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#100
MARCH 2021

Research eu

BRINGING YOU THE RESULTS OF EU RESEARCH AND INNOVATION

The first oral vaccine against diarrhoea

Giving artisanal butchers a competitive edge over industrial producers

Faster, more efficient industrial robots with real-time motion planning

SPECIAL FEATURE

THE NEW SYNERGIES OF SHOPPING: E-COMMERCE OR 'BRICKS AND MORTAR'?

Welcome to the 100th issue of Research*eu magazine!

Foreword by

Mariya Gabriel,
European Commissioner for Innovation, Research, Culture, Education and Youth

Research and innovation are crucial for Europe's recovery and sustainable future. They can help us solve some of the greatest challenges faced by our societies today, such as climate change, digital transformation and the coronavirus pandemic.

Disseminating research results to the individuals, industries and organisations that can utilise them best has been the key role of the Community Research and Development Information Service (CORDIS) over the past 30 years.

Reaching its 100th edition, the Research*eu magazine has contributed to this endeavour for over a decade now.

The return on our investments and the overall impact on society of Horizon Europe, the European Union's new research and innovation programme, depends on the effective communication, dissemination and valorisation of its results.

I am confident that promoting the outcomes of a broad range of EU-funded projects through a range of channels will play a fundamental part in achieving our common goals.

Editorial

Exploring the evolving synergies of shopping, how one EU-funded SME bucked the 2020 trend with their innovative rail haulage solution and getting to grips with quantum entanglement

Indeed, we are celebrating our **100th issue**, and following the kind words of Commissioner Gabriel we are also taking a trip down memory lane with a commemorative article that charts the rise and evolution of Research*eu magazine over the years. Many thanks to all of our readers for being with us all this time and a warm welcome to our newest readers, we hope you stick around for the ride!

Also, in this issue's special feature, we look at how technology is transforming how we shop by meeting seven EU-funded projects that are working in fields that will have a profound impact on the retail and commercial landscape of the next few years. From integrating innovative robotics into 'bricks-and-mortar' physical shops to increase their appeal to savvy new products to make e-commerce that little bit more convenient and environmentally friendly, it looks safe to say that with the future of shopping in a post-COVID world, nothing is set in stone.

And of course, we have our regular **Life After, Project of the Month** and **EU Agenda** features for you to get stuck into!

As always, if you have any queries, questions or suggestions (but hopefully never a complaint), please feel free to drop us a line at editorial@cordis.europa.eu.

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HEALTH

The first oral vaccine against diarrhoea

Enterotoxigenic Escherichia coli *bacteria are responsible for traveller's diarrhoea, the most common illness affecting over 35 million travellers every year. The ETVAX project successfully developed and tested a vaccine to protect travellers and children from low-income countries against diarrhoea caused by the bacteria.*

Enterotoxigenic *Escherichia coli* (ETEC) bacteria cause diarrhoea by ingestion of contaminated food or water. They colonise the small intestine and excrete toxins that induce fluid accumulation in the intestine, causing diarrhoea. Currently, there is no approved method for preventing ETEC-associated diarrhoea, and the recommendation is to use off-label antibiotics, such as Rifaximin, or the cholera vaccine Dukoral.

A VACCINE AGAINST ETEC

To address this problem, the EU-funded ETVAX (The first oral vaccine for protection against traveller's diarrhoea caused by ETEC) project developed the first oral vaccine in the world against ETEC-induced diarrhoea. "The ETVAX® vaccine consists of four different inactivated recombinant *Escherichia coli* strains expressing the most prevalent factors necessary for bacteria colonisation, as well as a toxoid for the LT toxin present in up to 60 % of all ETEC isolates," explains Björn Sjöstrand, ETVAX coordinator and CEO of Scandinavian Biopharma. The vaccine also includes the double-mutated enterotoxin of *Escherichia coli* dmLT as a mucosal adjuvant.

The vaccine is in late phase development. Six clinical studies for the adult indication and one clinical study for the paediatric indication have been successfully completed. The vaccine demonstrated an excellent safety and immunogenic profile in paediatric populations of studies conducted in Bangladesh and Zambia.

Two doses of ETVAX® were sufficient to mount significant mucosal immunoglobulin A immune responses against all vaccine antigens in all age groups, exceeding expectations. Interestingly, immune responses correlated with age, with the strongest and most pronounced response against all antigens being observed in adults and moderately decreasing by age. Further, the dmLT adjuvant enhanced the magnitude, breadth and kinetics of immune responses in infants, indicating its potential to drive early onset of immunity.

After receiving funding from the European & Developing Countries Clinical Trials Partnership, Scandinavian Biopharma initiated trials in Zambia and Gambia with so far promising results. "The outcome of these paediatric trials will pave the way for the pivotal Phase 3 trial which will lead to the pre-qualification of ETVAX® by the World Health Organization," emphasises Sjöstrand.

Furthermore, promising results were obtained in a randomised, placebo-controlled trial of ETVAX® in over 720 Finnish adult travellers in West Africa. Although the protective efficacy goal of 70 % against traveller's diarrhoea (TD) was not achieved, good vaccine immunogenicity was observed, along with broad protective efficacy against all ETEC and bacterial co-pathogens and parasites. As a result, participants had milder enteric illness and required fewer antibiotics. The vaccine offered broad significant protective efficacy against all ETEC, bacterial co-pathogens and parasites as well as against more severe TD. As a result, participants had milder enteric illness and required fewer antibiotics.

> *"ETVAX® will address a significant unmet medical need for the efficacious and durable prevention of bacterial diarrhoea in children living in developing countries."*

© Janet Chinyama, CIDRZ

HEALTH IMPACT

ETEC is a major cause of diarrhoeal disease in children in ETEC-endemic countries, leading to approximately 400 000 deaths in children below 5 years of age every year. According to Sjöstrand: "ETVAX® will address a significant unmet medical need for the efficacious and durable prevention of bacterial diarrhoea in children living in developing countries."

It is estimated that the vaccine alone ultimately has the potential to save thousands of lives and reduce morbidity leading to poor physical and cognitive development among infants. Considering the safety data seen in children from 6 months of age, ETVAX® stands out from other vaccine candidates that are under development against ETEC-induced diarrhoea. With respect to TD, a vaccine against ETEC would prevent the loss of millions of well-deserved holiday trips and negative long-term gastrointestinal syndromes.

ETVAX

- Coordinated by Scandinavian Biopharma Holding in Sweden
- Funded under Horizon 2020-HEALTH
- cordis.europa.eu/project/id/778253
- Project website: scandinavianbiopharma.se

Pioneering foam therapy offers hope to lung patients

Acute respiratory distress syndrome is a leading cause of death in COVID-19 patients and also has a devastating impact on sufferers of other conditions. A breakthrough drug delivery device has demonstrated huge potential in treating this deadly lung condition.

Acute respiratory distress syndrome (ARDS) is an inflammatory lung condition that has become the leading cause of death in COVID-19 patients. This rapidly progressing disease is characterised, among other factors, by the depletion of the lungs' inner liquid coating, necessary for the lung's expansion. This is exacerbated by the coronavirus.

"There is at present no effective treatment against this," notes the EU-supported LIFT (Liquid Foam Therapy (LIFT) for Acute Respiratory Distress Syndrome (ARDS)) project coordinator Josué Sznitman, associate professor of biomedical engineering at Technion – Israel Institute of Technology.

"Patients are mechanically ventilated with supplemented oxygen, in the hope that their lungs can heal themselves. However, about 40 % of those afflicted with ARDS are likely to die."

BETTER DRUG DELIVERY

A key challenge in treating this condition is getting the medication to where it is needed within the lungs. Common devices, such as nebulisers, are unable to effectively deliver drugs to the lungs, since only small particles can be inhaled, so doses remain low. Direct instillations of liquids into the lungs lead to bad drug distribution, as liquids drain downwards with gravity.

The LIFT project sought to address this by developing a unique foam formulation and delivery device, to treat ARDS and, potentially, other lung conditions.

"We wanted to demonstrate, in this project, that delivery of our foamed surfactant, used to replace the lungs' inner liquid coating, could be an effective treatment," says Sznitman. "We wanted to show that our foam is superior to liquids which have been unsuccessfully used in previous clinical trials."

Using rat and pig models, the project team set about demonstrating the efficacy of its patent pending technology. A working prototype of the Liquid Foam Therapy (LIFT) drug delivery device was constructed, and preclinical experiments were carried out using rats first.

Following successful results in rats, they then used porcine lungs. "Pig lungs were used to see if the treatment and the device would be effective in achieving homogenous drug distribution in larger human-sized lungs," explains Sznitman.

NEW LUNG TREATMENTS

The project team was able to demonstrate how foam can be effectively delivered to coat the inner lungs, opening the door to a new era of treatments for ARDS and other lung conditions.

The successful animal trials conducted during the LIFT project enabled the team to start preclinical trials in large animals. These will hopefully enable the team to start

> *This drug delivery technology can be leveraged for other lung therapies.*

clinical trials, treating – and ultimately saving the lives of – real patients. "The long-term goal is that this will become the gold standard for treating ARDS," says Sznitman.

The project team is also looking to broaden the use of this technology to deliver other therapies. "For example, we are exploring the possibility of delivering large doses of steroids to treat ARDS, including for severe COVID-19 patients," notes Sznitman.

"The results of the LIFT project have the potential to extend far beyond ARDS treatments," he remarks. "This drug delivery technology can be leveraged for other lung therapies, such as delivering stem cells directly to the lungs to treat conditions like chronic obstructive pulmonary disease (COPD)."

To realise all this potential, a start-up company, called Neshima Medical, has been launched. The aim is to bring these life-saving treatments for lung disorders to market as quickly and as safely as possible.

