cell provides clues to brittle bones and other disorders

Understanding a super-cell that degrades bone will help develop therapies for bone diseases common in aging populations.

Bone-related diseases are the most common cause of severe long-term pain and reduced quality of life for millions of people. They include osteoporosis, periodontitis and rheumatoid arthritis – the number of people suffering from these conditions is set to increase substantially as Europe's population ages.

The EU-funded EUROCLAST (Exploring Functional and Developmental Osteoclast Heterogeneity in Health and Disease) project brought together over 30 specialists, including around a dozen PhD students from seven institutions and two companies, to examine cells known as osteoclasts. These cells are

responsible for bone degradation which is important for skeletal renewal and repair.

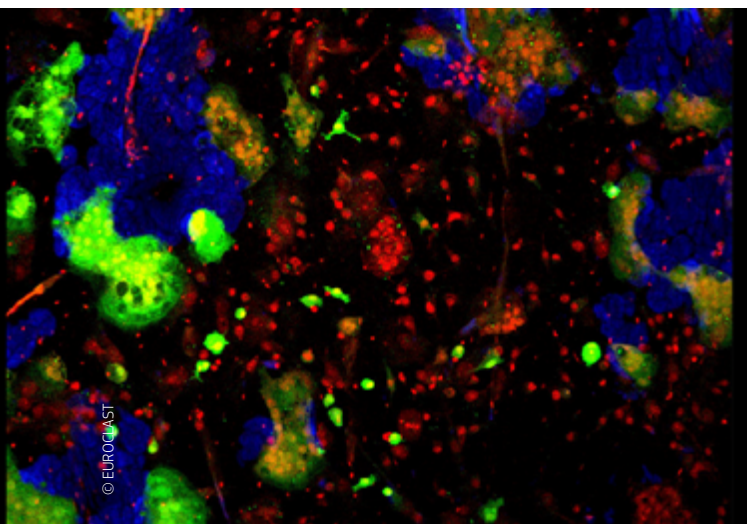
Most cells in the body have just one nucleus, but certain mononuclear cells fuse to form the super-large osteoclast cells which attach themselves to mineralised tissues such as bone and digest them. "All mineralised tissues can be digested by this cell," explains project coordinator Vincent Everts, a recently retired professor at the Vrije Universiteit Amsterdam in the Netherlands.

Investigating the precursor cells known as monocytes which fuse to form osteoclasts, "we found that osteoclasts differ according to the bone they digest or degrade. For instance, there is an osteoclast associated with the skull bone and a functionally different one associated with the long bones in the arm or leg," Professor Everts says. This is important in order to understand osteoclast effects in different disease states, occurring at different skeletal sites in the body.

OSTEOCLAST ACTIVITY

Osteoclasts lower the external pH (acidity) when attached to bone tissue which results in the mineral (calcium phosphate) being dissolved. This process is followed by the secretion of a number of enzymes that digest proteins in the bone. Too much osteoclast activity can result in lower bone density and brittleness as, for example, in osteoporosis patients.

By contrast, decreased osteoclast activity results in high bone density, as seen in the disease osteopetrosis where the bone becomes denser and hardens. "While this disease is rare, many key regulators of osteoclast activity have been identified by studying this terrible condition," says Professor Everts.



“Previously we were never able to visualise the inside of the cell in such detail but now we see what’s happening at different locations within it.”

Researchers were able to visualise this cell type using new types of electron microscopes used in other fields, which, in effect, slice the cell into a large number of sections producing a series of micrographs. "Previously we were never able to visualise the inside of the cell in such detail but now we see what's happening at different locations within it," he says.

A metabolic-labelling system was developed by the researchers to track how molecules and intracellular structures move and function within the giant cell, providing information on how bone degradation occurs, and which parts of the cell are actively involved in this digestion.

ASSAYS AND CELL DISCOVERY

Special assays were developed to analyse osteoclast activity in human serum – blood taken from patients – and investigate the enzymes expressed solely by these osteoclasts. This specific enzyme analysis technique is now being commercialised for diagnostic use.

The group's research also contributed to the discovery of cells that resemble osteoclasts. "The osteoclast is very difficult to culture and cannot be kept alive for very long," Professor Everts explains, "but if you have a cell that resembles the osteoclast, you can investigate osteoclast-like activity and the effect of inhibitors on these cells, or, alternatively, the effect of stimulating compounds, thus providing tools to investigate in detail how these cells function under normal and pathological conditions."

Such insights could pave the way for new diagnostic tools and therapies.

EUROCLAST

- Coordinated by VU Amsterdam in the Netherlands.
- Funded under FP7-PEOPLE.
- cordis.europa.eu/project/rcn/109790
- Project website: euroclast.eu

Catching up with ONCOSMART: Rolling out an innovative solution for better personalised cancer treatment

*In our special feature on blood cancer in issue 65 of Research*eu magazine, we interviewed the CEO of Italian SME Cellply, Dr Massimo Bocchi. He gave us a deeper insight into the company's novel ex vivo diagnostic system that would be the first ever fully-automated diagnostic system to evaluate the response of fresh tumour specimens to anticancer drugs in a clinical setting. More than a year later, we catch up with him to see how much further along the road to full commercialisation they've travelled.*

It has been a good year for Cellply. Back in September 2017, Dr Bocchi expressed his hope that in 2018 and 2019 the SME would be industrialising and clinically validating its *ex vivo* diagnostic platform on a larger set of patients – and thankfully it is happening!

"Indeed, we completed a pilot study on leukaemia that confirmed the performance we initially observed in predicting a patient's response to the treatment," Dr Bocchi explains. "We are now working on [the system's] commercialisation with a relevant partner in the medical manufacturing field. We also established important clinical collaborations in Europe to support our 2019 activities that will focus on expanding our clinical validation – both by increasing the number of patients enrolled

and by addressing multiple blood cancer types."

Regulatory clearance in Europe and the United States is still on the cards as well. "Our ongoing commercialisation and clinical studies are going to support the following certification process that will require further clinical studies dedicated to validation," Dr Bocchi says. "Our regulatory strategy is currently being updated to consider the EU's new *In Vitro* Diagnostic Device Regulation (IVDR) that is impacting on the certification pathway in Europe."

But what has really made a deep impact on Cellply's future ambitions for its impressive oncology diagnostic system was the news in May 2018 that it had been granted a further EUR 2.34 million through Horizon's 2020 Phase Two SME Instrument. "Our initial support from the European Commission will now continue with this new grant that will fund our commercialisation and clinical validation activities," Dr Bocchi enthuses. "Taking part in the SME Instrument programme has been



Dr Massimo Bocchi
CEO of Cellply
© Dr Massimo Bocchi

“Taking part in the SME Instrument programme has been a great opportunity in terms of not just funding but also visibility. It has allowed us to create important and vital relationships with relevant clinical and industrial partners.”

a great opportunity in terms of not just funding but also visibility. It has allowed us to create important and vital relationships with relevant clinical and industrial partners."

The new ONCOSMART (ONCOlogic patient profiling and personalized treatment through SMART bedside diagnostics) project grant officially began in September 2018 and will run until August 2020. Watch this space, as we'll definitely want to catch up with Dr Bocchi and his team again in another couple of years to find out more. In the meantime, we

wish Cellply all the best in their work to bring their diagnostic system – one that could potentially improve the treatment course of thousands of cancer patients throughout Europe – fully onto the market!

ONCOSMART

- Coordinated by Cellply SRL in Italy.
- Funded under H2020-SME, H2020-HEALTH and H2020-SOCIETY.
- cordis.europa.eu/project/rcn/207113
- cordis.europa.eu/project/rcn/217853
- Project website: cellply.com



Reform strategy to make Europe more innovative and entrepreneurial

Europe needs tailored reforms and interventions to rekindle and promote entrepreneurship as a vehicle towards more inclusive, innovative and sustainable economic growth.

Europe's entrepreneurial spirit needs to be encouraged if it's to get back on the road to sustainable and inclusive growth. "Making Europe more open to challenges by reforming its institutions to channel and give more access to essential resources: finance, knowledge and labour, for entrepreneurial ventures is what can reinvigorate growth, boost the transition to sustainability and stem the populist backlash that threatens the European project," says coordinator Mark Sanders from the EU-funded FIRES (Financial and Institutional Reforms for the Entrepreneurial Society) project.

FIRES focused on financial and institutional reforms for an entrepreneurial society in Europe. This will help to tackle the problem of the EU's lack of inclusive, sustainable and

innovative growth. "It's well understood that new business creation and experimental venturing are what bring innovation to the economy," explains Sanders. "Less well known, but equally important, is that entrepreneurship is essential in bringing about the major transition to more sustainable economic growth that Europe needs to make."

REFORM AGENDA TO STIMULATE ENTREPRENEURSHIP

The aim of the project was to first establish the need and inevitability of a tailored reform strategy. It was also crucial to recognise the strong historical path dependency in the process, as well as in the institutions that Europe has put in place to allocate the labour, capital and knowledge



“It’s up to policymakers to take up the challenges FIRES has identified and push forward with the tools created for promoting entrepreneurship in the EU.”

needed for entrepreneurial innovative venturing. To formulate well-founded proposals, FIRES brought together scholars from such fields as history, geography, law and economics.

The FIRES team produced a long list of potential interventions and selected reforms designed for Germany, Italy and the United Kingdom. It tailored the reform strategy to local contexts to show how various parts of the agenda can be relevant in different areas of Europe. In addition, the project presents an approach that can be repeated by other EU Member States.

STEPPING STONES TOWARDS SUCCESSFUL REFORM

Project partners designed a 7-step process to achieve a tailored reform strategy. It builds on the European regions’ rich and diverse history, assesses the bottlenecks in the entrepreneurial ecosystem and surveys relevant stakeholders in that ecosystem. Then, it proposes appropriate interventions from a menu of research-based policy proposals to improve the situation and assesses their legal context and political feasibility.

“A healthy entrepreneurial system is never finished,” notes Sanders. “Instead, it relies on positive feedback mechanisms: policymakers should thus evaluate and experiment, enabling the return to step one for the next iteration of possible reforms.”

The 7-step method is applicable to European, national, regional or local levels of governance. “We view this as a sound method that policymakers can use in tailoring a reform strategy to strengthen the entrepreneurial ecosystem,” he stresses.

FIRES also developed analytical tools to assess the viability and functioning of the entrepreneurial ecosystems in Europe. These tools identify strengths and weaknesses and evaluate the processes of venture creation and company formation across European institutional contexts.

The project ended in mid-2018, but the work has only just begun. “It’s up to policymakers to take up the challenges FIRES has identified and push forward with the tools created for promoting entrepreneurship in the EU,” concludes Sanders.

FIRES

- Coordinated by Utrecht University in the Netherlands.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/rcn/194574
- Project website: projectfires.eu
- bit.ly/2JmScoq

If you’ve enjoyed this edition’s special section on achieving a high-quality and secure food system, then check out our dedicated **RESULTS PACK ON FOOD SYSTEMS TRANSFORMATION** which we published earlier in 2018!

Browse, download or order this Pack on our website at:
cordis.europa.eu/article/id/400948



Europe's Muslim minorities under pressures of accountability and marginalisation

Following the 9/11 attacks in 2001, Europe's Muslim minorities have increasingly been put under pressure to speak out against terrorism and to denounce 'Islamic violence'. A recent study offers critical insights into the related marginalisation of Muslims in Europe and how they try to resist this.

The MUSLIM-NLNO (Muslims condemning violent extremism – An interdisciplinary analysis of public initiatives in the Netherlands and Norway 2001-2015) project, financed through a Marie Skłodowska-Curie (MSC) grant, explored recent developments in public debates in the Netherlands and Norway. The aim was to discover “what motivates Muslims to publicly speak up against violence committed in the name of Islam, how they try to convey their message through different forms of media, and how these statements are received in society,” says project fellow Dr Margaretha van Es.

The researcher considered archival material and undertook a multiple case study to explore in depth specific initiatives by Dutch and Norwegian Muslims over the period from 2001 to 2016. Two examples are the large protest march against ISIS, organised by Muslims in Oslo in August 2014, and the social media campaign #NietMijnIslam (#NotMyIslam) started by five Moroccan-Dutch friends after the 2015 Charlie Hebdo attacks in Paris. Dr van Es also conducted interviews with Muslim men and women actively involved in these initiatives. “What made this project particularly innovative,” she notes, “is that it paid attention not only to the discourses and practices through which Muslims are stigmatised and marginalised by the dominant majority, but also to their ‘strategies of resistance’: how do Muslims try to strengthen their position and find acceptance as equal citizens?”

A RESPONSE TO AND CRITIQUE OF ACCOUNTABILITY

The research findings indicate that “Muslims have spoken up against violent extremism far more often than what



is commonly acknowledged in public debate,” the MSC fellow states. A particularly important research finding, Dr van Es explains, is that statements made by Muslims against violent extremism often serve as a multi-layered critique. “Muslims ‘talk back’ not only to extremists who commit violence in the name of Islam, but also to stereotypical representations in Western societies of Islam as a violent religion, and to the unabated pressure on Muslims to prove that they are peaceful and loyal citizens.”

Interestingly, the MUSLIM-NLNO project also uncovered a gender factor with respect to the wider society's reception of Muslims' statements against violent extremism.

“*Muslims have spoken up against violent extremism far more often than what is commonly acknowledged in public debate.*”

“It seems that statements made by women are more easily believed, but given less weight by members of the dominant majority than statements made by men,” Dr van Es reveals.

FILLING IN A RESEARCH GAP

MUSLIM-NLNO has contributed a new and important perspective to this growing body of research through its consideration of Muslims’ efforts to resist marginalisation. Dr van Es also highlights the fact that “little attention is being paid to the vast majority of European Muslims who do not support violent extremism, but who face continuous pressure to clarify their stance and speak up against terrorism.”

Project results have been actively disseminated to create more awareness. A conference on ‘Religious Minorities’ Self-Representations: Claims of Difference and Sameness

in the Politics of Belonging’ was organised in 2017. This resulted in a series of blog posts by different conference participants, available on the ‘Religious Matters’ website hosted by MUSLIM-NLNO Project Manager Professor Birgit Meyer. A peer-reviewed article was published in the Journal of Muslims in Europe in 2018, and more papers are being prepared for future publication.