"We plan to finalise the clinical prototype of our delivery device by the end of 2020, and then prepare for clinical trials," adds Sznitman. "We are confident that we will be bringing to market a breakthrough pulmonary drug delivery device, applicable across a broad range of lung diseases."

LIFT

- Hosted by Technion – Israel Institute of Technology in Israel
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/813228
- Project website: bit.ly/LIFT-ards

HEALTH

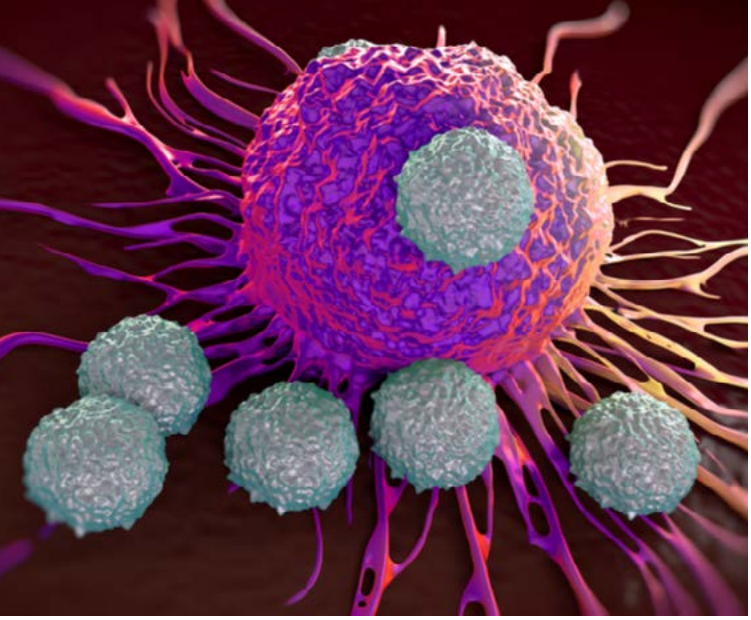
Combining metabolism manipulation with immunotherapy as an alternative anticancer strategy

Stimulating the immune system to fight cancer is the most significant breakthrough in anticancer therapy in the past few years. Scientists of the Immunometabolomics project have investigated ways to enhance immunotherapy by modulating the metabolism of immune cells.

Despite promising preclinical results, immunotherapy has not proved as effective in many cancer patients. The conditions in the tumour microenvironment in terms of nutrient supply, oxygen levels and acidity may contribute to immunotherapy efficacy by impacting immune cell activation and function. Moreover, the different cell types present in tumours may synergise or compete metabolically.

STUDYING THE METABOLISM OF ANTITUMOUR T-CELLS

To provide insight into immune cell metabolism, scientists from the Immunometabolomics (CD8+ T cell metabolism in anti-tumor response) project have focused on cytotoxic CD8+ T-cells known for their exceptional cytotoxic activity and killing of tumour cells. The research was undertaken



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with the support of the Marie Skłodowska-Curie Actions (MSCA) programme and followed two different research leads. The first was the pentose phosphate pathway that generates the high-energy molecule nicotinamide adenine dinucleotide phosphate (NADPH) necessary for anabolic reactions and ribose-5-phosphate sugar synthesis used in DNA and RNA. The second pathway was serine catabolism implicated in nucleotide synthesis.

The MSCA research fellow Juan Carlos García-Cañaveras along with the team of Agustín Lahoz at IIS-Hospital La Fe in Valencia cultured CD8+ T-cells *in vitro* in different media or under pharmacological inhibition of specific enzymes, such as glucose-6-phosphate dehydrogenase (G6PD) which is implicated in the pentose phosphate pathway. Using flow cytometry, they characterised the activation and proliferation of T-cells as well as their effector function through interferon-gamma and tumour necrosis factor-alpha production. They also performed metabolomics analysis using liquid chromatography coupled to mass spectrometry that allow for monitoring the incorporation of carbon isotopes into downstream metabolites and for inferring changes in metabolic pathways.

"We have overcome technical limitations and, using state-of-the-art mass spectrometry-based metabolomics, we have advanced into knowledge the CD8+ T-cell metabolism," emphasises Lahoz. Through novel cellular assays, the research team was able to assess the pentose pathway in a more sensitive and specific way and develop specific inhibitors for targeting G6PD in cells. These tools were central for deciphering the role of G6PD in effector CD8+ T-cell responses.

> *"We have overcome technical limitations and, using state-of-the-art mass spectrometry-based metabolomics, we have advanced into knowledge the CD8+ T-cell metabolism."*

Results showed that inhibition of the pentose phosphate pathway decreases effector response in CD8+ T-cells and can thus serve as a potential therapeutic target in autoimmune diseases. Ongoing work will determine if time-controlled enhancement of the pentose pathway in CD8+ T-cells could increase effector responses and antitumour activity. Moreover, the Immunometabolomics team is interested in the relevance of the pentose pathway in the low-glucose tumour microenvironment.

INSIGHT INTO SERINE METABOLISM UNVEILS NEW THERAPEUTIC TARGETS

With respect to serine metabolism, scientists developed an inhibitor against the key enzyme serine hydroxymethyltransferase (SHMT) implicated in nucleotide synthesis and thus in proliferation. Blocking serine catabolism in T-cell acute lymphoblastic leukaemia (T ALL) inhibited proliferation *in vitro* and increased survival in a mouse model of the disease. Collectively, these findings indicated that SHMT inhibition could serve a complementary strategy in the treatment of T ALL.

"Overall, enhancing antitumour immune responses is a key objective of our team, and we want to evaluate the combination of metabolism manipulation with immunotherapy as an alternative anticancer strategy," concludes García-Cañaveras. The recent regulatory approval of combining antifolate treatment and immunotherapy for lung cancer corroborates the Immunometabolomics anticancer strategy.

Immunometabolomics

- Coordinated by the Health Research Institute Hospital La Fe (IIS La Fe) in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/751423

SOCIETY

West Africa: the final frontier in the study of human evolution

Archaeological fieldwork in West Africa is expanding our knowledge about human evolution and helping unravel the story of our success as a species.

It has long been believed that Homo sapiens evolved from a single population located in a single place in Africa. However, new evidence is challenging this assumption.

"Recent research suggests that humans evolved from a diverse set of African populations who lived in different regions, from present-day Morocco to South Africa," says Eleanor Scerri, head of the Pan African Evolution Research Group at the Max Planck Institute for the Science of Human History.

In the aWARE (West Africa's Role in Human Evolution) research project, undertaken with the support of the Marie Skłodowska-Curie Actions, Scerri set out to get a better understanding of the range of environments and regions that shaped our species.

"To help fill the gaps in our origin story, we conducted an archaeological investigation across West Africa, one of the final frontiers for the study of human evolution," adds Scerri.

GROUNDBREAKING DISCOVERIES

Scerri says that going into the project, she was unprepared for West Africa's archaeological richness. "The first thing I had to do was strategise and decide which key sites needed to be prioritised," she explains. "However, because these priority sites were often remote and well off the grid, I also needed to do a significant level of fieldwork planning."

The planning paid off, as Scerri's fieldwork resulted in numerous groundbreaking discoveries. For example, the first and longest cultural phase associated with humans in Africa first emerged around 300 000 years ago. By 50 000 years ago, this original culture, termed the 'Middle Stone Age', began being replaced by a radically different one. This was happening everywhere in Africa, with the exception of West Africa, where the Middle Stone Age lasted another 20 000 years.

"By 11 000 years ago, our research showed that groups of hunter-gatherers using very different material cultures coexisted in the same river valley," remarks Scerri. "This is one of the earliest examples of cultural boundaries in the human record."

According to Scerri, the region's remoteness and ecological diversity may have played a role in isolating West Africa from the new technologies and lifestyles that were spreading across the rest of the continent. "Evidence suggests that the region acted as a reservoir for material culture and possibly even biological diversity over time," she adds.

If this is true, then West Africa's role in the human story may be incredibly important. "It's always been assumed that early human groups in different regions of Africa frequently went extinct," notes Scerri. "Finding areas where they could have survived – even thrived – for long periods of time helps us unravel the story of our success as a species."

> *"To help fill the gaps in our origin story, we conducted an archaeological investigation across West Africa, one of the final frontiers for the study of human evolution."*

A CRITICALLY IMPORTANT REGION

The aWARE project was the first of its kind to focus on human evolution in West Africa, conducting interdisciplinary fieldwork spanning several countries and ecosystems. As such, it laid the foundation for expanded studies and established West Africa as a critically important region for understanding human evolution – a region that we can no longer afford to ignore.

"It was once considered a fringe statement to suggest investigating the whole of Africa as a means of understanding human evolution," concludes Scerri. "Now, thanks in part to the work of the aWARE project, this is becoming the dominant view."

aWARE

- Coordinated by the Max Planck Society for the Advancement of Science in Germany
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/794117

SOCIETY

How infrastructure, mobility and politics in modern-day Asia have an influence on Europe

Knowing where, why and to what extent roads are being built between China and South Asia benefits Europe. Understanding contemporary dynamics between rising powers provides context on global politics and informs decision-making for EU investment and development interventions in Asia.

Bridging awareness of the geopolitical drivers and social impacts of rural road development in Asia's rugged highland areas is a pressing challenge for this century. Territorial conflict between China and India has complicated bilateral connections for decades. However, mutual economic, political and social interests have

facilitated new development interventions across the Himalayas. It's important to understand what happens in these remote frontiers and their significance in the world.

The EU-funded Road Diplomacy (International Infrastructure and Ethnography of Geopolitics in 21st Century Asia) project analysed and mapped the development of road infrastructure systems throughout politically sensitive and rapidly transforming regions of Asia's highlands. The focus was between China and South Asian countries such as Bhutan, India, Nepal and Pakistan. It investigated the geopolitical drivers and social impacts of road construction to work out the interrelated geopolitical and social impacts of infrastructure development on villages and countries as well as around the world.