Outreach to non-specialist audiences included a panel debate in Utrecht in 2018, held in collaboration with various Dutch-Muslim youth organisations. During the event, four panellists discussed how their struggle against Islamophobia intersects with different struggles against sexism, anti-black racism and sectarianism among Muslims.

MUSLIM-NLNO

- Coordinated by Utrecht University in the Netherlands.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/201101

SOCIETY

Uncorking Ancient Egypt’s wine heritage

Europeans who enjoy wine might spare a thought for the ancient Egyptians, for whom wine was rich in religious symbolism.

Many people think of wine as quintessentially Greco/Roman, although winemaking actually predates the Greeks by at least 4 000 years. Much of winemaking’s hitherto-neglected history involves the ancient Egyptians.

The EU-funded EGYWINE (Ancient Egypt’s Wine Rebirth) project studied Egyptian winemaking and preservation between the predynastic (3800-3300 BCE) and New Kingdom (1539-1075 BCE) periods. The team will use the genetic analyses of wine residues in ancient containers to infer Egyptian winemaking techniques.

The study also drew upon an unusual kind of ancient text. During its New Kingdom period, Egypt manufactured amphorae (60-cm ceramic bottles, with handles) to contain wine. The containers were inscribed in hieratic script, an everyday, cursive form of hieroglyphs. The inscriptions served the same function as today’s wine bottle labels, and helped in the selection of a good wine. The inscriptions included type of product, year of vintage, quality and sweetness, geographical origin, type of ownership (royal, temple or private), and the winemakers’ details. Analysis of the inscriptions, combined with separate analysis of the



“ Egyptians saw a connection between wine’s red colour and the blood of Osiris, god of the underworld and afterlife. Grapes and wine in Egyptian culture therefore symbolised revitalisation and rebirth. ”

CEREMONIAL DRINK

Egypt had a very organised system of wine production. Yet, the product was seen as a luxury, suitable for religious ceremonies. Pharaohs and priests used it for temple offerings. Large wine jars displaying the royal seal found in tombs from the Predynastic period (ca. 3800 BCE) at Abydos and Saqqara were interpreted to mean that the wine was meant for the deceased in the afterworld. From the Early dynastic period (ca. 2950 BCE), wine was also consumed during funeral ceremonies. Royalty and the nobility also enjoyed wine at banquets and during festivals.

It seems likely that Egyptian use of wine ended with the dynastic period around 343 BCE. The Greeks probably picked up Egyptian winemaking traditions during their rule of Egypt from 305 BCE.

In other results, the project team created a ‘Wine of Ancient Egypt’ website that elaborates on the above aspects of wine in Egyptian life. The site includes an interactive archaeological map of Egypt, showing wine-related scenes from tombs.

When the final results are published, the EGYWINE project will have revealed new information about Egypt’s winemaking heritage. This will include how the techniques evolved over time and ultimately influenced European winemaking. Wine is one of countless Egyptian legacies still alive in Europe.

jars’ ceramics, will help trace the diffusion of winemaking techniques to Europe.

ANCIENT MATERIALS, MODERN BOTTLENECKS

EGYWINE suffered setbacks and delays, and therefore has not yet reported the results of its analysis. “Over the last few years, exporting ancient material from Egypt to other countries has become impossible,” explains project lead researcher, Dr Maria Rosa Guasch-Jané, “and our lab is in France.” Thus, the project has completed neither the sampling of ancient grape residues nor their genetic analysis. The team is currently documenting its analysis of the amphorae inscriptions.

Nevertheless, the project’s preliminary literature review of archaeological evidence reveals considerable information about the role of wine in Ancient Egypt. Tomb-wall paintings are one of several sources of information as they often depict grape harvesting, winemaking and religious ceremonies.

“Egyptians saw a connection between wine’s red colour and the blood of Osiris, god of the underworld and afterlife,” says Dr Guasch-Jané. “Thus grapes and wine in Egyptian culture symbolised revitalisation and rebirth.”

EGYWINE

- Coordinated by Sorbonne University (Paris IV) in France.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/200870
- Project website: wineofancientegypt.com/the-project



TRANSPORT AND MOBILITY

Major advance in EU-wide travel

The way we use and pay for both local and cross-border travel is set to drastically change over the next few years. This is thanks to advances in technology and an exciting new approach to public transport.

Travellers are making increasing use of sophisticated electronic ticketing (e-ticketing) systems and journey planners. However, if they wish to travel to a different country, they must familiarise themselves with the local smartcard system, the cost of transport, and the best way to pay.

The solution to seamless cross-border travel lies in interoperable e-ticketing systems that exchange data and share information. The EU-funded Horizon 2020 ETC (The European Travellers Club: Account-Based Travelling across the European Union) project has developed the technical systems and determined the required governance to achieve this goal using the concept of account-based travelling (ABT).

This idea takes passenger and ticket information from a smartcard and places it in an 'account' on the cloud. In essence, the ticket is in the account not on the card.

Moreover, using this interoperable ABT concept does not require EU-level regulation. "ABT is recognised as the next step for many e-ticketing schemes," says project coordinator Roel Testroote.

SCHEMES JOIN UP

Project partners encouraged e-ticketing schemes and transport operators to embrace ABT. "The European Travellers Club (ETC) system can reside next to the existing ticketing system that is implemented in the country," explains Testroote. "We have developed standards, processes and technologies that are freely available to all interested parties, while receiving the benefits of interoperability," he adds.

The objective is to allow more schemes (or 'travellers clubs') in Member States and regions to recognise each



“Feedback from our pilot schemes is very positive about the advantages that cross-border and mobile-enhanced travelling can bring. Half of the respondents claimed they used public transport abroad more often thanks to ETC.”

other through the trust framework established by the ETC. This will enable travellers to seamlessly use their existing account across borders and schemes. According to Testroote: “Once this has reached a critical mass with the associated number of travellers, even those transport operators or schemes that are reluctant to join now, will have a strong incentive to participate.”

EXPERIENCE ABT IN THE LAB

Researchers developed a pilot in Germany to demonstrate ABT utility for both regional and cross-border travellers using on-line planned and booked tickets and a pilot in the Netherlands based on Pay-As-You-Go. Another pilot based in Luxembourg demonstrates the integration of transport and non-transport services (such as parking) through ABT. Testroote observes: “Feedback from our pilot schemes is very positive about the advantages that cross-border and mobile-enhanced travelling can bring. Half of the

respondents claimed they now use public transport abroad more often thanks to ETC.”

The systems developed by ETC are tested at the European Travel Lab, which is located within the Amersfoort train station in the Netherlands and acts as a permanent demonstration facility for informing the public, stakeholders and local authorities. “During a visit to the lab you can experience account-based travelling and get travel information immediately on your smartphone by using your home cloud-based account,” claims Testroote. “With our solution you can travel across borders using your own existing travel card and integrate other functions in the account-based system like parking.”

ETC’s ticketing solutions could make travelling seamless, resulting in greater use of public transportation and increased cooperation between transport authorities within Europe. An interoperable ABT system can contribute to more sustainable means of travel and help improve the quality of life of EU citizens.

ETC

- Coordinated by the ACCEPT Institute in the Netherlands.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/193375
- Project website: europeantravellersclub.eu

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Cross-border collaboration positions Latvian university as regional expert in smart transportation

Through cross-border collaboration and knowledge sharing, the EU-funded ALLIANCE project is positioning one Latvian university as a regional leader in smart transportation.

Latvia is working to establish itself as a leader in innovative transportation. At the centre of this strategy is the country's Transport and Telecommunication Institute (TTI) – a hub of scientific and technological know-how.

To help raise the institute's profile in the field of smart and sustainable transport, the EU-funded ALLIANCE (Enhancing excellence and innovation capacity in sustainable transport interchanges) project is linking TTI and its staff with two internationally recognised European research entities: Greece's University of Thessaly (UTH) and Germany's Fraunhofer Institute for Factory Operation and Automation (IFF).

To learn more about ALLIANCE's ongoing work, we sat down with two researchers heavily involved in the project – TTI professor and ALLIANCE project coordinator Irina Yatskiv and IFF's Klaus Richter.

What does the project aim to achieve?

Yatskiv: The ALLIANCE project is working to enhance the innovation capacity of TTI. Our end goal is to establish it as a leading research and innovation hub in the field of interconnected transportation systems – both at the national and regional levels. To accomplish this, we are working closely with our partners at UTH and IFF to organise training, staff exchanges, collaboration in research and publications, and general knowledge exchange.

Did you succeed?

Yatskiv: To buy into the design and development of sustainable transportation systems, Latvian authorities and businesses must first trust their national experts, including TTI. For this reason, representatives of the Department of Finance and Development Planning at the Ministry



of Transport and the Riga International Bus and Coach Terminal are all part of ALLIANCE's Scientific Excellence and Innovation Assurance Panel (SAP). They also actively participate in the project's train-the-trainer seminars and public discussions.

Furthermore, representatives of the City of Riga and Riga Airport are actively involved in ALLIANCE's collaborative research teams. And special round tables with representatives from various Latvian logistic centres were also organised.

By bringing government authorities and transport-related businesses into the project and having them work alongside TTI researchers, the ALLIANCE project successfully established TTI scientists as experts in the field of smart transportation. Having helped actual transport entities



Hon.-Prof. Dr.-Ing. Klaus Richter
Material Handling Engineering and
Systems Manager of IFF
© Klaus Richter

“ *The ALLIANCE approach to collaboration could serve as the gold standard for enabling cooperation and discussion on a common problem between different stakeholders, without jeopardising their identical expertise.* ”

address actual problems, these researchers now have the credibility to offer their services in Latvia and throughout the surrounding region.

What do you think have been the most important results that have emanated from this collaboration?

Yatskiv: One of the most important outcomes of the project thus far is the creation of the Sustainable Transport Interchanges Program (STIP). Based on a gap analysis, STIP looks at planned development of the Latvian transport networks and defines the required knowledge and skills. This process has led to the development of 12 new training courses in passenger and freight transport that help cover the identified knowledge and skill gaps that must be filled before these planned projects can be implemented.

Richter: Moreover, the digital format of the STIP could be understood as one significant contribution to the project's overall legacy. The first step was the development of the new training material in sustainable transport interchanges, curated and coordinated by UTH. The second step was the transformation of STIP to e-learning content, which is now accessible by all interested parties in manageable self-learning units.

The vision for the future is that the e-platform will enable a sustainable, barrier-free dissemination of up-to-date knowledge in the area of sustainable transport interchanges on a multidisciplinary level. It could also function as a collaborative working base between education, research and business.

Can you provide an example of how the project's partners contributed to the STIP?

Richter: IFF's focus was on sharing information on the use of state-of-the-art technology in the field of smart transportation. For example, we see the next level of ICT being its integration with the Internet of Things (IoT), which

will have a substantial impact on logistics and transport services. During the project, we saw how the logistics processes at Riga Airport could benefit from an IoT-enabled Smart Logistics Zone – a design framework for the optimal interaction of logistics, processes and systems. From this analysis, we created a blueprint for using IoT devices for the efficient management of equipment at airports. This plan was then shared through the ALLIANCE STIP.

Have you had to overcome any unexpected challenges throughout the project?

Richter: Whenever you engage in cross-border projects, some cultural challenges are bound to arise. As all the ALLIANCE partners come from different countries, we each have a different understanding of and approach to transport and logistics. For instance, in Germany, we view transport logistics as part of the entire supply chain. For this reason, we tend to take a systemic approach.

Regardless of these differences, I feel that the discussions between the project partners were fruitful and successfully integrated our different levels of expertise. In fact, the ALLIANCE approach to collaboration could serve as the gold standard for enabling cooperation and discussion on a common problem between different stakeholders, without jeopardising their identical expertise.

What are you most proud of from the project?

Yatskiv: ALLIANCE established a new way for research organisations and the business community to collaborate. As a result, we see that demands for TTI consulting services have increased. For example, we already have some requests for collaboration from Riga Airport. Furthermore, the project continues to raise interest in finding integrated solutions for Riga's transport system.

Was it only TTI that benefited, or did the partners also benefit from the collaboration?

Richter: The project's multidisciplinary and integrative approach, which represents the common thread of the project, also led to the transfer of best practices in applied PhD workshops from Germany to Latvia. Researchers and professors from different departments of Fraunhofer IFF were also involved in the project's activities, taking over the doctoral supervision of TTI PhD students, for example. Fraunhofer was also able to extend its work in applied research by adding tasks in the area of education and qualification, considering the specifics of Latvian and Baltic transport and logistics systems.



Dr Irina Yatskiv
Project coordinator of ALLIANCE
© Irina Yatskiv

I must mention that an ALLIANCE research team consisting of doctoral students and researchers from Fraunhofer IFF, TTI and Grenoble Alpes University (France) was honoured with the “Best Paper Award 2017” at the 14th International Multidisciplinary Modelling & Simulation Multiconference.

What’s next for the project?

Yatskiv: My hope is that ALLIANCE improved, to a measurable and significant degree, the overall scientific and innovation capacity of TTI in the area of interconnected

transportation systems. As a result, TTI will be more visible in the global transportation research community. But the legacy of the project is our researchers, common articles, mutual understanding and the desire to work together. Maybe this collaboration will result in a new project?

ALLIANCE

- Coordinated by the Transport and Telecommunication Institute in Latvia.
- Funded under H2020-Spreading excellence; widening participation.
- cordis.europa.eu/project/rcn/199367
- Project website: alliance-project.eu

TRANSPORT AND MOBILITY

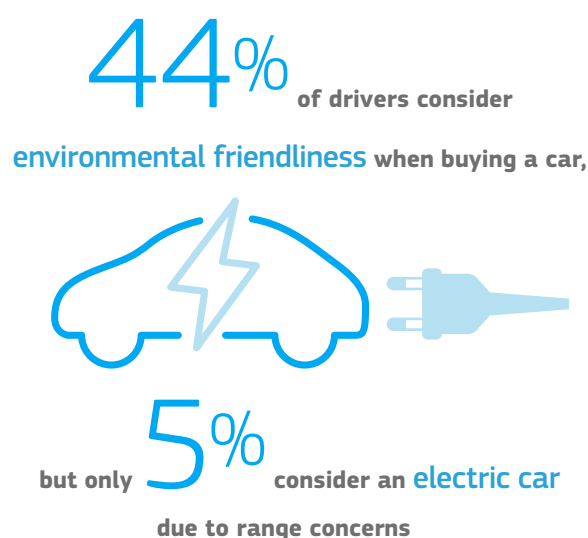
Extending the range of electric vehicles

To encourage the greater adoption of electric vehicles, researchers with the EU-funded CREEV project are developing an innovative range extender technology aimed at overcoming the key barrier of range anxiety.