INFRASTRUCTURE DEVELOPMENT CHANGES LIVES

Project researchers produced new empirical data on infrastructure development in 21st century Asia to generate an informed perspective on the social and geopolitical impacts of infrastructure development in the region. They also proposed a framework to better understand how similar processes operate in other global regions. "This is all of great importance today, particularly with respect to the rise of China as a global development and economic actor and leader of international finance and infrastructure investment," explains Marie Skłodowska-Curie Actions fellow Galen Murton, whose forthcoming book reveals how road planning, construction and use both reinforce and disrupt social, political and economic relations. "Roads change lives," he adds.

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> *"Specialised understanding of the geopolitics and social impacts of development in 21st century Asia is highly transferable and supports ongoing expert analysis for non-profit organisations, policymakers and donor agencies based in Europe, Asia and North America."*

The team addressed questions concerning sustainable livelihoods in a global hotspot that is rapidly transitioning into a new zone for international exchange. This included a critical cartography of trans-Himalayan road networks and rigorous theoretical and analytical training on infrastructure development with Chinese features for new conceptual frameworks on road diplomacy and inter-Asian interconnectivity.

CRITICAL, INTERDISCIPLINARY LENS ON GLOBAL RELATIONS

In addition, Road Diplomacy developed a more active and robust research network of road studies and infrastructure scholars in Europe, Asia and North America. Murton fostered close collaborations with six international research teams.

Results generated by the project have been used to improve interdisciplinary communications for social scientists and between development practitioners, donor agencies, policymakers and local stakeholders. Outputs have also helped to bridge the sectors of academia and development.

"Specialised understanding of the geopolitics and social impacts of development in 21st century Asia is highly transferable and supports ongoing expert analysis for non-profit organisations, policymakers and donor agencies based in Europe, Asia and North America," concludes Murton. "Road Diplomacy delivered new geographic insight that bridges international relations and anthropology and brings new knowledge to bear on contemporary studies of Asian geopolitics, international economics and global development."

Road Diplomacy

- Coordinated by Ludwig-Maximilians University of Munich in Germany
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/751131
- Project website: bit.ly/Road_Diplomacy
- bit.ly/road_diplomacy_pres

CELEBRATING

So, we've reached triple digits – **Celebrating 100 issues** of Research*eu magazine

*Research*eu magazine has been one of the shining jewels in the CORDIS editorial crown now for 10 years and so, to mark our 100th issue, we've been taking a little trip down memory lane and we invite you, our dear readers, to come along with us.*

Ten years is a mere drop in the bucket of history but the last 10 years have been particularly eventful, from various economic crises, tumultuous politics across the world and continued jumps in technological advancements that have become more and more vital to our everyday lives, from social media, to the ongoing maturity of technologies such as AI and Big Data. The world has also become much more aware of the dangers of climate change and efforts to tackle it have become increasingly serious. And of course, in the last year alone, we've had to deal with the health, economic, social and political fallout from the worst pandemic in a century.

Much of the cutting-edge research funded through EU programmes, from Horizon 2020 and now Horizon Europe, is dedicated to addressing these fundamental societal challenges faced not only by EU citizens but by everyone across the globe. And it has been our privilege over the last 10 years to disseminate the exciting EU-funded research results that are making all the difference.

Whilst the first issue of Research*eu was released in April 2011, we have to admit our origins go further back, first to 2008, when this magazine's direct predecessor was the *research*eu results supplement*, the more technical supplement to a more generalist magazine (the original *research*eu*, which is the predecessor of our sister EU online publication, *Horizon magazine*). But then we can travel back even further to 1994, when the *CORDIS focus* newsletter – the grandparent of them all – was published until 2007, when the *research*eu* era was ushered in.

History lesson aside, we're proud to have covered some truly fascinating topics over the last decade and showcased the EU-funded researchers who really have made waves in their specific field of interest.

To highlight just three examples, the EU research community's sustained focus on new technologies and solutions to work for a more sustainable world (issues 2, 13, 16, 19, 25, 34, 38, 54, 64, 86, 92 and 94), exciting developments in European space exploration (issues 5, 32, 53, 67, 73 and 90) and the development of innovative treatments for many major illnesses, such as cancer, infectious diseases and mental health disorders (issues 6, 7, 18, 22, 47, 50, 55, 65, 71, 76, 79, 84, 89 and 97).

Graphically, we have also gone through three comprehensive revamps over our 100 issues to keep the magazine fresh, with the latest incarnation happening from issue 76 onwards. We've over time also introduced new features as a response to valued reader feedback and suggestions, such as the EU Agenda events list and, most recently, the launch of the successful 'Life After' and 'Project of the Month' line of articles.

The print editions in English are posted for free to our thousands of worldwide subscribers but don't forget you can also read all our issues on cordis.europa.eu in French, German, Italian, Polish and Spanish.

So now as we embark on the beginning of the next era, our passion to bring our readers the very best EU-funded research results has not dimmed – and so to conclude this commemorative article, we went back to the editorial of the very first *Research*eu* in 2011 that poetically summarises the philosophy that has driven us over the past 10 years:

"Curiosity has long been the origin of some of humanity's most crowning achievements. Driven by wonder and imagination, scientists have often initiated the first step towards a spellbinding discovery. Centuries ago, mathematicians working by candlelight laid the foundation for modern computing. And few could ever have imagined how far their research has changed the world today."

And on that note, thanks for being with us and please, stay with us as we continue on our voyage of discovery together!

TRANSPORT AND MOBILITY

Composite materials herald the next generation of lightweight large-scale ships

Fibre-reinforced polymers offer shipbuilding that is more versatile, cost-effective and environmentally friendly. FIBRESHIP has demonstrated its viability.

Fibre-reinforced polymers (FRPs) offer multiple advantages to those involved in large ship construction. Being light, they reduce the weight of ships and so the power required, resulting in operational savings. FRP materials do not suffer from corrosion, therefore reducing maintenance costs. Compared to steel-based ship production, they generate fewer polluting emissions and while in service create less underwater noise, benefitting marine life.

To demonstrate the viability of using FRP for shipbuilding, the EU-supported FIBRESHIP (Engineering, production and life-cycle management for the complete construction of large-length FIBRE-based SHIPs) project designed three vessels: a 265-metre containership, a 204-metre roll-on/roll-off passenger (ROPAX) vessel, and an 85-metre fishing research vessel (FRV). These three categories of vessel were selected to demonstrate not only a range of market applications, but also structural configurations.

Compared to steel-based conventional ships, all three vessel designs were shown in simulations to achieve a significant structural weight reduction: 45.9 % for the containership, 36.2 % for the ROPAX and 69.6 % for the FRV.

An 11 x 11 x 8.6 metre demonstrator, weighing 20 tonnes, was built for a section of an 85-metre FRV. A test was performed on a structural FIBRESHIP-based bulkhead which surpassed the strict IMO FTP Code Part 11 on fire safety requirements. The material was resistant to fire for 83 minutes, exceeding the required time by 23 minutes.

© FIBRESHIP Consortium

"Despite some fire safety features, which need to be improved, and regulatory challenges to be overcome, FIBRESHIP shows it will soon be feasible to construct large-scale, sustainable ships using FRP materials," says project coordinator Alfonso Jurado, from TSI, the project host.

SUPPORT TOOLS

FIBRESHIP's vessel designs will be equipped with structural health monitoring systems to evaluate their hull-girder condition. To demonstrate this concept, an array of sensors was fitted to monitor the structural behaviour of a steel-based 260-metre containership, ZIM Luanda, and can be extrapolated to long-length fibre-based vessels.

"We monitored local deformations and general torsional and bending deformations of the hull-girder in real time, as the vessel travelled from Spain to Canada," explains Jurado.

To ensure safety and reliability, FIBRESHIP developed a series of software analysis tools. These checked issues such as fire resistance, thermal degradation, structural health, fatigue loads, dynamic structural behaviour and hydrodynamic performance. Underwater noise levels were also calculated, showing that the acoustic signature emitted by the fibre-based FRV was well below the maximum levels recommended by regulations.

The team created inspection and maintenance procedures for FRP-based ships to detect and control defects such as delamination failures in FRP bulkheads.

"We also developed a decision support tool which showed that FRP materials offer superior performance while costing less and needing less energy over their lifespan. Additionally, we created a cost-benefit calculator to estimate the cost of the building, operating and dismantling phases," notes Jurado.

> *"FIBRESHIP shows it will soon be feasible to construct large-scale, sustainable ships using FRP materials."*

REVOLUTIONISING EUROPEAN SHIPBUILDING

The versatility of FRP manufacturing enables the construction of more complex hull and superstructure geometries. The result can be more attractive than steel versions, an important factor when it comes to passenger transportation and leisure vessels. But it's not just a question of looks. As the vessels are quieter, they are also more comfortable.

To advance the work, the team is now working to reduce building costs and time using modular and automatised manufacturing and assembly techniques. They are also developing recycling and waste management procedures for dismantling.

"It is really important that these vessels enter the European circular economy strategy," adds Jurado.

FIBRESHIP

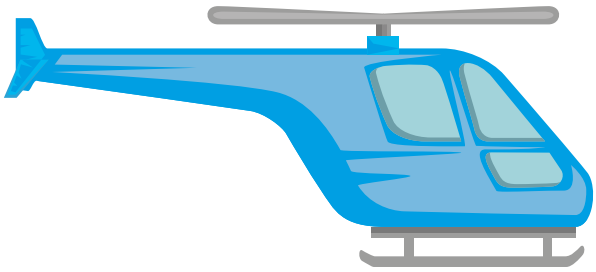
- Coordinated by TSI in Spain
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/723360
- Project website: fibreship.eu
- bit.ly/fibreship_video

TRANSPORT AND MOBILITY

Gearbox test rig for next-generation compound helicopter

For the past 60 years, helicopters have been built according to the same basic principle. Now, European partners are developing and testing a revolutionary new design for rotorcraft.