On paper, the electric vehicle (EV) looks well-positioned to become the future of transportation. In terms of breaking our dependence on fossil fuels, decreasing carbon emissions and lowering noise levels, the EV seems to tick all the right boxes. So, what’s the catch?

“The world is yet to see the benefits of large-scale electric vehicle adoption as fears over range anxiety remain a key barrier for purchase,” says Nathan Bailey, Project Coordinator of the EU-funded CREEV (Novel Compound Rotary Engine Range Extender for Electric Vehicles) project. “As a result, while 44 % of drivers consider environmental friendliness an important factor when buying a car, only 5 % even consider an EV due to range concerns.”

Traditionally, EV manufacturers addressed this issue using range extender engines. However, existing extenders tend to be too large and offer insufficient power density, thus



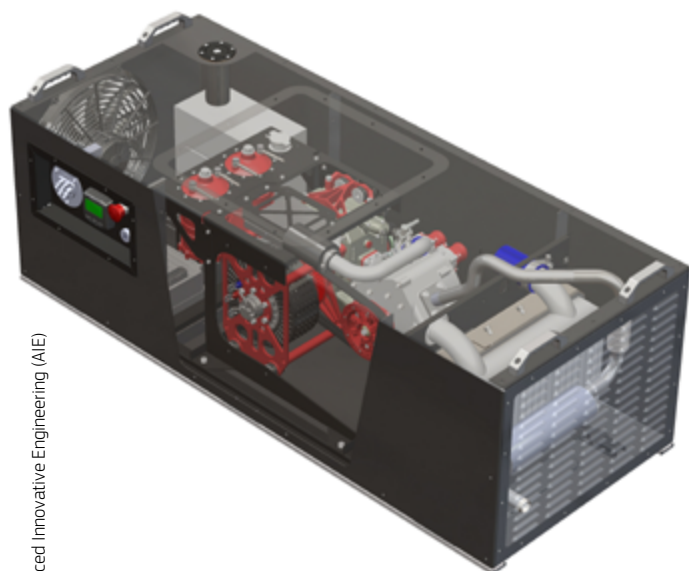
limiting their use in small commercial and domestic vehicles where space remains a premium.

What manufacturers need is a breakthrough innovation in EV range extender technology that significantly improves power density while also providing high-efficiency and low emissions, noise and vibration. What they need is CREEV.

“By taking advantage of available rotary type engines for compact applications and applying CREEV’s patent-protected innovations, we created a novel, high-efficiency, low-emission compact rotary engine range extender for electric vehicles,” explains Bailey.

AN ENABLING TECHNOLOGY

Rotary engines offer many advantages, including their small size, low weight, limited vibration and high-power density. But due to their significant exhaust energy, heat and emissions, these engines have been overlooked as a possible EV solution. However, these limitations can be overcome by pairing the rotary engine with a rotary exhaust expander unit like CREEV.



© Advanced Innovative Engineering (AIE)

For example, by expanding the gas to near atmospheric pressure before it leaves the expander unit, CREEV reduces overall engine noise and heat. CREEV then acts as an exhaust reactor, consuming unburned exhaust products during the expansion process and reducing the emissions of HC, CO and NOx. Furthermore, because the expansion of gas is controlled within a secondary rotor chamber,

“ I am confident that CREEV will soon see wider use in the light commercial EVs of today and the autonomous ones of tomorrow. ”

exhaust energy that would otherwise be lost is recouped back into the engine drive. This alone increases the overall efficiency of the engine package by up to 20 %.

“A compact solution, CREEV adds to the existing advantages of the rotary engine’s low weight, smooth operation, efficient recharging capacity and small size,” says Bailey. “It has proved to be a vital enabling technology for extending the range of pure-electric vehicles, where battery technology is still very limited in terms of range, weight and re-charging time.”

ATTRACTING SIGNIFICANT INTEREST

With the market for EVs in Europe growing by 1 300 % in the last two years, CREEV offers a market opportunity worth an estimated EUR 79 million over six years. Not surprisingly, the project has attracted significant interest, including from a large OEM. Currently, project researchers are working with the OEM to develop a road-worthy, pure-electric van that will serve as a test-bed for demonstrating the benefits of implementing CREEV into hybrid electric vehicles.

“We continue our engagement with EV OEMs and operators, testing and refining our solution,” adds Bailey. “As a result of this ongoing work, I am confident that CREEV will soon see wider use in the light commercial EVs of today and the autonomous ones of tomorrow.”

CREEV

- Coordinated by Advanced Innovative Engineering (UK) Ltd in the United Kingdom.
- Funded under H2020-LEIT-ICT, H2020-SME and H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/205027
- Project website: creev.technology
- bit.ly/2Psugp7



Drones soar up to clouds to understand ice-formation effect on climate

EU-funded scientists used instrument-bearing drones to investigate the effect of aerosols on ice crystals in clouds which are thought to affect climate and climate change.

The interaction between clouds and aerosols is believed to play an important role in climate change, but its relevance is poorly understood. The EU-funded BACCHUS (Impact of Biogenic versus Anthropogenic emissions on Clouds and Climate: towards a Holistic UnderStanding) project brought together 20 institutions and organisations from a dozen countries – more than 60 researchers specialising in clouds containing ice – to investigate how aerosols alter cloud properties and affect precipitation.

Aerosols result from human activities or occur naturally as dust, pollen, fungal spores, bacteria or marine organics. “We investigated the importance of biogenic (natural or pre-industrial) versus anthropogenic (human-made) emissions

for aerosol-cloud interactions in regions that are key regulators of the Earth’s climate, such as the Amazon rain forest or the Arctic,” said project coordinator Ulrike Lohmann, Professor for Atmospheric Physics at the Institute for Atmosphere and Climate Science, ETH Zurich, Switzerland.

“Very little data is available for many of these regions, particularly over oceans,” she notes. “To start with we wanted to know what fraction of the cloud is composed of water droplets versus ice crystals and then how this was affected by aerosols.”

In Europe’s mid-latitudes, even low-lying clouds can contain ice; this is significant because ice clouds precipitate more readily and influence the radiation budget more than water clouds. This balance between radiation from the sun and what the Earth radiates back is an important equation in climate-change modelling.

INNOVATIVE USE OF DRONES TO STUDY CLOUDS

As well as using satellite remote-sensing measurements and data from the ground, research vessels and large

research aircraft, the project also used drones. These were equipped with commercially available lightweight temperature, humidity and aerosol sensors and sent a few kilometres into the sky. This was the first time scientists used drones for this kind of vertical profiling, enabling the project to take measurements that are more representative of the atmospheric conditions of ice formation in clouds than ground-based measurements.

Drones are preferable to research aircraft, which fly too fast through cloud. "You get only a few measurement points using aircraft," she says. "Drones are light and highly flexible. They can also facilitate more frequent cloud measurements in different locations around the world, particularly remote regions where data is missing."

UNIQUE DATABASE ON ICE CLOUDS

The drones were first used over a remote location in Cyprus, where the air is often laden with desert dust. The information was fed into a unique database on ice clouds, bringing together long-term observations and field data on cloud microphysical properties, ice-nucleating particles around which the crystals form and aerosols.

"There are databases for aerosols, and databases for all meteorological variables, but a database for ice-nucleating particles did not exist. We built it from scratch," Professor Lohmann says. The first commercially available instrument

for measuring ice-nucleating particles, based on a design developed by the project's researchers, only became available a few years ago. "It is a very young discipline," she explains.

With analysis of Greenland ice cores, the BACCHUS database will include data on the pre-industrial period going back to around 1300 AD.

A BACCHUS team circumnavigated the Antarctic on the research vessel Akademik Tryoshnikov to collect data for polar climate models. "We were able to get many measurements of ice-nucleating particles in a previously under-sampled area of the Southern Ocean," Professor Lohmann says.

"We also wanted to see how important future Arctic ship traffic could be for clouds and how much ship pollution matters in such a pristine environment." So far results have been too diverse to derive conclusions, partly due to uncertainty about the sources and longevity of natural aerosols.

BACCHUS

- Coordinated by ETH Zurich in Switzerland.
- Funded under FP7-ENVIRONMENT.
- cordis.europa.eu/project/rcn/110886
- Project website: bacchus-env.eu

CLIMATE CHANGE AND ENVIRONMENT

Citizen science and improved modelling for a better understanding of climate dynamics

Given the need for a consistent picture of climate variability, the EU-funded CLARITY project borrowed methods from statistical physics and drew on the power of citizen science to point the way forward.

CLARITY (Uncovering information in fluctuating CLimate systems: An opportunity for solving climate modeling nodes and assist local community adaptation measures)

set out to uncover information about data fluctuations in climate records using the two most prominent providers of global datasets used to track temperature anomalies.

This data was then used as input for a Bayesian modelling strategy to improve modelling reliability.

The team found that even if the data provided by these two products comes from the same sources – recordings from global ground meteorological stations – their different methodologies paint different pictures of the long-term dynamics of global temperature anomalies. They therefore propose that future investigations should cross-check such statistical analyses with corresponding results obtained from actual observations. They also propose that meaningful analysis should take into account the methodology underpinning the data preparation.

Towards this end, the project collected contemporary climate records, crowd-sourced in the city of Venice.

STATISTICS AND MODELLING

Most basic statistical characterisations are linear – that is, they trace transformations over time in a deterministic way with one data point leading ineluctably to another. However, dynamic systems such as climate patterns simply can't be adequately reduced to this account. One of the biggest challenges when trying to make climate change projections is to accommodate fluctuations and anomalies within longer-term trends.

“CLARITY’s community-oriented approach helps bring about socially relevant climate science, collecting public data for a more inclusive discussion about adaptation. It could be extended to future public planning and policy design to engage end-users in all stages of data assessment.”

Based on previous successes with similar complex systems, the two statistical methods used by CLARITY to attempt this were detrended fluctuation analysis (DFA), and wavelet transformations (WT) analysis. These methods are generally used to characterise the so-called long-term persistence (LTP), also called long-term correlations of records from complex systems. They both do so by measuring fluctuations of the record around a certain trend line, in time windows of different lengths.

These methods were applied to global temperature anomalies and other climate data as project supervisor, Prof. Angelo Rubino, elaborates, “Because DFA and WT systematically eliminate linear trends in the data, combined they enable an assessment of how systems – in this case climate patterns – behave over longer periods of time, allowing us a fuller picture.”



To reduce uncertainty, or error, the data was then exposed to Bayesian modelling, which applies a formula to a given dataset to find an optimal model for representing this data. As Prof. Rubino elucidates, “What is unique about this modelling is that it incorporates not only data, but also additional sources such as expert opinions, as further input in its quest to find the best fitting model.”

CROWDSOURCING FOR ALL THE DATA UNDER THE SUN

Another part of the project's work was to collect contemporary climate data crowdsourced from the city of Venice and surrounding towns.

These community-centred efforts included measuring the ambient UV index with static sensors deployed in the terraces, yards and roofs of schools, universities and a hospital, as well as other assorted outdoor spaces accessible to supporters of the project. Additionally, solar UVA and UVB radiation and personal exposure to solar UV radiation (pUVR) were continuously measured with sensors worn by volunteers, including tourists.

The DFA and WT analysis of the UV data is still to be undertaken, but the team has applied these methods to the pUVR data and is gaining a greater insight into patterns of individual behaviour under the sun, such as the duration of overall exposure and duration of periods spent outside.

FROM UNDERSTANDING TO ACTION

CLARITY's scientific results help deepen our understanding of the complex interactions driving the processes of climate change which could lead to more efficient adaptation and mitigation strategies, in light of the European commitment to the Paris Accord.

The project's use of DFA and WT statistical analysis to understand climate data is an approach which can be replicated for other climate systems or datasets, both to produce specific measures for data dynamics, and to use those to test the accuracy of climate models.

Prof. Rubino is also keen to point out the possibilities for citizen science, saying, “CLARITY's community-oriented approach helps bring about socially relevant climate science, collecting public data for a more inclusive discussion about adaptation. It could be extended to future public planning and policy design to engage end-users in all stages of data assessment.”



PROJECT OF THE MONTH

Addendum

We'd like to clarify some points about last issue's Project of the Month that highlighted the CARESSES project. The Pepper robot which appeared at the UK House of Commons Select Committee, whilst owned by the CARESSES consortium member, the University of Middlesex, was not itself equipped with CARESSES-specific software. Rather, the software has been installed in another, similar Pepper robot that has been developed by four other CARESSES project partners: The University of Genova, Orebro University, SoftBank Robotics and JAIST University in Japan.

We apologise for any confusion and we wish the CARESSES project the very best in a truly fascinating field of research.

CLARITY

- Coordinated by Ca' Foscari University of Venice in Italy.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/200979



SPECIAL FEATURE

A SECURE AND HIGH-QUALITY FOOD SYSTEM, FROM FARM, FACTORY, TO FORK

Editorial

“Food is our common ground,
a universal experience” (James Beard)

One of the key ingredients for any visit to our Old Continent organised by non-Europeans is usually to throw themselves enthusiastically into Europe's rich culinary culture. And Europeans are indeed deeply passionate about food to the point where many traditional dishes are lavishly entwined into our sense of national identity – think of Italian pizza, Polish pierogi, British fish and chips, Austrian schnitzel, to name but a few.

However, how Europeans source, purchase and even think about their food consumption has undergone radical changes over the last two decades. Consumer habits and expectations towards food have radically changed, with increased interest in organically-sourced ('bio') products, locally-sourced products to support local economies, and a desire for more vegetarian/vegan options. Consumers now expect to be able to evaluate the nutritional value of products through clear and precise labelling. In part responding to these changing societal expectations, European-level legislation has ensured that the European food system has amongst the highest standards in the world with regards to food safety.