The EU-funded MUTR (Multipurpose test rig for transmissions gearboxes) project focused on the design of the gearbox test system for the newly created Rapid and Cost-Effective Rotorcraft (RACER) helicopter demonstrator. RACER is an experimental compound helicopter developed by Airbus that combines high speed



> *The test rig is a powerful device that allows us to trial not only the normal travel modes, but also all emergency and overload conditions to which the main rotorcraft reducer may be exposed during operation.*

For the past 60 years, helicopters have been built according to the same basic principle

and vertical take-off and landing and features wings and propellers for propulsion support instead of a conventional tail rotor. The rotorcraft is driven by two engines, one of which can shut down and restart once in flight to save fuel and increase range.

Researchers from the Czech Aerospace Research Centre (VZLU) carried out the design and implementation of an auxiliary (adaptive) gearbox that is part of a multipurpose testing device for validating special newly designed helicopter gear reducers for RACER. This is a key component for the helicopter's drive device, transmitting power from two turbo shaft motors to the main rotor and side rotors.

VALIDATED UNDER EMERGENCY CONDITIONS

The team first designed the test rig and then designed, manufactured and tested the hydraulic torque loader (torquer) and the torquer test rig for the validation of RACER. "The test rig is a powerful device that allows us to trial not only the normal travel modes, but also all emergency and overload conditions to which the main rotorcraft reducer may be exposed during operation," states project coordinator Petr Pick.

The proposed test mode comprised four parts: the main gearbox plate, side load groups, adaptive gearbox, and support mechanisms. Validating the main reducer

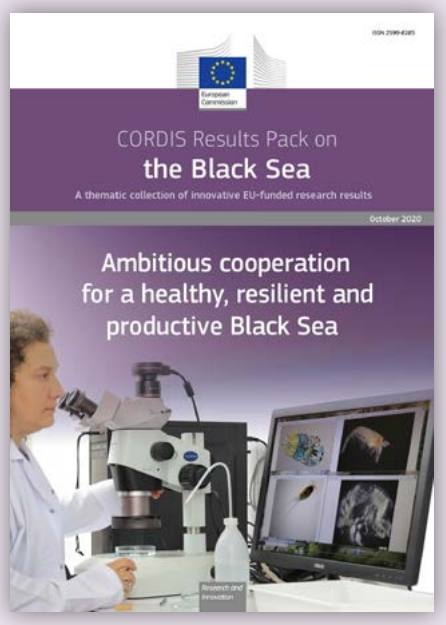
AMBITIOUS COOPERATION FOR A HEALTHY, RESILIENT AND PRODUCTIVE BLACK SEA

Today, the Black Sea is one of Europe's most important seas. Rich in biodiversity, heritage and natural resources, it has been a prominent waterway for goods, ideas and people for millennia. But the Black Sea is facing significant challenges.

In the last 50 years, there has been increasing environmental and ecological pressure on the Black Sea basin. This has mainly been due to the impact of human-induced factors, such as eutrophication (the growth of harmful algal blooms) and hypoxia (loss of oxygen), overfishing and the introduction of alien species. Finally, climate change is also having a clear detrimental effect on the Black Sea.

This CORDIS Results Pack highlights important and cross-sectoral EU-funded research initiatives that have been working towards ensuring the sustainable future of the Black Sea by supporting its research and innovation ecosystem.

To find out more, browse, download or order a physical copy of the Results Pack here: cordis.europa.eu/article/id/422446



on the test rig is the same as for the actual rotorcraft, thus enabling the measured values to be applied to the verification and certification process.

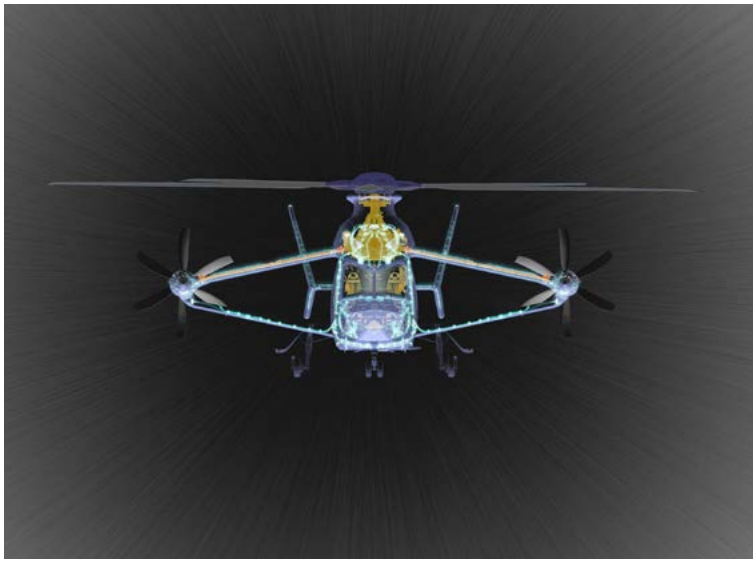
The energy-efficient hydraulic torquer simulated the load from the side rotors. The power transmitted by the shafts representing the drive units was conducted from the adaptive gearbox to the main gearbox, which branches into two side rotor branches and one main rotor branch. The layout results in three power loops in which the power flow can be independently changed, while simultaneously allowing the simulation of running in single-engine inoperative mode and in different flight modes of the machine.

A RELIABLE, EFFICIENT TORQUE LOADER

In addition to two pairs of gears, a unique torquer and torque meter, located in the gearbox, make it possible to perform load tests and calibrate the torquer. The hydraulic system used by the torquer not only loads the torsion, it also solves the problem of cooling gearing and gearbox bearings.

According to Pick: "VZLU is developing the interconnection of the lateral rotor gearboxes via vertical transmission shafting, supported on two or three auxiliary bearing housings, to lock the two gearboxes together. The transmission shafting is connected to the lateral gearboxes by means of bevel gearings."

Gearbox testing requires an efficient, reliable and durable torque loader. MUTR exactly meets all these criteria and has been successfully validated for a load capability up to 5 900 Nm at 3 330 rpm. The device can also be applied to sophisticated load simulation systems like the RACER test rig.



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MUTR

- Coordinated by the Czech Aerospace Research Centre (VZLU) in Czechia
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/717199
- Project website: bit.ly/mutr-project

TRANSPORT AND MOBILITY

Helping aviation embrace data-driven innovation

Due to security and privacy concerns, Europe's aviation sector has long shied away from sharing data between stakeholders. But that could soon change thanks to a new platform that will help aviation better leverage the power of big data, opening the door to a range of industry-disrupting services and solutions.

Industries of all types are using the power of big data and analytics to fundamentally transform how they do business. The notable exception is the aviation industry. In fact, there is currently little data diffusion and sharing between the different stakeholders of the aviation-related sectors.

> *The European aviation industry needs to leverage the surge of multisource data in order to gain augmented intelligence and open the door to a range of unprecedented services.*

"The European aviation industry needs to leverage the surge of multisource data in order to gain augmented intelligence and open the door to a range of unprecedented services," says Dimitrios Alexandrou, business innovation director at UBITECH, a Greek technology company.

With a focus on building a data value chain, the EU-funded ICARUS (Aviation-driven Data Value Chain for Diversified Global and Local Operations) project is helping the aviation industry embrace data-driven innovation. "Using big data analytics, deep learning, data enrichment, and blockchain-powered data sharing, the ICARUS project aims to deliver a unique data and intelligence platform for the aviation industry," adds Alexandrou, who serves as the project coordinator.

A ONE-STOP SHOP FOR AVIATION DATA AND INTELLIGENCE

The objective of the project is to conceptualise, design and develop the ICARUS platform. When finalised, the platform will enable data exploration, blockchain-empowered sharing, and the brokerage of a large variety of heterogeneous data sources. It will also serve as a one-stop shop for aviation data and intelligence – covering the entire big data lifecycle, from data collection to curation, exploration, integration and analysis.

"The platform will provide users with a deeper understanding of, for example, flight optimisation, pollution awareness, tourism operations, the passenger experience – even how aviation can cause an epidemic to spread," explains Alexandrou. "As such, it will be an invaluable tool for the aviation industry, aviation-related service providers, and other cross-sectoral stakeholders."

The platform will also serve as a trusted and secure sandbox-style workspace where users can conduct analytical experiments in a safe and confidential closed-lab environment. "The ICARUS platform aims to address the security and privacy concerns that have made the aviation industry and related industries reluctant to leverage big data technologies," notes Alexandrou.

According to him, the platform has already received expressions of interest from a number of external stakeholders.

ENABLING DATA-DRIVEN INNOVATION AND COLLABORATION

Despite some delays caused by COVID-19, the ICARUS project succeeded in creating a platform that enables data-driven innovation and collaboration across the aviation sector.

"The ICARUS platform effectively addresses the industry's reluctance to explore, curate, share, trade, integrate and deeply analyse big data in a trusted and fair manner," concludes Alexandrou. "In other words, it provides the big data that will drive the design and implementation of the innovative new services that will disrupt the aviation industry."

The platform will soon be available in beta format. Project researchers are currently exploring the best business plan for bringing the platform to market.

ICARUS

- Coordinated by UBITECH in Greece
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/780792
- Project website: icarus2020.aero
- bit.ly/3qdH7Kp

LIFE AFTER...

Catching up with ITECCO Demo: A successful rail freight solution that bucked the 2020 trend

*The ITECCO Demo project ran from October 2016 to March 2019 which allowed Innofreight, an innovative Austrian SME, to develop their 'InnoWaggons' with the aim of increasing rail freight transport productivity, specifically regarding the transport of raw materials, such as steel. We featured the project in issue 88 of Research*eu magazine and to find out how things have gone since the end of the EU-funded project, we catch up with Hannes Pichler, logistician at Innofreight.*

The crux of the Innofreight solution developed during the project ITECCO Demo (Demonstration and market replication of Innofreight's innovative rail logistics equipment for the raw material supply of the steel industry) was a modular platform system centred around the InnoWaggon, allowing for separation of the freight container from the wagon's frame – essentially like a giant LEGO DUPLO set, which was how Pichler originally described the concept to us in our first interview. By the end of 2019, Innofreight had produced and put onto the market around 1200 freight cars and 12000 containers – but how have they done in 2020?

Not such a terrible year

"We prepared for problems," begins Pichler. "But luckily they did not appear, despite the enormous general economic problems caused by the pandemic and the negative effect on industry overall." Indeed, Innofreight have been in the fortunate position that their business did not suffer as expected during such a difficult year.

"We believe the focus and the demand of our customers was even more focused on very modern and high-performance solutions, which we are able to offer," he continues. "We've even begun to connect our specific offer based on the InnoWaggons with accompanying digital solutions. In fact, this has been such a promising prospect that we've founded an entirely new company, Innofreight IT-Solutions GmbH to really take this further." This is just one avenue that Pichler and his colleagues are taking, with an ever-increasing emphasis on making their offers and solutions as flexible and as intelligent as possible.

Up-to-date figures from Innofreight's operating equipment throughout Europe confirm the upward trajectory of the company since 2019, with 15000 containers of different types and 2000 InnoWaggons now on the rails.

Reflecting on EU support

For Pichler, the EU support that Innofreight received under the ITECCO Demo project came exactly at the right time. "It was a moment when the company was transforming from a middling-size company to a larger one. Consequently, the EU funding helped cushion us from the financial risk and this really allowed us to concentrate on producing the best solution possible for our target customers and markets."

© Innofreight

To emphasise this point, Pichler believes that the EU support allowed him and his colleagues to achieve the level of work that would normally take 4-6 years in the space of just two and a half. He concludes: "In hindsight, it was absolutely the right thing to do and helped us work ourselves up into a different and higher business sphere!"

Hannes Pichler
Logistician, Innofreight
© Innofreight

"We've even begun to connect our specific offer based on the InnoWaggons with accompanying digital solutions."

ITECCO Demo

- Coordinated by Innofreight Speditions in Austria
- Funded under Horizon 2020-TRANSPORT, Horizon 2020-LEIT-ICT and Horizon 2020-SME
- cordis.europa.eu/project/id/738296
- Project website: innofreight.com

Bringing nature's own technology to the fore of the clean water revolution

Water is a precondition for human, animal and plant life – but climate change poses a threat to the world's water supply, with many regions at risk of severe drought. An EU-funded project has developed a membrane inspired by nature's own technology to sustainably secure safe and clean water for all.

While Europe is largely considered to have adequate water resources, climate change has made water scarcity an increasingly widespread phenomenon. Regions notably in southern Europe suffer from water stress and resort to desalination of brackish and seawater to secure their supply of freshwater.

With increasing demands for freshwater anticipated in the coming years, the desalination industry is expected to grow. Reverse osmosis (RO), currently the most widely used desalination technology in Europe, exploits the osmosis principle, removing salt from seawater by transferring water through a series of semipermeable membranes. This is an energy-intensive process, however, which contributes significantly to the continent's carbon emissions, as well as releasing by-products, such as brine, which can be detrimental to the environment.

NATURE'S SUPER WATER PURIFIERS TO THE RESCUE

To overcome the challenge of water scarcity and make the process of desalination more sustainable, water tech company Aquaporin has developed a biomimetic membrane based on the aquaporin water channel protein to boost standard polymeric membranes with a biological water channel. The company has taken this breakthrough technology to new heights in the EU-funded AMBROSIA (Aquaporin-Inside™ Membranes for Brackish water Reverse Osmosis Application) project, which produced the world's first biomimetic brackish water reverse osmosis (BWRO) membrane and developed it from lab to industrial scale.

With its potential to disrupt the current RO technology, making it more cost-effective and energy- and water-efficient, AMBROSIA's biomimetic membrane is an

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important contribution to the desalination industry. Project coordinator Jörg Vogel explains how the project scaled the membrane from small coupons, no more than a few square centimetres in size, to a full roll-to-roll production of several thousands of square metres: "Within 3 years of the AMBROSIA project, we achieved this task and developed industry-standard elements that can match or outperform commercially available products from suppliers with more than 30 years of manufacturing experience. This means that we now have a pre-commercial Aquaporin Inside® BWRO membrane available."

PIONEERING TECHNOLOGY FOR DRINKING WATER AND INDUSTRIAL APPLICATIONS

The journey from small pilot scale to coating hundreds of metres of membrane was not without challenges and required a collective effort from the whole company. "We had a lot of troubleshooting to do," says Vogel, "especially to ensure that we could transfer the protocols from lab to machine and make a stable and consistent product. This involved the R&D group in Denmark, running more pilot trials with our team in Singapore as well as many tests on the full-scale machine itself. In the meantime, our protein and research specialists had to optimise our Aquaporin Inside® solution to fit the new requirements of large-scale production, while our business development and sales team worked hard to find potential customers and test partners that were willing to try something new."

The biomimetic membrane lays the groundwork for targeted product development in the desalination, and food and beverage industries, as well as in the development of low-energy BWRO filtration for industrial and municipal water. In fact, the membrane is already playing a key role in research and innovation projects in Europe and further afield. "It will feature in the context of the Horizon 2020 REWAISE project, where the membrane's chemistry will be further optimised and tested in pilot industrial and near-commercial settings," notes Vogel. "And we are also developing BWRO filtration for water and resource recovery in a European project focusing on municipal waste water."

The significant results achieved by AMBROSIA will ultimately contribute to global efforts to overcome water scarcity, one of the biggest challenges of our times.

AMBROSIA

- Coordinated by Aquaporin in Denmark
- Funded under Horizon 2020-ENVIRONMENT and Horizon 2020-SME
- cordis.europa.eu/project/id/783848
- Project website: bit.ly/ambrosia-project

CLIMATE CHANGE AND ENVIRONMENT

Economic modelling shows impact of soil and climate change on agriculture

It might seem obvious that soil characteristics would significantly influence crop production, but this is actually underexplored. MYCLIMATE correlated soil and weather to track changes in agricultural production due to climate change.

The influence of soil characteristics has often been neglected by mainstream agricultural economics. This is now starting to change as soil comes to be regarded as a useful buffer against climate change, for example for carbon capture and storage.

The study of agricultural economics often doesn't include an analysis of the positive, and negative, impacts of soil characteristics, temperature and rainfall.

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The EU-supported MYCLIMATE (Methodologies Yielding CLimate IMpact Assessments Through Economics) project was set up to help correct this. "Some modelling simply can't adequately take into account the dynamic properties of natural systems. MYCLIMATE used methods to represent the variable effects of soil, temperature and rainfall," explains Simone Pieralli, the Marie Skłodowska-Curie Actions fellow responsible for the project.

Taking French field crop production for the period 1990-2015, MYCLIMATE found that climatic variables accounted for 58.5 % of the variability in output, on average over 25 years. This variability was additionally accounted for by changes in inputs – such as fertilisers – (22 % of variation), technological adaptation (18 % of variation) and changes to soil characteristics (1.5 % of variation).

APPLYING PRODUCTION ECONOMICS MODELLING

MYCLIMATE bridged the gap between two previously separate branches of economics. "I saw the pros and cons of climate econometric methods and production economics index theory and so applied a mix of the two to climate change," adds Pieralli.

The project was granted the use of confidential European Commission farm accountancy data network information which held crop output data from French farms from 1990 to 2015.

Annually, data is collected from a sample of commercial farms by region, size and type of agriculture. Farms are approached on a rotation basis: participating some years and not others.

This data was paired to environmental data, including for soil properties – principally soil carbon and soil pH – recorded in the GIS SOL database in France. Analysis also included daily weather data from the Joint Research Centre, with grid-marked locations and a 25 km resolution.

> *"Some modelling simply can't adequately take into account the dynamic properties of natural systems. MYCLIMATE used methods to represent the variable effects of soil, temperature and rainfall."*

MYCLIMATE also used daily minimum and maximum temperature, alongside daily precipitation data. This meant that for each day of the 25 years, MYCLIMATE could mathematically reconstruct how many hours each grid location was exposed to certain temperatures.

POLICY IMPLICATIONS

A key finding was the influence of increasing weather variability, on average over the 25 years, but especially after the year 2000. This has important implications for policies which need to be focused on the critical drivers of production.

"If weather is key to determining output variability rather than farm-managed inputs like fertilisers, then subsidising farmers could be considered more important during climatically difficult years," says Pieralli.

A complication acknowledged by Pieralli is that climate change impacts will be felt differently depending on the region, crops and even timing of the weather events considered. For example, some winter crops may be relatively unaffected by summer droughts and heatwaves. Whereas some wines may be favoured by climate change.

With one of the main methods developed by MYCLIMATE already publicly available in a working paper from INRAE, Pieralli is working to publish further results. Currently he is continuing to research the interplay between economics, soil and climate change, while based in New Zealand.

"I want to develop methods to consider farm-specific production impacts, the influence of farm location, and timing of weather events, and most importantly, introduce pollution and emissions into the equation," he concludes.

MYCLIMATE

- Coordinated by the National Research Institute for Agriculture, Food and Environment in France
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/705360

SPECIAL FEATURE

THE NEW SYNERGIES OF SHOPPING: E-COMMERCE OR 'BRICKS AND MORTAR'?