But challenges remain. Following several international and European food safety scandals, such as the widely publicised 2013 horsemeat scandal, and the 2017 tainted eggs scandal that originated in the Netherlands, European confidence in the safety of the food system was shaken.

Therefore, guaranteeing high food safety standards has been the focus of some of the EU-funded projects that we're featuring in this month's special feature. For example, the **STEFY** project has successfully developed a new generation of fast, portable and multi-parameter food safety devices which will be deployed in the wine and flour/cereal industry to identify mycotoxins and allergens. Meanwhile, the **FieldFOOD** project has brought new technology that could decontaminate tainted food with an electric pulse closer to commercial viability, and the **BINGO** project has explored the use of biological control of pests as an alternative to chemical pesticides.

Food safety is of course of paramount importance, but in this special section we also wanted to highlight how innovative projects are also focusing their attention on increasing the quality of food and meeting the demands of consumers outlined above. Going 'back to basics' and returning to traditional methods appears to be the key here. The **TRADITOM** project has investigated the characteristics of traditional tomato varieties and found how their great taste can complement the mass production and cost effectiveness of producing one of Europe's most staple fruits (not a vegetable!). Finally, the **TREASURE** project has aimed to help European consumers to rediscover traditionally-used pig breeds and their healthy, high-quality meat products.

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

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A 20-minute test for uncompromising food safety

An Italian SME has successfully completed the development of a new generation of fast, portable, multi-parameter food safety testing devices. These devices will help the wine and flour/cereal industry identify mycotoxin and allergens – and this is just a start.

A growing world population, international trade and rising consumer demand for high-quality and ever-safer products are putting the food industry under great pressure. Never have food safety monitoring systems been so crucial, and never have they seemed less up to the task either.

In such a context, it seems only right for the sector to crave multi-parameter, onsite, fast and flexible testing devices, as opposed to currently available in-lab benchtop equipment and fast but imprecise onsite test devices. The first company to meet these requirements certainly has a bright future ahead, and Italian SME Proxentia – a spin-off of the University of Milan – is well aware of it.

In 2014, Proxentia was granted EU funding for a feasibility study on its innovative portable food testing device, capable of detecting allergens and mycotoxins in a liquid matrix. Now, they've just completed phase 2 of this SME Instrument-supported project, and they are getting ready to enter the wine and cereal markets.

"The STEFY project is about providing easy, precise and reasonably priced measurements of food safety at production sites which cannot be obtained with present technologies," says Matteo Salina CEO at Proxentia, continuing: "Our patented Reflective Phantom Interface (RPI) technology exploits the basic optical properties of light reflection. When a light beam hits the interface between distinct materials, a reflected beam is produced. The technology immobilises particular receptors on tiny spots of the sensor surfaces,

“ Our patented Reflective Phantom Interface (RPI) technology exploits the basic optical properties of light reflection. ”



receptors selectively ‘capture’ the target molecules whose presence and/or concentration must be determined, and the reflectivity of the spots gives a direct, quantitative and real-time measurement of the amount of captured target molecules. We can measure and quantify tens of molecular targets simultaneously, each by a distinct spot.”

STEFY (Sensor Technology for Food analysis) also stands out through its portability and cost-effectiveness. It is composed of three main components: single-use cartridges to detect and quantify multiple molecular targets in a liquid sample; a compact reader performing the analysis thanks

to Proxentia’s RPI technology and sending it over to a remote control unit using WiFi; and dedicated software for smartphones, tablets and laptops to help users control the reader and analyse the results. A combination that, according to Salina, will “revolutionise the world of food safety”.

Imagine a tanker truck filled with wine ready to be bottled or assessed by an oenologist: in such situations, timing is crucial. Proxentia’s technology will provide all the information needed and send it to the user in 20 minutes, and the risk of finding an end-product with non-conforming components is completely eliminated. Promotion towards oenologists, specialised journalists, producers, bottlers and laboratories has already begun, and Salina says that they are very enthusiastic about the device.

Thanks to phase 2 funding, Proxentia has been able to complete the device’s industrialisation phase. The company has already started approaching potential clients, and new cartridges for additional food applications such as milk and entirely different domains such as disease diagnosis are currently in development.

STEFY

- Coordinated by Proxentia in Italy.
- Funded under H2020-SME and H2020-LEIT-NANO.
- cordis.europa.eu/project/rcn/203337
- Project website: proxentia.com

Next-generation PEF technology promises safer and healthier food at a lower cost

Imagine a technology that would decontaminate food with an electric pulse. Whilst tantalising, the promises of Pulsed Electric Field (PEF) applications for the food processing industry have so far failed to translate into a commercial success reaching the height of their potential. The FieldFOOD consortium identified existing bottlenecks and developed its own pulse generator to resolve them.

The FieldFOOD (Integration of PEF in food processing for improving food quality, safety and competitiveness) project finds its roots in what we could call a paradox. On the one hand, PEF is extremely appealing: it can prevent the negative impact of heating associated with other food processing technologies, reduces energy needs and water consumption, and provides safer, healthier food with a longer shelf life. But on the other hand, there are still obstacles to its widespread adoption. Apart from its use in potato processing and for the pasteurisation of fruit

juices and smoothies, the technology has not yet met with the success it was promised.

“The starting point of our proposal was to conduct a survey involving all project partners, to identify the bottlenecks that prevented the introduction of the technology. These included the fact that PEF processing was intended to supersede instead of complement existing food processing technologies, the lack of a systematic approach to its integration, industrial systems lagging behind end-user



requirements, and high costs associated with existing PEF generators,” explains Prof. Javier Raso, coordinator of FieldFOOD on behalf of the University of Zaragoza.

To overcome these problems, Prof. Raso and his team conducted a systematic process analysis of applications such as fruit juice processing, tomato product processing, winemaking, olive oil extraction and cider production. They identified the specific requirements of all these sectors, designed modular, portable and low-cost pulse generators and modified processing steps and parameters to successfully introduce these generators in the processing line.

“Our technology is miles apart from its costly, bulky and heavy counterparts. It is portable, allows for the process to be quickly adapted depending on the product being treated, and is small enough to be integrated in existing production lines without the need for major renovations,” says Prof. Raso. “It even allows for a rental system, thereby avoiding the need for large capital investments

“ *Our technology is miles apart from its costly, bulky and heavy counterparts. It is portable, allows for the process to be quickly adapted depending on the product being treated, and is small enough to be integrated in existing production lines without the need for major renovations.* ”

that some companies, particularly SMEs, would find difficult to commit to.”

In the case of winemaking, PEF treatment with FieldFOOD technology was found to halve maceration time and result in a fruitier wine. The energy required for the physical peeling stage was reduced by 20 % and, in the case of oil and fruit juices, extraction was improved by up to 5 %.

The technology was successfully demonstrated at a pilot plant, a demonstration which also helped the consortium in identifying room for improvement towards easier market introduction. “We are also following up on our research into suitable know-how generated in FieldFOOD, to evaluate the industrial feasibility of the application of PEF not only to other applications in the food industry, but also for other sectors such as pharmaceutical or biotechnological industries,” Prof. Raso concludes.

FIELDFOOD

- Coordinated by the University of Zaragoza in Spain.
- Funded under H2020-FOOD.
- cordis.europa.eu/project/rcn/193342
- Project website: fieldfood.eu

New device lets food industry monitor safety along entire value chain

Researchers with the EU-funded FOODSELF project are taking food safety out of the lab and into the field. The goal is to develop a point-of-care device that provides the same level of results as a lab-based analysis, but that can be used directly in the field.

In 2016, the global food safety testing market was valued at well over EUR 11 million. Between 2018 and 2023, it is forecasted to grow by 7.2 % (CAGR). With numbers like these, it should come as no surprise that the food health

and safety arena is a crowded one, with many large companies offering solutions to protect our food against pathogens, allergens and toxins. The problem, however, is that these devices require that the testing be done in a lab.

BIOLAN, a European SME operating in the field of biosensors for food safety monitoring, is on a mission to disrupt this lucrative market. Its goal: to create a point-of-care device that provides the same level of results as today's lab-based systems even when used in the field.

The first step towards achieving this is FOODSELF (FOOD Safety monitoring by Electrochemical Lateral Flow Immunoassay), an EU-funded project aimed at overcoming the current limitations of lateral flow (LF) technology for the development of a rapid quantitative test. "The device we set out to create was essentially modelled on the common, easy-to-use pregnancy test," explains project coordinator Arrate Jaureguibeitia.

EASY TESTING, QUICK ANSWERS

A pregnancy test, scientifically referred to as a lateral flow immunoassay (LFI), is a simple, paper-based device that detects the presence or absence of a targeted substance in a liquid sample without the need for specialised and costly equipment. You use the test and just minutes later you get an answer: a line if you are pregnant, no line if you're not.

Similarly, the FOODSELF device is a paper-based test capable of providing the user with quick answers. But instead of telling you if you're pregnant or not, FOODSELF lets the user know whether the food being tested is safe.

To do this, project researchers developed a more sensitive method of LFI, called electrochemical lateral flow immunoassay (ELFI). By applying electrode samples to the device, the user gets a quick, quantitative analysis of the product. "This ELFI prototype is the basis for developing an easy-to-use analytical device that the food industry

“The device we set out to create was essentially modelled on the common, easy-to-use pregnancy test.”

can use to monitor safety along the entire food value chain,” says Jaureguibeitia.

MOVING TOWARDS COMMERCIALISATION

Through the FOODSELF project, BIOLAN developed an innovation strategy focused on paper-based bio-sensing devices. But in today's high-tech world, why paper? "Applying such alternative materials as paper to manufacturing diagnostic devices is an opportunity to reduce the use of single-use plastic devices," explains Jaureguibeitia. "BIOLAN aims to apply paper as an active bio-sensing platform to develop eco-friendly diagnostic devices."

According to Jaureguibeitia, commercialising paper-based immunobiosensors has the potential to allow the food industry to better monitor such parameters as allergens and pathogens. "Because it is highly accurate, portable, fast and user-friendly, FOODSELF will have a clear and positive impact on the quality control process of food production," she concludes.

FOODSELF

- Coordinated by Biolan Microbiosensores S.L. in Spain.
- Funded under H2020-SME.
- cordis.europa.eu/project/rcn/208424
- Project website: biolanmb.com/rd
- bit.ly/2P7D1k5



Traditional tomatoes for happier consumers

Traditional isn't necessarily synonymous with old-fashioned. The TRADITOM project has looked into the characteristics of traditional tomato varieties and found how great taste, mass production and cost effectiveness can actually go hand in hand.

Looking at tomatoes in our favourite supermarket, it'd be easy to forget that we are looking at a seasonal product: No matter the time of the year, the market will have no shortage of highly productive, good-looking and cheap tomatoes with a long shelf life. But as our grandparents will be quick to remind us, no matter how good they look, these hybrid tomatoes are nowhere as tasty as their ancestors.

It's not misplaced nostalgia. The truth is, in the race for ever higher productivity, producers actually seem to have forgotten about flavour. Did you know, for instance, that disease resistance is obtained by crossing tomatoes with their hardly edible wild counterparts, in turn negatively affecting flavour? The resulting increase in production has reduced the number of possible consumer choices, and, to make things even worse, globalisation means that these tomatoes are harvested while still green and stored at low temperatures, which also decreases their flavour.

Meanwhile, local farmers maintaining a wealth of traditional varieties and cultivation methods and supplying great-tasting tomatoes are under threat. Since quality doesn't pay off and scientific approaches to capture and describe the value of the traditional varieties and methods are lacking, there are just not enough incentives for them to hold on to the old ways.

By digging in the traditional European tomato pool, the TRADITOM (Traditional tomato varieties and cultural practices: a case for agricultural diversification with impact on food security and health of European population) consortium aimed to provide a scientific basis to what made these varieties survive until now, to help make them more competitive and, as Prof. Antonio Granell, coordinator of the project, puts it, "kill the old myths".

"By analysing the large phenotypic diversity of traditional varieties, we found for instance that some of them have



© TRADITOM

comparable yields to modern hybrids, while others are large and tasty, have extended shelf life, high levels of healthy metabolites, or have a diverse composition of flavour compounds,” he explains. “Our research can be used to valorise these varieties as well as increase resilience without compromising on characteristics.”

The project team notably found out that flavour essentially revolved around three sugars, three acids and close to 30 volatile compounds. They even know which genes and which version of those genes (alleles) are best at making the fruit accumulate optimum amounts of those compounds, for tomatoes tasting like no other.

“We could ‘reintroduce’ the superior alleles of genes back into those modern varieties or use our knowledge for introducing yield, shelf life and disease resistance genes in the background of selected traditional varieties,” Prof. Granell explains. “Whilst the first approach may appear more complicated, several flavour compounds can be affected simultaneously by reintroducing good alleles of a small number of genes present in traditional varieties. We also showed the second approach could work by producing F1 hybrids between elite lines from companies and traditional varieties. This can be extended to a larger number of TRADITOM varieties that satisfy different consumer needs.”

Other key project findings relate to consumer tastes and how their demands can best be met. For example,

“Our research can be used to valorise these varieties as well as increase resilience without compromising on characteristics.”

whilst consumers prefer tomatoes with high sugar levels, increasing sugar content in fruit often penalises yield. But thanks to TRADITOM, sweetness can now be increased without the need for more sugar by acting at the picomolar level of some volatiles tricking our senses into making us think the fruit is sweeter than it really is.

According to Prof. Granell, the market should start thinking about what consumers want, instead of what producers and the rest of the value chain are more comfortable with and get the most profit from. To make this a reality, he and the rest of the consortium intend to continue their work through different projects.

TRADITOM

- Coordinated by the Spanish National Research Council in Spain.
- Funded under H2020-FOOD.
- cordis.europa.eu/project/rcn/193297
- Project website: traditom.eu
- bit.ly/2Qri48B

Perfect beverages and liquid food down to the molecular level

Swedish SME Opsis has successfully applied FT-NIR technology to beverages and liquid food. They promise pinpoint accuracy in ingredient measurements, with time savings, reduced production cost and increased product quality into the bargain.

Bartenders and cocktail enthusiasts know it: proportions matter. A bit too much or slightly too little of an ingredient, and the person drinking will never look back.