Editorial

"Shopping is my cardio" – Carrie Bradshaw, 'Sex and the City'

For many, a day of shopping is a favourite pastime, as so eloquently inferred by the fictional character we quote this month. Shopping perceived as a leisure activity really only came into being during the 1980s and 1990s, as free time and disposable incomes zipped upwards following a credit-flushed economic boom that defined the age. Consumer spending became an extremely important component to analyse when measuring an economy's overall state and future prospects.

However, over recent years, fears have grown about the health and continued viability of city centre or out-of-town 'bricks-and-mortar' shops. The very phrase has only become widely used since the rapid growth of e-commerce beginning in the early 2000s. The rise of e-commerce is seen by many as a wonderful convenience, where you can shop to your heart's content from the comfort of your own home, whilst for others it represents a scythe that is mowing down traditional in-person shops (both independent and cherished national chains) and, as a consequence, the wider local and urban economies that depend on them.

In Europe, e-commerce has grown tremendously over the past few years and some of the world's most sophisticated e-commerce markets are found in the EU-27, such as France and the Netherlands. Indeed, household and individual survey data collected at the beginning of 2020 and presented by Eurostat in January 2021 estimated that 7 out of 10 internet users from the 12 months prior made online purchases in the same period. The survey also showed that the youngest respondents were the most eager and frequent of online shoppers.

The COVID effect has also played a major role in the fortunes of e-commerce over the past year as many people turned to online orders due to the closing of physical stores. But, according to a recent report by Ecommerce Europe, the impact of the virus on e-commerce is more nuanced than it first appears. Their latest survey report published in January 2021 argues that whilst many sectors saw strong online sales, others (such as online travel and ticket sales retailers) saw significant decreases. Nonetheless, the broad expectation is that COVID-19 will result in a huge and permanent leap forward for e-commerce that otherwise could have taken another 5-10 years to achieve without the pandemic.

So, is there a future for 'bricks-and-mortar' stores or are they destined to be steamrollered by a relentless e-commerce juggernaut in the post-COVID landscape? In an attempt to provide clarity, this special feature of Research*eu showcases seven EU-funded projects, some of which have focused their work on what could be viewed as the e-commerce side of the issue and others on the 'bricks-and-mortar' side.

As in so many cases, innovative technologies appear to be the key. From using robots and other digital tech in indoor shopping centres and supermarkets to improve the customer's experience (and thus to entice them through the door) to new tools to help make e-commerce an even easier experience, perhaps the question we ask at the top of this page – e-commerce or 'bricks and mortar'? – isn't as black-and-white as one may have initially thought. Perhaps it's not a simple zero-sum 'one or the other' but in fact there's space for both to be able to hold their own and complement each other in the post-COVID world.

Of course, only time will tell.

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

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Humanoid robots could help reboot the shopping mall experience

It's easy to see how social robots could help in the current COVID context; as hospital receptionists or as waiting staff, they could perform useful functions, safely. MuMMER is developing a robot that goes beyond state of the art, to achieve genuine engagement.

Recently there has been a lot of excitement about 'social robots' which appear to naturally interact with people by following programmed rules, triggered in response to human behavioural cues. There are a number of scenarios where they could even replace humans, as more convenient or more cost-effective options, or in hazardous environments, for example.

One potential market is shopping malls, where the eye-catching novelty of robots, combined with a range of customer-focused functions, could increase consumer engagement in this highly competitive environment.

Yet, many social robots still fall short of real interaction, often serving as little more than glorified touchscreens.

The EU-supported MuMMER (MultiModal Mall Entertainment Robot) project has designed a humanoid robot based on SoftBank's Pepper platform which is able to interact autonomously and naturally with members of the public.

"A problem with current consumer robots is that people expect more of a conversation. But with systems not set up to deliver this, they are often disappointed. When people approach the MuMMER robot they can have a real conversation," says researcher Mary Ellen Foster from the University of Glasgow, the project host and the project coordinator.

AT THE CUTTING EDGE OF ROBOT-HUMAN INTERACTION

To understand the needs and challenges of multiple stakeholders, the team worked with customers, mall management and shop owners, who all co-designed

© VTT

the robot's behaviour. These stakeholders also helped evaluate the robot's performance.

"These co-design sessions helped us understand that while some of our initial ideas were compelling, such as having a robot security guard, they were impractical for our chosen hardware platform," explains Foster.

"It became clear that a combination of guidance and chat, including support for selfies, was the appropriate model."

Consequently, the team concentrated on developing a mechanism for the robot to track and identify the bodily movements of people in close proximity, to determine whether they intended to engage or not. This allowed the robot to respond appropriately.

In addition to running a social chatbot system to enable conversation, the robot was designed to guide customers to locations in the mall. Here, the team used 'perspective-taking' to ensure that when the robot pointed to or referred to a landmark, a 3D model of the mall enabled it to give accurate directions.

CUSTOMER RELATIONS

The MuMMER system was deployed next to the information desk in the Ideapark shopping mall in Finland for several hours a day, for 14 weeks. To evaluate success, the project team conducted a survey amongst the key stakeholders, generating a wealth of data for future developments.

While the results are still being analysed, broadly speaking the respondents were positive about the robot, despite some technical linguistic and computer vision challenges.

> *When people approach the MuMMER robot they can have a real conversation.*

"While the final version was technically limited, albeit eventually a fluent Finnish speaker, we still believe that this approach is the best long-term solution for successful social robots in public spaces," notes Foster.

The MuMMER team blended technical expertise from across specialisms including: audiovisual sensing; social signal processing; interaction management; navigation; and localisation. Crucially, the consortium also included both Ideapark as well as SoftBank Robotics Europe.

Much of the underlying code developed by MuMMER is currently available as reusable open-source software for robotic components. The whole system could be available to partners, working with the project team, who are seeking to further explore robot-human interaction in public spaces.

The analysis of the long-term interaction is due to be completed by the end of this year.

MuMMER

- Coordinated by the University of Glasgow in the United Kingdom
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/688147
- Project website: mummer-project.eu

Returned online sales get better, more environment-friendly treatment

As online customers, we essentially want platforms where it's easy enough to buy and then return the item if we don't like it. But it'd certainly be a plus to know that our decision to do so won't harm the environment. Dutch company BuyBay, which received EU support under the SMILE project, guarantees both.

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It's the dark side of e-commerce we as consumers do not know about, or simply refuse to see. With each purchase we decide to send back because it's not exactly what we had in mind, we take a risk of seeing a perfectly fine and usable product end up destroyed or sent to landfills.

The idea of throwing away brand-new products, just as citizens are being reminded about sustainability and the scarcity of resources, is troubling. But at the end of the day, it's simple maths: Whilst unused products can easily be sold as new again, used ones have to be thoroughly checked, repaired and repackaged. Such a process is time-consuming and costly, sometimes much more than simply disposing of the used product.

To break this vicious cycle, Oliver Lauterwein, CCO at BuyBay, believes in three key measures: avoiding returns by educating customers and helping e-tailers to be 100% transparent about the products they sell; immediately getting new products back in stock; and giving returned products a second life, which is precisely where BuyBay excels.

"BuyBay uses a combination of advanced grading and pricing algorithms software for marketplaces, so that they can sell all products to a suitable buyer for a good price," Lauterwein explains. Concretely, BuyBay takes care of everything. "We receive returns, sort them, inspect them and, if necessary, we repair or repolish them. After that, it's time to repackage the product and find a suitable buyer," he adds.

Major brands, manufacturers and retailers in Europe have already entrusted BuyBay with the reselling of their returned products. The benefits for them are rather significant. First, they can focus on their core business while receiving two or three times more net recovery of costs of returned products. Then, they decrease processing costs in their own warehouses. But most importantly, they take an important step towards a circular economy.

INCREASING TRUST AND RAISING USED ITEMS' VALUE ACROSS EUROPE

Once they leave BuyBay's warehouses, the renewed products are sold on multiple marketplaces in Europe. Customers then benefit from unmatched transparency with the product they choose to buy, while being guaranteed high standards in terms of delivery time, returns and warranty.

"We are successful because we know everything about each single returned item: its origin, initial value, updated value and current opportunities on the market. We provide our partners with real-time insight into the product flow, which enables us to achieve excellent buyer matching and pricing for them. If necessary, we take on the entire logistical process and use our expertise to make recommendations on how to diminish return risks," Lauterwein notes.

In June 2018, BuyBay received EUR 1.9 million of EU support under the SMILE (A smile in return) project to renew their software, improve their data model and plan their expansion across Europe. Two years later, the company has managed to make its first footprints outside Benelux.

The future looks bright for the company: "Our software is further improved, our new data model enables AI features and our international expansion is going well with exponential growth figures. The kick-start that the EU gave us was a huge driver to break from a

> *BuyBay uses a combination of advanced grading and pricing algorithms software for marketplaces, so that they can sell all products to a suitable buyer for a good price.*

start-up/scale-up to a profitable mid-size European leader in the returns business," Lauterwein concludes.

SMILE

- Coordinated by BuyBay in the Netherlands
- Funded under Horizon 2020-SME, Horizon 2020-Societal Challenges and Horizon 2020-LEIT
- cordis.europa.eu/project/id/812411
- Project website: buybay.com

Plytix: A web store to rule them all

Selling products across different reseller platforms, marketplaces and listing sites is a great opportunity to reach wider audiences. But it also makes keeping track of actual product success and profitability much more difficult than with a single web store. Plytix has solved that problem with a clever product information management platform.

E-commerce has changed drastically since the launch of marketplaces such as eBay and Amazon in the mid-1990s. The number of 'e-tailers' competing for internet users' interest has grown exponentially, and all of them now have access to multiple online platforms to sell their products.

There is still a hiccup though: Whilst analytics solutions have evolved too, there is still no reliable solution to quantify product success across multiple marketplaces. As Morten Poulsen, CEO and co-founder of Danish start-up Plytix, puts it: "Brands can now sell their products on Amazon and other listing sites like Google Shopping and Facebook Catalogues, while also relying on third-party reseller web stores for additional sales. Never before has it been so important to see how products perform across all these different channels, but there are currently no ways to collect and consolidate such data."