The same principle applies to food processing plants, for which getting ingredient levels right can be complicated but nonetheless crucial to keep the business afloat. So far, these producers have mostly operated on a combination of gut feeling and technology capable of identifying the different components in liquid food and beverages. They have known,

for instance, how much sugar there was in their products. The composition of this sugar, however, has been unknown.

These days are over. By successfully applying FT-NIR technology – a technology using near-infrared light and algorithms to quantify gas components – to liquids under the FAME (Development and demonstration of an innovative FT-NIR-based system for food content analysis) project, Opsis is now capable of distinguishing ingredients at molecular level.



Dr Olle Lundström
Sales Director OPSIS LiquidLINE
© OPSIS

“ *With our technology, you can actually adjust these valves precisely to have an optimised process, depending on whether you want to save time or cost, or have a maximum yield.* ”

technology and make it applicable to liquids as well, be it milk, wine, spirits, sugar or water.

The second challenge consisted in making online measurements – that is, taking samples from production lines from which many different products with different behaviours, temperatures, flows and pressure come out – and bringing these to a stable laboratory environment. This was essential to make a very detailed analysis possible.

Our last challenge was related to prediction models and calibrations. It's pretty much like taking a prism and trying to split out the spectrum into understandable data. To do that, you need a mathematical estimation model able to convert light into a value. This was a great challenge and this model required much fine-tuning to become applicable to the many different possible environments.

What would you say were the main achievements brought about thanks to phase 2 funding?

Phase 2 funding helped us take the technology we had for gas and bring it to liquids. But it also helped us identify customers interested in using this technology. We now have customers that have been running this technology for a while and are very interested in it over the long term.

We have not been able to release this information publicly yet, but we are currently discussing a future press announcement related to two major multinational corporations we have been working with.

Can you describe the use cases for these two customers?

Customer number one is a sugar refinery producing liquid sugar and syrup. Such products, in order to become and remain liquid, require a certain composition of different sugar types. If producers were to use only saccharose, the sugar would freeze or remain solid. Thanks to our technology, the customer can measure and control the exact levels of glucose, fructose and saccharose needed on its production line. This not only helps to improve the

How is FT-NIR relevant to the food industry?

Dr Olle Lundström: Compared to technologies currently in use in the food processing industry, which mostly relies on NIR only, FT-NIR provides better resolution. Using it, you can continuously identify small details that had never been captured before on production lines.

FT-NIR has been around for 30 years but has so far been used mainly in laboratories and for industrial applications. With this project, Opsis successfully brought its own FT-NIR Gas technology – used for pollution monitoring – into the food processing industry.

Is it really useful to scrutinise food at the molecular level?

For some market players it won't be interesting, unless they are looking for something very detailed and specific. For example, there are already solutions available to quantify sugar on production lines. You don't need FT-NIR for that.

However, no technology can measure what type of sugars are in a product. Thanks to FAME, we can now differentiate between fructose sugar, maltose sugar and glucose sugar.

What are the main challenges you faced in bringing this technology to the food industry?

The first challenge, and perhaps the most important one, was to develop this technology for gas. It took 30 years to get there. FAME has been building on this extensive research and development process to take this existing

quality of the final product, but also causes less waste and decreases production cost.

The second customer deals with fermentation to produce alcohol. That process also requires specific combinations of sugars, and our equipment allows us to measure and even monitor the fermentation process. No one except Opsis can do this today.

If you had to convince a new potential customer, what would be your main arguments?

Imagine you have a food processing plant, using some kind of liquid. Today, you have no choice but to keep adjusting all sorts of valves based on gut feeling to get the product you want. With our technology, you can actually adjust these valves precisely to have an optimised

process, depending on whether you want to save time or cost, or have a maximum yield.

What are your objectives for the next five years?

Within six months, we intend to go public with the announcement of our two main customers. Once it's done, we will expand across Europe to get closer to the plants. Then, we'll start looking into worldwide expansion.

FAME

- Coordinated by Opsis in Sweden.
- Funded under H2020-SME and H2020-FOOD.
- cordis.europa.eu/project/rcn/198906
- Project website: liquidline.se/Online/tabid/955/Default.aspx

Biocontrol: a natural approach to food security

Instead of using potentially harmful pesticides to protect our food supplies from pests, researchers working within the EU-funded BINGO project are using the natural enemies of pests to control their populations.

Although keeping our food safe and secure is a multi-front battle, one of the main threats comes from native and invasive pests. In particular, invertebrate pests are responsible for destroying an estimated 20 % of the world's annual crop and stored products.

Historically, society used pesticides to protect our food supplies. However, due to the negative impact pesticides have on the food itself and the surrounding environment, regulations have strictly limited their use. One solution is



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biological control, which controls pest populations using their natural enemies.

To avoid having to import non-native natural enemies that put local biodiversity at risk and often go against international protocols for protecting biological resources, researchers with the EU-funded BINGO (Breeding Invertebrates for Next Generation BioControl) project are optimising the biological control of pests using existing and native enemies. “A powerful way to optimise biological control is to use genetic knowledge, both on the natural enemy and on the pest itself,” says BINGO project coordinator Bart Pannebakker.

AN UNTAPPED RESOURCE

According to Pannebakker, genetic variation for traits involved in biological control is a largely untapped resource for improving the efficacy of existing and native biological control agents. “Our goal was to use the natural genetic variation present in native natural enemy populations to improve their performance as biocontrol agents,” he explains.

Key traits for biological control are those that determine the main events in the natural enemy’s life. These so-called life-history traits determine the reproductive potential (fecundity, sex ratio, searching behaviour) and the environmental sensitivity (starvation resistance, temperature tolerance, diapause) of a natural enemy.

“By better understanding the genetics underlying these traits, we were able to design efficient rearing, sampling and release strategies for natural enemies,” says

Invertebrate pests are responsible for

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and **stored products**

“A powerful way to optimise biological control is to use genetic knowledge, both on the natural enemy and on the pest itself.”

Pannebakker. “Likewise, knowledge on the genetic variation of those traits in pest species helps us determine the most efficient way to target them.”

A VIABLE SOLUTION FOR FOOD SECURITY

The BINGO project enabled the further use of genetic methodology in biological control. For example, they developed genome sequences for four biocontrol agents, which will help improve the use of biocontrol agents. “Using these genomic resources, we compared the genetic diversity of biocontrol agents in commercial cultures with samples from the field,” adds Pannebakker. “What we found is that while the commercial cultures work well in practice, the genetic diversity is limited, which could be an issue when these agents face new or adverse conditions.”

Researchers also developed molecular markers to determine the population structure of biocontrol agents in the field. These markers serve as another method for monitoring the impact released biocontrol agents have on local natural enemies.

Thanks to results like these, BINGO has put the spotlight on the application of genetic techniques and knowledge for the improvement of biocontrol. “Although there is more work to be done, BINGO successfully raised awareness about the applicability of genetic techniques for biocontrol,” concluded Pannebakker. “As a result, biocontrol has taken a big step towards becoming a viable solution for food security.”

BINGO

- Coordinated by Wageningen University in the Netherlands.
 - Funded under H2020-MSCA-ITN.
 - cordis.europa.eu/project/rcn/193816
 - Project website: projectbingo.eu
- ▶ bit.ly/2rRLsYd

A new lease of life for local pig breeds

Industrialisation has pushed the pig breeding industry into a corner. As their practices increasingly become unsustainable in the face of social, ethical and environmental requirements, the TREASURE project suggests a return to their local roots.

The importance of livestock's genetic diversity is increasingly acknowledged: it helps farmers improve their breeds, adapt to changing environments and meet constantly evolving societal and consumer demands. In the case of pigs, this change has led to support for *in situ* gene banks, but also – and perhaps most importantly – the realisation that most local pig breeds are still, to this day, untapped or not securely maintained.

But whilst most seem to agree with the principle that genetic diversity can contribute to a more sustainable agricultural system, there is still a wide gap between what consumers want – they are increasingly wary of

food origin, quality and sustainability – and the information and products they get.

“Nowadays, consumers make product quality inferences based on extrinsic cues like non-intensive rearing, animal welfare, tradition, the local economy, as well as intrinsic cues such as sensory quality attributes, in order to decide on acceptability and repurchase,” says Dr Marjeta Candek-Potokar, TREASURE (Diversity of local pig breeds and production systems for high quality traditional products and sustainable pork chains) project coordinator. “Our project enriches this range of information and impressions with details on the genetic structure and



adaptive capacity of local breeds, as well as on how product quality is actually linked to local pig breeds, feeding resources, animal management in extensive systems, processing techniques, and the 'know-how' of producers and processors."

The goal, for Dr Candek-Potokar and her team, was to allow consumers across Europe to rediscover traditionally-used pig breeds and their healthy, high-quality meat products, as well as to provide incentives for industry to develop new ones. They did it first by characterising breeds at genetic and phenotypic level, and then by considering the application of genomics to conserve and manage these breeds.

"Interesting and unique phenotypes characterise several autochthonous breeds. We could identify the genetic mechanisms for these traits, in turn creating interesting opportunities to further exploit these local resources. As these breeds are autochthonous, the goal was also a better understanding of their adaptive capacity to local environments (level of gene expression or microbiota characterisation). This was studied in relation to production practices, breed but particularly to nutrition. Besides, the genetic and phenotypic information acquired will be important for future breeding programmes," Dr Candek-Potokar explains.

THE TRUTH BEHIND THE MYTH

To convince industry of the added value of local breeds, the team also questioned current industry biases. Most industrial meat producers will be quick to underline, for instance, how local breeds tend to have slow growth and high fat deposition, as opposed to modern breeds whose so-called 'precision feeding' brings out much more potential at a lower cost.

“*The genetic and phenotypic information acquired will be important for future breeding programmes.*”

According to TREASURE researchers, however, the problem lies in how we just don't know enough about the potential of local breeds and how to optimally exploit it. One of the project's most important undertakings in this regard consisted in the use of locally-available feeding resources and a modelling approach to evaluate local breeds' ability for protein deposition, in turn uncovering their specific nutritional needs. Besides, the team also conducted a cost-benefit analysis for different breeds and analysed their production systems with emphasis on ecosystem services.

As Dr Candek-Potokar points out, "The project's main idea was to come up with a new paradigm of pig production that would be able to answer key societal concerns. The pig production system of the future should consider that land use and availability are key bottlenecks for agricultural production, and that livestock production must be limited and in line with available natural resources, while providing high-quality food products."

TREASURE

- Coordinated by the Agricultural Institute of Slovenia in Slovenia.
- Funded under H2020-FOOD.
- cordis.europa.eu/project/rcn/193290
- Project website: treasure.kis.si/



Lighting the way to sustainable fishing

Out of every five fish caught, one is the 'wrong fish', as most of the world's 6.4 million commercial fishing vessels cannot select which species they catch. This incidental capture and death of non-target marine creatures, known as 'bycatch', threatens endangered species and juvenile fish, and consequently fish stocks.

Bycatch contributes to the decline in fish stocks with the result that over 63 % of fish species are no longer within biologically sustainable fishing levels. With over 1 million people globally relying on fish as their primary source of protein, this situation poses a major threat to future food security.

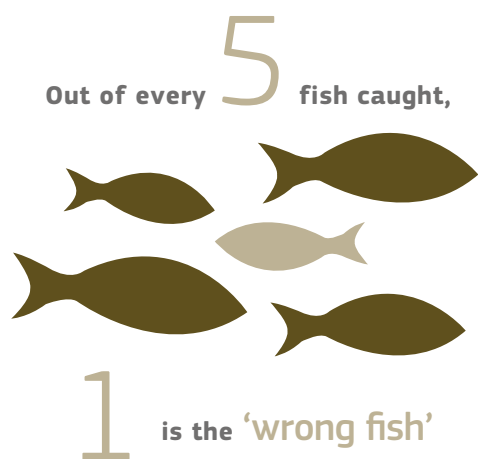
The EU-funded Horizon 2020 PISCES (Reducing bycatch – Saving fishing crews money – Facilitating compliance – Enabling the long-term sustainability of the fishing industry) project addressed the problem of bycatch by developing light emitting diode (LED) units that can be attached to commercial fishing gear. "We have created a new technology that allows the simple application of new discoveries in fisheries science," says Dan Watson, project coordinator and CEO of SafetyNet technologies.

THE APPLIANCE OF SCIENCE

Researchers exploited the reaction of fish to light to enable fishing crews to guide fish out of their nets, thereby avoiding or lowering bycatch. "You can set the LED units to a certain type of light to attract or repel a particular species of fish, which allows fishermen to put 'logic' into their nets," explains Watson.

During sea trials, PISCES attached their specially developed LEDs to different parts of a variety of fishing gear to see where it is most effective in guiding fish into or out of the net. Trials were conducted in collaboration with industrial and scientific partners to make sure that the results are based on real-life situations and scientific fact. Having validated a prototype in North Sea field trials, the UK





government's Centre for Environment, Fisheries and Aquaculture Science provided independent verification of a 60 % reduction in bycatch.

FISHING FOR SUCCESS

The greatest challenges facing PISCES concerned access to fishing crews and supply chain stakeholders due to the disparate nature of the industry and demanding working practices, especially regarding time. According to Watson: "The investigating team overcame these obstacles by using social media, online conversation tools and simply conducting interviews in fishing locations to gain as many insights as possible from stakeholders."

Furthermore, access to accurate and reliable fisheries data – both managerial and financial – also proved difficult. "While it was possible to find out the size of the global and national fishing fleets, it was often difficult to find more granular details with which to identify common trends in fishing practices, beyond conversation or speculation," Watson observes. "However, eventually our conversations with stakeholders bore fruit with many participants sharing their own datasets with the team or pointing the way to more expansive and robust data sources."

"Currently, the bycatch issue costs us about a billion dollars globally every year and is a considerable threat to food security. PISCES worked successfully with local fishermen to solve real problems, establishing effective lines of communication with stakeholders to find a solution to bycatch and help ensure the future of fisheries and the fishing industry. The project will benefit society by harvesting fish more sustainably, enabling the ocean to continue supplying food to a growing human population," Watson concludes. Furthermore, commercialisation of this technology is expected to generate more jobs while increasing revenues.

PISCES

- Coordinated by SafetyNet Technologies Limited in the United Kingdom.
- Funded under H2020-SME and H2020-FOOD.
- cordis.europa.eu/project/rcn/213298

FOOD AND NATURAL RESOURCES

Strategies for promoting gastronomy across Europe

Food and gastronomy are increasingly recognised as elements of regional innovation contributing to economic development. To expand sustainable practices across Europe, the FOODEV project identified key resources and practices.

Linking food and gastronomy to sustainable development requires input from multiple disciplines given the multi-functional nature of food. With a Marie Skłodowska-Curie individual fellowship grant, the EU-funded FOODEV (Food

and Gastronomy as leverage for local development) project implemented an interdisciplinary approach to determine the conditions that favour building on local features. "Our key objective was to identify successful sustainable

“ Our key objective was to identify a successful sustainable development strategy based on food and gastronomy that could be implemented in other European regions. ”

development strategies based on food and gastronomy in different European regions,” explains project coordinator Prof. Tommy Andersson.

FOODEV carried out a multidisciplinary literature review across three main research areas – agriculture and rural studies, place marketing and branding, and food tourism – to identify the core of food and gastronomy potential for sustainable development of the places. Partners selected and analysed common, recurrent and significant local food and gastronomy resources.

The rationale was to identify the resources and actors supporting the development strategies in different regions and determine how they were interrelated. Apart from reducing fragmentation across research areas, the analysis offered a resource-based interpretation of food and gastronomy potential for sustainable place development. Moreover, FOODEV partners performed a survey on EU-funded projects with in-depth interviews with project coordinators to investigate project sustainability.

A CASE STUDY APPROACH

FOODEV investigated bottom-up community development in Italy by analysing long-term cooperation between local stakeholders and universities. “This case study emphasised the role universities might have in supporting grassroots multi-stakeholder networks,” outlines Dr Chiara Rinaldi the leading researcher of the project. The persistence of individuals and their ability to self-diagnose problems, to critically reflect on issues and support local assets was paramount for success in this particular case study.

In Sweden, project partners investigated how medium-level organisations are able to negotiate at global and regional level, and across different stakeholders with diverse needs and objectives. They demonstrated that cooperation among engaged individuals across different organisations was key to realising sustainable place development.

Furthermore, FOODEV results showed that to ensure strategy success, to achieve place distinctiveness and attractiveness, locations must be linked with culture. Project activities

ensured a systematic understanding of multiple issues and problems within each sector and how they interrelate.

“Paramount to sustainable development is knowledge transfer; FOODEV envisions a network where knowledge, learning and innovation can be shared,” states Prof. Andersson. Closing the research and innovation gap through translational research approaches and maximising researchers’ contributions will enhance development in the food sector.

FOODEV analysis through the lens of sustainable local development is expected to impact wider audiences. Resource mapping will support stakeholders’ understanding of local available resources and enable policymakers to formulate policies and integrated approaches for development.

Project results will be presented at the ‘Tomorrow’s Food Travel (TFT)’ conference that will be held at the University of Gothenburg in October 2018. The research on food and gastronomy for sustainable place development is continuing with the new project ‘FOODbiz – University and business learning for new employability paths in food and gastronomy’ coordinated by the University of Macerata in Italy, and involving the University of Gothenburg in Sweden as well as one Erasmus+ initiative of the Partnership for Higher Education among six EU countries.

FOODEV

- Coordinated by the University of Gothenburg in Sweden.
- Funded under H2020-MSCA-IF
- cordis.europa.eu/project/rcn/203870



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INDUSTRIAL TECHNOLOGIES

Sound software for fault detection in machinery

Experienced operators claim they can tell if their machine is functioning properly merely by listening to the sounds it makes. EU-funded researchers have gone one better by developing technology based on the human auditory system that can, through sound analysis, 'hear' if industrial machinery is due for maintenance.

Eliminating the risk of downtime and reducing maintenance costs are very important for industry as these factors affect productivity and quality while decreasing profits. Industry, therefore, has major incentives to find a solution that is easy to implement and simple to use.

Using sound analysis, the EU-funded Horizon2020 neuronSW (Early detection and prediction of mechanical malfunction of machinery by sound analysis) project developed an innovative ground-breaking approach for predicting mechanical malfunction in industrial machinery. Researchers combined advanced algorithms, machine learning and Big Data analysis to imitate the human auditory cortex and enable the early detection and prediction of mechanical breakdown. "The technology leverages machine learning, the cloud and the Internet of Things (IoT) to deliver a detection service which emulates human intuition about sound," says Jiří Čermák, technical manager of project partner SME NeuronSW Ltd.

EAR FOR PROBLEMS

Via Neuron soundware technology (neuronSW), manufacturers can conduct intelligent audio diagnostics and monitor key items of machinery by the sounds they produce. "The integrated hardware and software platform

automatically gathers the sound of machines in real time and continuously assesses the equipment's health. It works in a similar way to experienced operators who use their ears to diagnose broken machines," explains Čermák.

The system works both offline and online and can be integrated into existing software or third-party IoT platforms. "This effectively transforms data into knowledge and actions," claims Čermák. "Sound and vibration sensors (microphones) can be quickly and cheaply installed on all types of machinery, enabling assets without a digital interface or operated by legacy systems to be digitalised without expensive upgrades."

Excitingly, there are almost no limits to the application of the audio diagnostic technology, which can be used for anything that has a moving part and produces sound. "However, it makes most sense to first focus on critical pieces of machinery, expensive assets, quality control, and assets in remote areas with difficult access," Čermák points out. He continues: "Different industries cooperated with neuronSW to create solutions for heavy machinery, including cogeneration engines, automotive fuel pumps, wind turbines, escalators, AC systems, PC assembly, quality control of electric motors, and predictive maintenance of packaging machines."

A BRIGHT FUTURE

According to Michal Bambušek, NeuronSW Ltd's Sales Manager, the project also focused on sales and marketing plans. "We trained sales staff and identified key markets and go-to-market strategies for the neuronSW technology and conducted case studies to develop and adapt it to different fields," he says. "We made some new important business contacts that helped us discover some new areas and uses for our technology, which helped to enhance it and allowed us to progress."

"We believe that, in the future, predictive sound maintenance will become a standard feature of most machines with moving parts, helping manufacturers and operators alike. As for future research, we are doing everything we can to learn from case studies and upgrade our technology and research."



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Both machines and people will benefit from the technology developed through the initiative. “There is no doubt that asset maintenance is one of the core areas of exploration in many industries worldwide,” adds Čermák. “We believe that, in the future, predictive sound maintenance will become a standard feature of most machines with moving parts, helping manufacturers and operators alike. As for future research, we are doing everything we can to learn from case studies and upgrade our technology and research,” he concludes.

NEURONSW

- Coordinated by NeuronSW Ltd in the United Kingdom.
- Funded under H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/rcn/213675
- Project website: neuronsw.com
- ▶ bit.ly/2Od26cT

INDUSTRIAL TECHNOLOGIES

Safe and sustainable geopolymer concrete

A basic ingredient of concrete, ordinary Portland cement (OPC), is the most commonly used type of cement for construction of buildings and infrastructure. However, OPC production is responsible for 5-8 % of all man-made carbon dioxide (CO₂) emissions across the globe.

Low carbon alternatives to OPC are being actively sought by scientists. One solution is geopolymer materials, low CO₂ binders that can be produced by reusing industrial wastes like fly ash from coal-fired power stations or blast furnace slag. However, the development of synthetic building materials is currently hampered by public health and safety concerns.

The EU-funded Horizon 2020 By-BM (By-products for Building Materials) project addressed these challenges by developing environmentally-safe geopolymer building materials that comply with safety standards. “The initiative combined experience gained from geopolymer and radiological research to develop new eco-innovative construction materials with a low CO₂ footprint from the



recycling of industrial by-products,” says project coordinator Prof. Marios Soutsos.

Geopolymer concrete offers several benefits over conventional OPC apart from significantly lower CO₂ emissions. For example it provides improved fire resistance and a viable use for ‘waste’ materials, which may otherwise be destined for landfill.

CONCERNS ADDRESSED

Although the geopolymer concrete can be beneficial from both an economic and a sustainability perspective, there are concerns among public authorities and scientists. “In some cases, constituents in the by-product may affect human health and pose environmental risks. In addition to the potentially toxic compounds, there is a possible risk from enhanced levels of naturally occurring radioisotopes (NORs),” explains By-BM research fellow Dr Zoltán Sas.

Project partners therefore developed innovative, low CO₂ and inherently safe geopolymer concrete from industrial wastes with as low radiological risk as possible according to the European Basic Safety standards defined in the EU’s Council Directive (2013/59/Euratom).

Researchers collated scientific reports concerning NOR content in industrial by-products and constructed a database to provide information about the global situation. In addition, data on various industrial by-products from different European countries were collected. This included air pollution control residue from municipal waste incineration, fly ash from coalfired power stations, cement kiln

“With the [By-BM] database, it is possible to identify the materials with elevated risk.”

dust, incinerated sewage sludge ash and red mud from aluminium oxide production.

DATABASE OF GEOPOLYMER SAMPLES

Scientists determined the mineralogical and chemical composition of the by-products using X-ray diffraction and X-ray fluorescence and the NOR content through high-resolution gamma spectrometry. The radon release rate, a radioactive gaseous element, was measured using a radon accumulation chamber connected to active radon monitors. “Owing to the gamma spectrometry new information was published regarding the NOR content of certain by-products such as cement kiln dust, sewage sludge ash, and the dust from incinerators,” comments Prof. Soutsos.

The consortium also classified geopolymer samples according to the current national legislation, standards and recommendations based on their NOR content. The online version of the draft NOR database can be used to identify safe selection of materials according to their constituents, i.e. the use of by-products and other raw materials. According to Prof. Soutsos and Dr Sas: “With the database, it is possible to identify the materials with elevated risk and furthermore their possible variability.”



5-8% of man-made
CO₂ emissions come from the production
of ordinary Portland cement

By-BM can be used by the construction industry to ascertain the safe use of by-products in geopolymer concrete based on their radiological features. "It will enable researchers to better understand how the radiological aspects of industrial by-products should be considered regarding the reuse of these materials for new construction materials and how the risk originating from the NOR content can be minimised," Prof. Soutsos concludes.

BY-BM

- Coordinated by Queen's University Belfast in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/200995
- Project website: bybmproject.com

INDUSTRIAL TECHNOLOGIES

Lead-free bearings for greener large-bore engines

Lead-free bearings are one of the missing pieces in the technological shift that will eventually allow large-bore engine manufacturers to reduce their emissions, while not compromising on reliability and lifespan. Research and development under the BeLEADFREE project could be the breakthrough they expected.

Whilst lead disappeared from most engines a long time ago, some sectors still have no choice but to use it. These include manufacturers of large-bore engines for the likes of boats and power generation applications: torn between

the need to reduce exhaust emissions, stop using lead and satisfy ever more stringent criteria for engine design, these industries have had trouble coping with the pace of society's changes.



There is, however, strong stakeholder interest in potential lead-free alternatives, as Dr Yi Zhang, research and development manager at Daido Metal, explains. “The global trend of reducing exhaust emissions, especially NOx, has already led to significant changes in large-bore engine design. But whilst these developments improve engine efficiency and reduce emissions, they also create an ever-harsher engine environment.”

This makes for a rather conservative industry when it comes to changing materials or production processes: whilst lead replacement for the sake of environmental protection and better engine design is acknowledged as a must, large-bore engines are expected to remain in service for tens of thousands of hours. The slightest technical or reliability issue could lead to catastrophic failure.

The BeLEADFREE (High Strength Bearing for Large-Bore LEAD FREE Engines) project might be just what the industry had been waiting for: large bore engine bearing products that not only are lead-free, but also address the technical challenges faced by global large-bore engine manufacturers.

In only two years, the project consortium managed to successfully come up with novel manufacturing approaches, design and build a pilot production line and validate the performance of its new material on a real fired single cylinder engine with an independent EU testing organisation.

“We have reached our initial objective on lead reduction and elimination without compromising on the performance required by the market in terms of future large-bore engine design,” Dr Zhang says. “The test, which included an independent validation of the single cylinder engine, has demonstrated a significant improvement in terms of fatigue, wear, cavitation, corrosion and tribological performances. This means, in short, that the lifespan of current materials is considerably extended and, subsequently, that the negative impact of large-bore engines on our environment will be reduced thanks to less frequent replacements.”

“*The BeLEADFREE project might be just what the industry had been waiting for: large-bore engine bearing products that not only are lead-free, but also address the technical challenges faced by global large-bore engine manufacturers.*”

As Dr Zhang points out, the material's structure can also vary under different loading conditions, which allows it to adapt automatically and optimise engine operation. This, in turn, improves fuel efficiency and reduces emissions.

The new material has been proved on both environmental and technical aspects at high TRL, and Daido Metal plans to keep promoting it in the near future. Stakeholders' feedback has been very positive so far, and Dr Zhang says that customers now seem to have more confidence and desire to accept the new material for their engines.

Commercialisation shouldn't be expected anytime soon due to the long product development cycle associated with large-bore engine industry. However, Dr Zhang hopes that most of the industry will adopt and shift towards lead-free large-bore engine development within five years, in light of BeLEADFREE's achievements.

BELEADFREE

- Coordinated by Daido Industrial Bearings in the United Kingdom.
- Funded under H2020-Industrial Leadership and H2020-Societal Challenges.
- cordis.europa.eu/project/rcn/203394
- Project website: beleadfree.eu



PROJECT OF THE MONTH

An award for using ultrasound to create advanced industrial materials

The EU-funded OptiNanoPro project has won the prestigious ChemPlast Award in the category of 'Best technological innovation for development of new materials', which promotes the use of nanotechnology to improve the features of plastics using ultrasound.

The award recognises the project team's development of a new technology for the dispersion of additives and nanoadditives within plastic, which entails the use of an ultrasonic vibration system in which the plastic is blended with different additives to ultimately obtain an *à la carte* material. Currently in the patenting process, the technology allows for nanoadditive plastics that have overall improved mechanical benefits and increased barrier properties, and even reduces the weight and final costs of the pieces to be manufactured.

Keep a look out for an upcoming **CORDIS Results Pack on Advanced Industrial Materials**, which will feature a more comprehensive article on OptiNanoPro's successes.