Plytix addresses this gap by inviting brands to store and manage their product information on their dedicated product management platform. There, they can upload and modify all their product data and benefit from direct synchronisation with the likes of Amazon, Walmart, Google Shopping and Facebook. They also benefit from a brand portal allowing resellers to place orders.

"Plytix is really easy to use," Poulsen explains. "As a user, you just need to go Plytix.com and connect it with your Google Analytics. It takes only three clicks and doesn't require any development whatsoever. Plytix will fetch data directly from the Google Analytics through an API (including historic data) and present it in the Plytix platform together with all your other product information. This will allow you to slice and dice your data across all product attributes."

A NEW REALM OF POSSIBILITY

Direct connection with Google Analytics is quite useful indeed. It grants access to all product-level analytics data directly from the Plytix platform, alongside existing product information. Brands can see the performance data from their own web store, but they will also find equivalent data from any third-party web store selling their products. This is all enabled by product matching using global trade identification numbers (GTINs), which are designed so that each prefix is unique to a brand.

Plytix received EU support under the project PISPA (Plytix Information Sharing Platform and Analytics – Testing product market fit for a disruptive Information sharing platform for brands and resellers), and Poulsen says this support is the very thing that allowed his company to commercialise a technology that otherwise wouldn't have been prioritised. Four years after the project's launch, the Plytix analytics technology has managed to collect data from thousands of brands and resellers worldwide, and it keeps growing every day.

FUTURE PLANS UNFOLD

In the foreseeable future, the company's efforts will focus on getting more data. "From there on, we will deploy predictive analytics that will allow our platform to tap into a pool of aggregated data from hundreds of thousands of brands as well as provide actionable insights to each based on big data," Poulsen notes. Plytix would then be able to provide small-to-medium businesses with access to a sophisticated recommendation engine that they could deploy on their site. This engine would then give recommendations based on a collective data pool of a worldwide network of web stores and marketplaces.

Poulsen even foresees a solution allowing developers to create the world's first dynamic web stores: Instead of just sorting products alphabetically, by price or by date, web stores would then be able to sort products based on the predicted preferences of each visitor.

PISPA

- Coordinated by Plytix in Denmark
- Funded under Horizon 2020-SME and Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/744418
- Project website: plytix.com

Cross-border alliances for successful, pan-European online sales

Not every e-tailer can afford to ship products to other European countries. Logistics, cost and consumer trust are some of the main barriers to successful expansion. But what if retailers could form cross-border alliances? The DSMFACIL project has been investigating the potential of such collaborations.

The Digital Single Market (DSM) is one of the priorities of the European Commission for the years to come. But realising it is not as simple as it may seem. Besides language barriers preventing consumers from buying on e-commerce platforms based in other countries, the sector also faces other difficulties. Delivery costs, low consumer trust related to delivery and after-sales support, and low consumer awareness of foreign retailers are just some of the many issues to deal with.

To overcome these barriers, the DSMFACIL (Facilitating a digital single market in Europe through cross-border alliances) project, undertaken with the support of the Marie Skłodowska-Curie Actions programme, suggests cross-border alliances leading to win-win situations for all partners involved. Project partners investigated such solutions and laid the groundwork for their facilitation. Nevin Mutlu, assistant professor at Eindhoven University of Technology, discusses the team's work and potential impact on Europe's DSM.

What would you say are the main barriers to the DSM right now?

Nevin Mutlu: There are several issues that need to be dealt with in order to realise the DSM in Europe. Since the conceptualisation phase of our project (around 2016), the European Commission has passed regulations to address some important legislation-related issues like overly complicated VAT rules for cross-border purchases and geo-blocking. But I think additional challenges remain.

I think geo-blocking for instance is a symptom of a much bigger problem: Most retailers choose to implement geo-blocking not because they want to block sales from foreign consumers, but because the fulfilment of such orders can be extremely costly and unreliable. As such, I believe that an important barrier to the DSM concerns differences across countries in terms of their logistics infrastructure (both physical and non-physical aspects). This leads to fulfilment issues in cross-border order delivery, which in turn impacts consumer demand and leads to a big fragmentation in the European digital market.

How does DSMFACIL explore this issue?

We use an interdisciplinary approach to provide not only predictive analyses through econometric models, but also prescriptive insights via supply chain optimisation techniques.

To give you an example, our first study with Ton de Kok, Sarah Gelper and Faranak Khooban focused on consumers' cross-border purchases. We used individual-level online purchase data on close to 21 000 consumers

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across 27 EU countries and investigated whether the differences in logistics infrastructure indeed contributed to fragmentation in the European digital market.

More importantly, we tried to find out whether the effects of such differences could be mitigated (or exacerbated) by other macro-level factors in these countries such as economic wealth, regulative environment or culture. The insights we gained from this study have been essential in developing realistic supply chain optimisation models, as they helped us identify the settings under which cross-border alliances can be successful.

Speaking of which, what makes you think cross-border alliances could be the solution? Could you provide a couple of examples of successful such alliances?

The motivation for cross-border alliances in the retail sector comes from the airline industry. Through code-sharing practices, airlines from different countries can collaborate to extend their portfolio of route offerings to customers. The key to success here is to identify alliance building as a win-win situation.

The situation is quite similar for the retail industry, albeit with different sets of constraints. Traditionally, the transportation infrastructure in Europe is designed for large-volume freight transport, not for small-sized e-commerce shipments. Unreliable logistics is a key issue that leads to fragmentation. So, what we did with our project is explore the idea of cross-border alliances where retailers can leverage their own domestic networks for marketing, storing and delivering their partners' products more efficiently in their own country.

Collaborations between local retailers have been observed in practice. For example, Marks & Spencer collaborates with Ocado in the United Kingdom for the delivery of its e-commerce orders. German retailer Aldi makes use of the unoccupied space in Kohl's stores in the United States so that consumers can combine their grocery shopping with fashion shopping in a single visit to the store. There are several other successful examples which

The motivation for cross-border alliances in the retail sector comes from the airline industry. Through code-sharing practices, airlines from different countries can collaborate to extend their portfolio of route offerings to customers.

demonstrate how resource sharing between retailers can be useful for all parties involved. Our study explores if such mechanisms can work in international markets.

What are the project's most important outcomes so far? What do you still need to achieve?

We have shown that the variations in logistics infrastructure across European countries contribute to fragmentation. In their cross-border purchases, consumers favour retailers from countries with high logistics capabilities. But our findings also show that improved logistics capabilities do not always lead to higher cross-border sales, and that the rule of law in a country is a big determinant in how much demand retailers can attract from abroad. Consumers would indeed be very reluctant to buy from countries where regulatory systems cannot be trusted, no matter how good the logistics performance is.

This highlights the potentially complementary nature of these two aspects (logistics and the rule of law) in policymaking, emphasising that government investment and policies focusing on one issue may not substitute for the lack of the other.

Our findings also provide important insights for retailers looking for suitable locations and trying to identify partners with whom cross-border alliances can work. Currently, we are in the process of analysing the precise impact of such collaboration on retailers' win-win revenue/cost sharing schemes. We believe that there is a lot to be explored in this realm.

In COVID times, the 'buying local' concept has grown to become a mainstream marketing argument. How can such evolution be reconciled with your work?

Buying local means protecting the environment by reducing transport and supporting local economies. It may be a good alternative for produce, but not everything can be bought locally. At the end of the day, it may actually be more environment-friendly to produce items where raw materials are readily available, or in places where more renewable energy is used. In such a setting, additional transport may be justified.

Since not everything can be accessed locally, our project focuses on making cross-border e-commerce flows more

efficient by sharing resources such as distribution centres or last-mile delivery. As such, alliances can also support the environment. Additionally, by developing a win-win mechanism between retailers, the setting we envision is not only a competitive setting where domestic and foreign retailers compete. They can also collaborate.

What do you hope will be the long-term impact of the project?

Being a publicly funded project, it is our genuine goal to see European society benefit from our work. I see this happening through policymaking and efficiencies gained in retail logistics operations.

In the long run, I hope that our insights will help increase cross-border e-commerce engagement in Europe, which will directly benefit retailers by expanding their markets, and consumers who will enjoy a wider variety of goods and services. Hopefully, this will also set the ground for innovation and price reduction incentives due to increased competition.

DSMFACIL

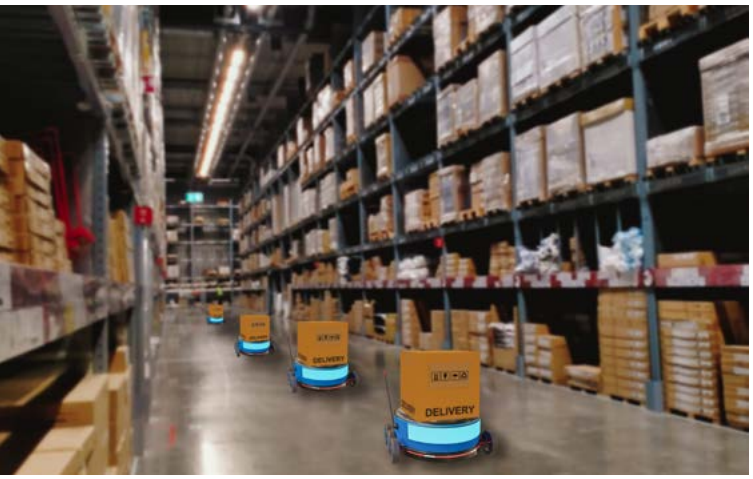
- Coordinated by Eindhoven University of Technology in the Netherlands
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/798371

Full circle automation for tidier supermarkets

If they are to keep competing with or even complementing online sales, supermarkets need solutions to handle the logistics problems they face on a daily basis. The REFILLS project has trialled various automation solutions to make these stores all neat and tidy.