OPTINANOPRO

- Coordinated by IRIS Technology Solutions in Spain.
- Funded under H2020-LEIT-NANO.
- cordis.europa.eu/project/rcn/198814
- Project website: optinanopro.eu

“Nanotechnology can provide packaging with improved barrier properties as well as repellent properties resulting in easy-to-empty features that will on the one hand reduce waste at consumer level and, on the other hand, improve their acceptability by recyclers. Likewise, solar panels can be self-cleaning to increase their effectiveness and extend the period between their maintenance and their lifetime by filtering UV light that causes material weathering. In the automotive sector, lightweight parts can be obtained for greater fuel efficiency.”

Maria Eugenia Rodriguez,
Director of the Composite Materials Unit at project partner Eurecat.



© Image courtesy of ChemPlastExpo

If you are interested in having your project featured in 'Project of the Month' in an upcoming issue, please send us an email to editorial@cordis.europa.eu and tell us why!



DIGITAL ECONOMY

Cataloguing media content by AI-based, automated, real-time analysis and processing

The annotation of media content is a major labour-intensive and error-prone process, especially for SMEs. An EU initiative has developed state-of-the-art AI technology to meet the challenge of efficient and cost-effective extraction and cataloguing of media metadata.

The media production industry is evolving and expanding both rapidly and globally. It's primarily driven by the exponential growth in use of mobile devices such as phones and tablets, the ubiquity of internet access and the subsequent explosive increase in demand to consume content. This has created an acute and ever-growing need for rapid, automated means of metadata enrichment solutions for media content. However, existing enterprise-level and high-end solutions are extremely costly and complex to implement for the large number of SMEs that operate in the creative sector.

ADDRESSING CONTENT AND ARCHIVING CHALLENGES

The EU-funded ReCAP (Real-time Content Analysis and Processing (ReCAP) for Agile Media Production) project was initiated "in response to the rapid proliferation of media content produced to satisfy the consumer trend for accessing media content anywhere, on any device and at any time," says chief technology officer Boris Prohaska from ReCAP's commercial partner ToolsOnAir. This has led to challenges in multiple industry sectors responsible for the creation of media content. "Simply put, there are too many files, not enough time, and not enough people to view and catalogue them all. As a result, companies involved in the creation and distribution of media don't know enough about the content."

Team members conceived ReCAP to tackle the resulting multiple challenges of content discovery, compliance of content with set criteria and rules, rights management and archive enrichment. The aim was to provide an affordable, automated, scalable, integrated and open commercial software solution. They set out to create a platform to address the real-world challenges faced in production media workflows.

BOOSTING CREATIVE PRODUCTIVITY

ReCAP leveraged existing technology developed in the EU for the analysis of media content to build an innovative solution primarily aimed at creative SMEs that need a solution quickly and don't normally have large technical teams to manage complex ICT projects. Operating in an AI environment, the software solution can process multiple content items simultaneously, faster than real time, and produce meaningful and accurate information for people, or other systems, to use.

The solution enables automatic metadata enrichment. It's capable of supporting live as well as streaming content and can be deployed both locally and in the cloud. "ReCAP seeks to reduce the amount of labour-intensive, mundane, repetitive, error-prone and manual tasks typically assigned to people whose skills could be used more productively in the creative production process," explains technical coordinator Werner Bailer.

Project coordinator NMR Consultancy Limited engaged with a European Commission Expert Group to assess the investment potential of products emerging from ReCAP. Independent experts evaluated leadership team capabilities, product and market readiness, and financial strategy. The Expert Group determined that ReCAP was ready for investment.

Development of the system and the analysis algorithms have continued since the end of the project. In September, partners demonstrated ReCAP at IBC in Amsterdam, Europe's most important broadcast technology trade show.

"ReCAP's unlimited AI offer provides the opportunity for users to focus on being creative, and saves them from the



prospect of demanding tasks associated with manually tagging and logging thousands of hours of media content,” concludes Prohaska. “The project also allows businesses to make informed decisions about their rich media content while providing tools for more cost-effective and efficient media content production.”

RECAP

- Coordinated by NMR Consultancy Ltd in the United Kingdom.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/rcn/205986
- Project website: recap-project.com

DIGITAL ECONOMY

More stories, more sense from Big Data

The YDS online platform is helping different stakeholders exploit Open public data and retrieve meaningful insights, especially in the areas of open government data and journalism.

The massive amounts of data that technology generates – from the social web to public records – can offer valuable insight in identifying social issues and even improving public services. Known as Big Data, the information must be however processed in a way that yields useful patterns and conclusions.

ENHANCED TRANSPARENCY IN GOVERNMENT

The concept of open government data, which focuses on transparency, accountability and reusability of data held by a government, requires new solutions for using Open Data to the benefit of the public and the public sector.

The EU-funded YDS (Your Data Stories) project developed a highly customisable online platform to exploit data in a spirit of transparency, collaboration and participation. “YDS can support users to interconnect, search, analyse, explore and understand available data to extract insights, facts and material for supporting data-led stories,” says project coordinator Anna Triantafillou.

From a technical perspective, YDS represents a semantic data model for combining different data sources. “It offers an easy and user-friendly solution allowing the drilling down, visual exploration and combining of data into meaningful stories,” explains Triantafillou. The YDS infrastructure involves visualisation apps ranging from

web applications and powerful interfaces that help users exploit data to mobile and social media applications that inform citizens and gather their feedback.

FROM PUBLIC PROCUREMENT TO INTERNATIONAL TRADE

Importantly, the YDS platform has been piloted and validated through three different usage scenarios in three European countries. The first pilot, titled Follow Public Money, advanced fiscal transparency and participation in Greece through smart personalised re-purposing by citizens and businesses of large volumes of publicly available data related to public procurement. The pilot was based on the open data set provided by the Greek Transparency Programme Initiative (Diavgeia) and Greece's National Strategic Reference Framework 2007-2013. "The Diavgeia project represents the most progressive transparency effort on a global scale, based on comprehensive, proactive, real-time and machine-processable open data provision," highlights Triantafillou.

The second pilot, dubbed Tracking Development Aid and International Trade, analysed international development cooperation and its relations to international trade from a Dutch point of view. The scope of the pilot was extended to include many European countries.

In parallel, the third pilot on Cross-Europe Financial Comparability focused on the comparability of financial data across EU Member States to examine data at EU level,

“YDS can support users to interconnect, search, analyse, explore and understand available data to extract insights, facts and material for supporting data-led stories.”

national level and local level. It particularly studied the city of Galway in Ireland and compared it to other EU cities.

YDS can also exploit the social web to enhance the use of Big Data. "The project's proposed solutions can explore and capitalise on the synergy between the semantic and social web," reveals Triantafillou. The project coordinator points out that the social web can provide insights into public interest regarding a certain topic, for example a construction project, helping to assess its impact on society. "Interesting analyses, ranging from 'top-10' lists to news stories, can be pushed to the social web, helping to raise interest in specific and usually human-driven data aspects," she adds.

BETTER ARTICLES AND MEDIA STORIES

One of the most interesting features of YDS is that it can bring data from different sources together to enrich a story. "Citizens or journalists know that interesting stories



can emerge from exploring open governmental data sets, and they want to use the data to tell these stories,” notes Triantafillou. YDS ultimately serves as an interactive canvas enabling citizens and journalists to find the hidden stories in data.

The latest version of the YDS platform was released in January 2018 after successful validation involving the three test case scenarios. The platform will no doubt be very useful in the media sector, such as for journalists

and news organisations looking to identify, investigate and create news stories.

YDS

- Coordinated by Athens Technology Center in Greece.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/rcn/194402
- Project website: yourdatastories.eu
- bit.ly/2CLb676

DIGITAL ECONOMY

One step closer to a truly secure and trustworthy cloud

The increased adoption of cloud computing by SMEs isn't without its drawbacks. There's an urgent need to enhance the confidentiality and integrity of outsourced data.

SMEs have serious concerns about the security and availability of data stored in the cloud. Following a rash of recent data breaches and surveillance scandals, customers are calling for end-to-end security whereby only end users and authorised parties have access to their data.

Thanks to EU funding, the TREDISEC (Trust-aware, RELiable and Distributed Information SEcurity in the Cloud) project set out to “design new security primitives that not only ensure data protection and user privacy, but also maintain the cost effectiveness of cloud systems,” says coordinator Beatriz Gallego-Nicasio Crespo. “We stepped away from a myriad of disconnected security protocols or cryptographic algorithms to converge on a unified framework where all objectives are met to the highest possible degree.” The project addressed the confidentiality and integrity of outsourced data in the presence of a powerful attacker who controls the entire network.

BETTER DATA SECURITY AND SOLID PRIVACY GUARANTEES

Project partners tackled security and privacy issues by analysing, designing and implementing a set of cloud

security primitives that are integrated naturally with existing cloud capabilities and functionalities. Specifically, they designed 27 primitives, and implemented and tested 25 of them. The primitives deal with various combinations of security and cloud functional and non-functional requirements. These include data integrity with verifiability and availability, confidentiality and efficiency, and secure and efficient data processing. The primitives make it possible for cloud providers to efficiently search and process encrypted data. Six primitives are protected by patent applications.

The project team designed a unified framework to allow for efficient integration of the security primitives without causing cloud service providers and end users to incur any additional processing and storage costs. “Cloud security solutions currently on the market don't support TREDISEC's novel functionalities like deduplication and proof of retrievability,” stresses Gallego-Nicasio Crespo. Data deduplication is a specialised technique used for compressing data.

Team members integrated a number of compatible primitives within the framework in the form of recipes. These recipes offer a unified software package and the



corresponding installation requirements for integrating the entire recipe or collection of primitives within the cloud environment of customers.

The developed technology will offer several benefits. It permits security engineers and security solution developers to design, implement and offer their primitives in a standardised, modular and well-documented package that facilitates use and adoption. The various primitives have been organised in self-sufficient modules that provide a rich set of application programming interfaces together with their detailed documentation.

TOWARDS LARGE-SCALE ADOPTION OF THE CLOUD BY SMES

“The reliance on modularity is not by chance – we designed the framework to allow prospective users to select only those components that meet their needs,” explains Crespo. “It’s also noteworthy that the framework will be open source and readily available to all organisations willing to integrate it into their business life cycle.” This feature will allow business integrators or cloud providers to find the

“TREDISEC solutions should boost the resilience of existing cloud infrastructures against attacks and vulnerabilities, protect data end-to-end, and make secure and trustworthy cloud systems a reality.”

best solution to meet their security concerns, and offer consumers a security-enhanced cloud offering with direct economic and reputational benefits. Consumers of security-enhanced cloud services and solutions will see their security concerns mitigated. Thanks to the end-to-end approach followed by the primitives, they won’t need to put all their trust in cloud providers.

“TREDISEC solutions should boost the resilience of existing cloud infrastructures against attacks and vulnerabilities, protect data end-to-end, and make secure and trustworthy cloud systems a reality,” concludes Crespo. “Ultimately, the project will positively shift the public’s perception of outsourced services, empowering users to take control of their data and restore their trust in ICT and online services.”

TREDISEC

- Coordinated by Atos SA in Spain.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/rcn/194205
- Project website: tredisec.eu



New nanosatellite energy solution increases reliability and efficiency, at reduced cost

Between the late 1990s and 2012, around 10 small satellites were launched annually; the next six-year forecast is for over 3 000. The European space sector has a chance to gain a prime global position, helped by the right energy storage system.

The small-satellite (nanosatellites) sector is growing, driven by increased miniaturisation, standardisation and reducing costs. However, crucial for its success – in offering high performance for a wide range of applications – is efficient and reliable energy storage.

The EU-funded MONBASA (Monolithic Batteries for Space-ship Applications) project set out to develop an energy storage solution – compliant with existing standards and regulations, reliable, with high energy efficiency, while remaining light and compact. The researchers designed new thin film components, crucial for the next generation of high voltage all-solid state Li-ion rechargeable batteries.

Ensuring standards of safety, robustness, energy density, vacuum compatibility, radiation resistance and an operating temperature window makes the batteries ideal for space applications, as well as others such as the Internet of Things (IoT).

OUTPERFORMING THE CURRENT STATE-OF-PLAY

While nanosatellites have become very popular, with the number of developers and projects ever-increasing, MONBASA's starting point was that innovative energy storage solutions could boost the sector even further.

The team first developed a solid state battery based on a high voltage electrode couple and ceramic solid electrolytes, with ionic conductivities much higher than commercial solid electrolytes. As the integration of the solid electrolyte has to be achieved for the consecution of a functional full cell, getting the contact right between cathode and electrolyte was critical. To fully analyse the physical and chemical properties of the battery interfaces, the most advanced analysis tools were employed.

The next step was to study battery integration with state-of-the-art satellite sensors such as microelectromechanical systems (MEMS), a crucial technology for sensors and actuators in advanced satellites. The solution was tested and validated under space-like conditions.

"We adopted processing methods from the microelectronics and technological glass industry, that are compatible with nanosatellite fabrication. These were crucial for obtaining high quality thin film Li-ion battery components that outperformed current commercial components," project coordinator Dr Miguel Ángel Muñoz explains.

MONBASA has demonstrated that thin film electrodes tested against commercial liquid electrolytes can have a lifetime one order of magnitude longer than conventional commercial electrodes. In practise this means that the current Li-ion cells could be increased by only changing the electrodes.

Theoretically the liquid electrolyte should not be stable at the high voltages delivered by the MONBASA cathode. However, the thin film cell kept more than 80 % of its initial capacity for more than 2 000 cycles, at high current rates and after integrating the solid electrolyte, stable at high voltages, the cell performance will be even higher.

The project also found that the MONBASA processing method for the negative electrode, tested against a commercial reference solid electrolyte at only 45 °C, matched the performance of conventional cells operating at 70 °C.

As Dr Muñoz summarises, “The MONBASA all-solid-state batteries have the potential to overcome the challenges the space sector currently faces with commercially available Li-ion batteries.” He elaborates: “Longer living battery components will result in fewer failures and so longer satellite lifetimes. Smaller sized thin film high voltage batteries will allow smaller satellites, reducing collision risks. And a wider temperature window will improve safety and performance under extreme conditions.”

ENSURING, AND EXPANDING, CRITICAL SERVICES

In its Space Strategy for Europe, the European Commission emphasized the importance of innovative space data and technologies, for services indispensable in the daily lives of European citizens. Small satellites are especially useful for novel applications as they are relatively inexpensive to build and launch, affording opportunities

within a range of target markets, such as telecommunications, agriculture, transport and the environment.

These services help protect and manage critical infrastructure, strengthen economic competitiveness, manage the resources for a growing population and tackle climate change pressures. Beyond space satellites, the project results are of interest for other applications such as powering autonomous sensors for IoT, and wearable devices such as for health monitoring.”

But Dr Muñoz points out, “Future efforts will have to be focused on optimising interfaces that enable the integration of a thin film cathode with a thin film electrolyte. In parallel, upscaling components fabrication should be prioritised.

MONBASA

- Coordinated by CIC energiGUNE in Spain.
- Funded under H2020-LEIT-SPACE.
- cordis.europa.eu/project/rcn/200831

SPACE

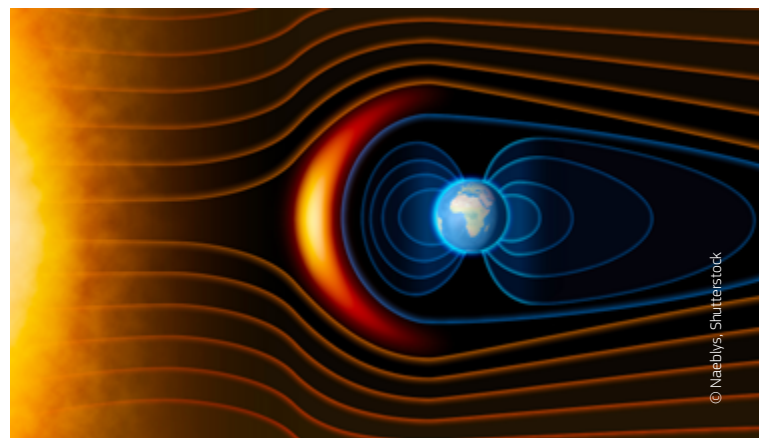
New study uncovers the behaviour of cosmic rays in the Heliosphere

EU-funded researchers have furthered our understanding of the process that describes the Sun's influence on cosmic rays. The implications could be revolutionary for high-energy astrophysics and solar science.

First discovered in 1912 by physicist Victor Hess after a high-altitude balloon flight, cosmic rays are constantly bombarding the Earth's atmosphere, producing showers of secondary particles that even sometimes reach the Earth's surface. Cosmic rays are mainly made up of high-energy particles such as protons or electrons. Thanks to detailed and continuous measurements of cosmic rays, researchers can now see that the cosmic-ray flux changes over relatively short timescales.

GONE WITH THE SOLAR WIND

When travelling inside the Heliosphere – a bubble-like region of space dominated by the Sun, which also contains the solar



“*If this model is correct, it will enable us to plan safer interplanetary space missions in the future.*”

system – cosmic rays are deflected and decelerated by the turbulent magnetic fields of the Sun and by the out-flowing solar wind. These built-in shields provided by the Sun decrease the flux of cosmic rays that reaches Earth.

“This shield is not stationary though. Instead, it changes periodically with the 11-year change in the Sun’s magnetic activity cycle. The visible change of the cosmic-ray flux with the Sun’s magnetic activity is known as solar modulation of the cosmic-ray flux on Earth,” notes Prof. Bruna Bertucci, who has been in charge of the EU-funded Marie Skłodowska-Curie Individual Fellowships grant for the MATISSE (Multichannel Investigation of Solar Modulation Effects in Galactic Cosmic Rays) project.

Researchers modelled solar modulation to better understand the process by which the Sun’s changing activity influences the cosmic-ray flux that reaches Earth.

SKIRTING LIMITATIONS

Researchers have poured time and effort into establishing a general framework to interpret different types of data that are usually analysed in physics separately. “We believe that progress in the field of solar modulation relies crucially on merging expertise from different fields. Different field activities include direct measurements on high-energy particles collected in space, counting rates from ground-based neutron monitors, and observations of the Sun’s magnetic activity operated by space probes or solar observatories,” emphasises Prof. Bertucci.

For a long time, the study of solar modulation has been limited by the scarcity of cosmic-ray data. “Nowadays, the Alpha Magnetic Spectrometer (AMS) – a particle physics experiment module that is mounted on the International Space Station – which has been listening for cosmic-ray strikes over the past seven years offers researchers the opportunity to make substantial advances in the field,” notes Prof. Bertucci.

The data from the AMS is highly valued because they accurately measure the behaviour of all different cosmic ray species over a wide energy interval and along an

extended time period; prior to its installation, researchers had to rely on data sets of few particle species with higher error rates, limited either in energy or in time or both.

COMPLEX TIME-DEPENDENT BEHAVIOURS

In collaboration with researchers working on the AMS, MATISSE has contributed to the measurement of the temporal variations of the proton, helium, electron and positron fluxes in cosmic rays. Researchers have reported that the proton and helium flux densities that reach Earth every month increase when solar activity is low – just like after the solar maximum that occurred in 2014.

If results are seen on a yearly timescale, the ratio between proton and helium fluxes shows a remarkable long-term relationship. This puzzling behaviour reflects fundamental properties of the cosmic-ray transport in the Heliosphere and is now under further investigation.

PROTECTION AGAINST COSMIC RAYS

By modelling basic transport processes in the Heliosphere, the team explored the time lag between the solar activity changes and the corresponding changes in the cosmic-ray flux measured in Space. They compared the outputs of their cosmic-ray modulation model to the large collection of observations of cosmic-ray proton fluxes over time. This helped them demonstrate that the best fit to data occurs with an eight-month lag between the solar cycle and the cosmic-ray flux variation.

Project findings are very important as knowledge of the current solar activity could allow us to accurately predict the solar modulation that will occur eight months from now. “In crewed missions, the exposure to the cosmic radiation represents an important risk factor that has to be quantitatively addressed. If this model is correct, it will enable us to plan safer interplanetary space missions in the future,” notes Prof. Bertucci.

MATISSE

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- Coordinated by the University of Perugia in Italy.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/203324



FUNDAMENTAL RESEARCH

A unitary theory of metric analysis helps unveil structures within data

As the EU-funded MANET project worked with abstract geometric structures, it was able to model a range of phenomena as integral curves of vector fields. This allowed the project to shed light on retinal vessels and cortical connectivity, as well as vehicle dynamics and traffic flow.

Measurement underpins much of our understanding about the world – with metrics a branch of mathematics used to measure distances between points in geometrical settings. Metric analysis allows researchers to consider problems in understanding the structure of non-regular spaces, referred to as ‘non isotropic’, where movements in some directions are precluded by a constraint. This is perhaps best demonstrated by the movements of robots, typically constrained by the physical relation between parts.

However, metric analysis is proving to be inadequate for fully describing and explaining movement in all systems in time and space. The EU-funded MANET (Metric Analysis for Emergent Technologies) project was established to develop a unitary theory of metric analysis with

the potential to answer long-standing open problems in mathematics, so far unsolvable using a singular approach.

The project developed new instruments for metric analysis, applicable to a broad spectrum of emergent technologies, with a concentration on computer vision, brain models and traffic dynamics.

‘THE GEOMETRY OF THE AMBIENT’

Explaining the inception of MANET, project coordinator Prof. Giovanna Citti, says, “Mathematics is the language of science, yet despite a large amount of data generated from new technologies, from different scientific domains,

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we still don't always understand the underlying structures of the phenomena they refer to. MANET developed metric analysis tools that probe the geometry of biological and complex systems."

In its quest for a unitary theory, MANET applied a variety of approaches, such as geometric measure theory and minimal surface theory, to open mathematical problems. The team were especially interested in investigating so-called degenerate partial differential equations (PDEs). These are equations which can describe the relationship between the function of a phenomenon and its rates of change – when this has an unknown number of variables. It is an approach often used to explain phenomena such as heat or sound.

As Prof. Citti elaborates, "MANET used very sophisticated instruments to study apparently different problems, such as understanding human vision and traffic flow. From a mathematical point of view these structures can be similarly described."

OF THEORETICAL AND APPLIED INTEREST

MANET's unitary theory succeeded in shedding more light on the structure and functionality of the parts of the brain responsible for perceptual phenomena. In particular, the research looked at how visual illusions can occur and at the ability of the brain to recognise 'perceptual units', grouping a multitude of elements such as a flock of birds, in its attempt to make sense of the world.

The work produced useful results for the future design of computer visualisation and interpretative devices, such as medical diagnostics.

MANET's work, to more accurately map the activation of retinal vessels in time and space within the visual cortex of the brain, has wider implications. As Prof. Citti expounds, "Our method is really powerful because it allows us to represent and classify the retinal vessels across different planes and dimensions, giving us rare unambiguous detail. This approach can be applied to study a range of degenerative illnesses, such as diabetics, since curvature and other geometrical properties of retinal vessels are considered efficient biomarkers."

In terms of its focus on traffic flow, the project started from an abstract mathematical theory called 'transportation theory' which they then applied to traffic dynamics to create a model capable of calculating the probable density of traffic at different times and different places, of obvious use to urban planners.

As Prof. Citti concludes, "I think that our results on metric analysis offer instruments to all mathematical fields from geometry to probability theory, as they provide elements useful to a wide range of models."

MANET

- Coordinated by the University of Bologna in Italy.
- Funded under FP7-PEOPLE.
- cordis.europa.eu/project/rcn/109584

FUNDAMENTAL RESEARCH

Role of consonant bias in word learning in infants

EU-funded scientists have investigated speech-sound processing in human infants to determine its role in the development of language and understand the origins of the consonant/vowel functional bias.

In speech processing as well as in the world's languages, there is bias towards consonants compared to vowels. Consonants are more suited to lexical processing, while vowels are better for syntax-related processes. However,

it wasn't known whether this 'division of labour' was a uniquely human attribute that plays a role in early syntax and lexical acquisition, or the result of the asymmetry present in the input.

“*The ability to target consonants preferentially in words may be a uniquely human ability.*”

The Horizon 2020 SPIDE (Speech-sound Processing in Infant Development and Evolution) project addressed this question, exploring the developmental and evolutionary origins of an infant's ability to assign specific functional roles to the different categories of sound comprising speech.

Researchers conducted experiments on infants and rats to test the hypothesis that the disproportionate use of consonants compared to vowels is not a by-product of their physical differences. They also investigated whether it plays a significant role in early language acquisition and if it derives from more general biases shared with other species.

A BIAS TOWARDS CONSONANTS

Scientists used both behavioural and neuroimaging techniques to investigate the origins of the consonant/vowel asymmetry in language acquisition and evolution. “Our studies of infant behaviour showed that infants learning Spanish switch from an overall bias for vowels in familiar words when five months old, to favouring consonants at 12 months,” say project coordinator Prof. Juan Manuel Toro and Marie Curie grantee Dr Camillia Bouchon.

The use of eye tracking revealed that younger infants respond more after vowel mispronunciations than after consonant mispronunciations. Interestingly, this pattern was reversed in older infants who responded more after consonant mispronunciations than after vowel mispronunciations. A comparative study using the same stimuli in laboratory rats demonstrated significantly greater sensitivity to a vowel mispronunciation than to a consonant mispronunciation.

Results suggested that there is a transition from an acoustical strategy to a phonetic one during language learning in infants. “Vowels appear to be better for lexical recognition in both five-month old human infants and in a non-human species, suggesting that the ability to target consonants preferentially in words may be a uniquely human ability,” explains Prof. Toro.

LANGUAGE DEVELOPMENT

SPIDE has increased scientific understanding of language acquisition and how human predisposition for language evolved. According to Prof. Toro: “It also contributes to research on impaired language development, identifying the early signs of speech sound processing delays in babies and how exposure to more than one language may influence the use of consonants and vowels.”

In addition, SPIDE showed that the ability to assign a particular linguistic role to consonants in words is not present in non-human animals such as laboratory rats, even when they are able to perceive and categorise consonant and vowel sounds and memorise word forms. This suggests that this ability is part of the uniquely human ability for language.

The project's results will provide scientists with a better understanding of the developmental and evolutionary origins of consonant/vowel functional bias. “Our findings may act as a potential precursor of specific language impairments, like dyslexia and other language development related disorders, and help create suitable therapies,” Prof. Toro and Dr Bouchon conclude.

SPIDE

- Coordinated by Pompeu Fabra University in Spain.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/200464





AGENDA

FEBRUARY 2018

WORLDWIDE
World Cancer Day
→ worldcancerday.org

**4
FEB**

**5→7
FEB**

SINT-GENESIUS-RODE, BELGIUM
MYRTE Final International Conference:
'Accelerator driven HLM nuclear reactor
for transmutation and high-tech
applications'
→ vki.ac.be/index.php/component/jevents/eventdetail/491

WORLDWIDE
International Day of Women and
Girls in Science
→ un.org/en/events/women-and-girls-in-science-day

**11
FEB**

**12→14
FEB**

KOLI, FINLAND
DIABOLO Final Conference
→ diabolo-project.eu/2018/10/diabolo-final-conference-12-14-february-2019

**AMSTERDAM, THE
NETHERLANDS**
International EPRISE Roadshow
→ photonicsroadshow.eu/events/2018-11-23-amsterdam

**14→15
FEB**

**20
FEB**

BRUSSELS, BELGIUM
5th 'A Healthy Diet for a Healthy Life'
International Conference
→ healthydietforhealthylife.eu/index.php/5th-international-conference-of-jpi-hdhl?jij=1541329006231

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EVENTS**
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events](http://cordis.europa.eu/events)

**5-7
FEB**

BRUSSELS, BELGIUM

BAMB Final Conference: 'Building as Material Banks – A Pathway for a Circular Future'

As the Horizon 2020 BAMB project comes to an end, the project will be hosting an industry conference (5 Feb) to share the BAMB tools and results with industry players and then two BAMB 'Industry Days' (6-7 Feb) bringing together researchers and experts on the built environment from around the world. Part of the prestigious SBE19 Conference Series.

→ bamb2020.eu/post/bamb-final-event

UPDATED CORDIS RESULTS PACK ON PRECISION FARMING

Precision farming is at the forefront of a 21st century agricultural revolution, promising increased production whilst ensuring sustainability. We've added four new project articles to our updated Results Pack on Precision Farming – check out the Pack here:
cordis.europa.eu/article/id/400295



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