We've all at least occasionally walked into supermarkets during their busy times (or in the early days of the COVID-19 lockdown) only to find messy shelves, devoid of the precious grocery item we've been hunting for. In such scenarios, assistants would be easy targets. Too easy perhaps, as even the most organised assistants will have a hard time ensuring that all supermarket shelves are well sorted and filled at any one time.

For shop owners, sorting goods has never been so costly and time-consuming. But it's not like they have a choice: the sensorial experience is the very thing that enables bricks-and-mortar shops to differentiate themselves from their online competitors.



To help them, REFILLS (Robotics Enabling Fully-Integrated Logistics Lines for Supermarkets) suggests automation solutions that will help sort items, track the ones missing from shelves, retrieve them from storage and even refill empty shelves. Bruno Siciliano, coordinator of REFILLS on behalf of the CREATE Consortium and the University of Naples Federico II, discusses the project's technologies and their benefits for shop owners and supermarket staff alike.

What would you say are the main logistics problems currently faced by supermarkets?

Bruno Siciliano: The main in-store logistics problem is to have all products available at all times for customers, while also keeping the inventory low and having lean just-in-time processes.

Receiving a huge variety of different products each day and restocking them efficiently to refill shelves is complex and comes at a high cost. Besides, searching for the right place in the store, transporting all products within the store and finally having a fast and ergonomic process for restocking the shelves is very time-consuming.

How do you aim to overcome these problems?

Firstly, by reducing the time and cost required to search product locations within a store. We do so by digitalising the store layout and autonomously presorting goods in the backroom according to this layout. Secondly, by autonomously transporting and distributing the pre-sorted products to the correct place in the store. Thirdly, by helping clerks when handling heavy boxes for shelf refilling. We also attempted to solve this problem by using robots to fill the shelves, but this was mainly a challenge for research.

You picked three scenarios for your project. Why this approach?

We looked at all conventional in-store logistics processes and identified repeatable tasks. These include sorting and identification of products, in-store logistics and pick-and-place applications. In the first scenario, mobile robots would inspect shelves and generate semantic environment maps for layout identification and store monitoring. The second scenario employs robots for three tasks: autonomous sorting of cases from mixed-case pallets in the backroom; autonomous transportation of trolleys from the backroom to the shop floor; and assistance provided to clerks. In the third and final scenario, we tried to handle a wide variety of products and refill shelves autonomously.

Can you tell us more about the robotic systems you developed?

We have developed specific hardware using a modular approach. A scanning unit identifies products within the shelves, and stores their position and the way they are showcased. From there on, a pointer unit with a light beam assists clerks in finding the right spot for replenishment.

To enable further automation, we modified and repurposed a robotic arm with extended range and specialised geometry. This enables a SCARA robot to push objects from a trolley to the back of the shelf without colliding with other stored objects.

The last robotic system was developed to transport trolleys filled with products near the shelves, as well as move the mentioned robotic systems within the store. Our logistic software and store management system, which is integrated in the working robots, carriers and scanning units, plays an important role too. It allows communication with the clerks through smartphones or tablets. This can also provide customers with useful information on the products within the store.

“We looked at all conventional in-store logistics processes and identified repeatable tasks. These include sorting and identification of products, in-store logistics and pick-and-place applications.”

Is there any innovation that particularly stands out for you?

Under our first scenario, layout identification and shelf monitoring were intended to be the data basis for all REFILLS' robotic modules. But they turned out to be a very valuable source of data for other processes at retail stores as well.

In the second scenario, we developed a special depalletising cell where a robot equipped with a suitably reconfigurable gripper with sensors is capable of picking boxes of different sizes and dimensions from a mixed-case pallet. This system may have great potential also in warehouses.

Finally, the third scenario enabled us to test and enhance the capabilities of the robots to handle and manipulate a wide variety of products autonomously in various environments including retail stores, using vision and tactile sensing.

How do you see the future of 'bricks-and-mortar' shops, in the face of ever-growing market share for online shops?

Choosing goods in bricks-and-mortar shops is first and foremost a sensorial experience for the customer, and this will remain the differentiating factor from online shops. With that being said, retail stores increase costs related to logistics and service personnel.

That's where automation can make a real difference. Some retail stores already have introduced self-service checkout stations and even automated product billing with chips on the products for self-checkout. Automation may not only reduce the cost of logistics, but also enable retail stores to function as a hub that can be used by online and delivery services thanks to robotic system solutions.

What are your follow-up plans, if any?

DM and the University of Bremen, among others, have started a related project which is all based on semantic shop maps similar to those generated in the first scenario of REFILLS. The project is called Knowledge4Retail (K4R). It is part of Germany's 'AI strategy' and funded by the

Federal Ministry for Economic Affairs and Energy. K4R aims to establish a new generation of information systems for retailers and their supply chains, coming together in a digital innovation platform and ecosystem.

Looking further ahead, I think REFILLS was a great opportunity to validate robotic technologies in logistic applications where robots work close to humans. This experience and the knowledge we gathered can be used in fields with similar problems such as hospitals or intelligent factories.

REFILLS

- Coordinated by the CREATE Consortium in Italy
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/731590
- Project website: refills-project.eu

Autonomous robots aim to enhance customer service

The robots are coming! But no need to panic, these robots aim only to improve the customer experience. That's because one technology company is using artificial intelligence, autonomous systems and robotics to design a fleet of robots that businesses can use to independently interact with – and help – their customers.

Whether it be retail, hospitality, transportation or real estate, all businesses are, to paraphrase Simon and Garfunkel, 'just trying to keep their customers satisfied'.

Ask any of these businesses and they will be quick to tell you that the key to customer satisfaction is great customer service. Yet if good customer service is so important, why is so much of it still so bad?

"Billions of euro are lost every year across various industries due to bad customer service," says Andrei Danescu, CEO and co-founder of BotsAndUs, a London-based technology company specialising in robotics and artificial intelligence.

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With the support of the EU-funded BOTSANDUS (First Assistant Robot for Retail, Hospitality, Airports and Real Estate Buildings) project, the company is working to leverage the power of technology to put an end to bad service. According to Danescu, the project aims to build an innovative solution that can help businesses avoid losing sales and alienating customers due to inadequate customer service.

"Our mission is to create a fleet of autonomous customer service robots that work for and alongside people," he explains. "To do this, we are building robots that not only are truly helpful and easy-to-use, but also use customer-centred human-robot-interaction algorithms."

BotsAndUs' portfolio currently consists of two fully autonomous service robots called Bo and Mim. While Bo can independently interact with customers in multiple languages, deliver real-time insights, and even show customers where to find a product, Mim provides bricks-and-mortar retailers with real-time access to accurate and relevant store data.

PUSHING THE BOUNDARIES OF HUMAN-ROBOT INTERACTION

With the aim of preparing the company's robots for commercialisation, this project conducted multiple proof of concept trials with some of Europe's biggest brands, including British Airways, MediaMarktSaturn, Heathrow Airport and dnata.

"Not only did these real-environment trials validate the robustness of our solutions, they also confirmed our assumptions on how humans and robots interact," remarks Adrian Negoita, CTO and co-founder of BotsAndUs. "This allows us to push the boundaries of human-robot interaction and develop state-of-the-art algorithms for optimal communications in noisy environments and with groups of end users."

Another important outcome of the project was the development of autonomous navigation technology designed specifically for dynamic public spaces, such as airports. "Using distributed artificial intelligence systems, we created a fleet intelligence infrastructure that allows our robots to both learn from each other and collaborate on tasks," adds Negoita.

Negoita notes that when the COVID-19 pandemic wreaked havoc on the retail and travel industries, many companies turned to technology and, in particular, robotics. "We used this opportunity to focus our technology on helping create and enforce social distancing policies without compromising customer service and satisfaction," he says. "We spent significant time and resources building the bridge between the online and offline realms so businesses could offer their customers a seamless and safe experience."

REDEFINING CUSTOMER SERVICE

The BOTSANDUS project has the distinction of being the first to deploy robots in real, public environments – a breakthrough that has garnered notable attention in the global press, including coverage by CNBC, CNN, 'The Wall Street Journal' and Forbes.

Billions of euro are lost every year across various industries due to bad customer service

"We will continue to chase our vision of bringing easy-to-use and helpful robotics that can liberate us from dull, repetitive and even dangerous tasks, allowing humans to focus their time on the things that truly matter," concludes Danescu. "As we expand into new markets, we will continue to redefine customer service, ensuring that companies of all sizes and types can keep their customers satisfied."

BOTSANDUS

- Coordinated by BotsAndUs Ltd in the United Kingdom
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/849938
- Project website: botsandus.com

Redeemable ads for more effective ad-to-store marketing

Paying for online advertising to drive in-store sales is very much a leap of faith. With their AD-TO-STORE platform, French start-up Browse&Go proposes a new type of online ad that can, for the first time, generate quantifiable impact.

Not all online marketing is meant to drive online sales. With drive-to-store marketing, advertisers can also tap into local indexing to incite potential customers to go to their shop. Available means range from simple Google Maps indexing to push notifications and more advanced product locator services which help internet users find the closest geographical place selling the product they're looking for.

It's not all roses though. The trick with drive-to-store marketing is that it's all based on geolocation. The EU's General Data Protection Regulation (GDPR) has also

helped make sure that activating it requires user consent, which is difficult to obtain. As Stéphane Wallart, associate founder of French start-up Browse&Go, puts it, this all results in a situation where "nobody knows the real impact of online advertising on shop visits, even less so when it comes to shop sales."

Browse&Go's AD-TO-STORE (Public Marketplace Platform for Digital Marketing applied for driving in-store Sales) solution, which was supported by EU funding under a project of the same name, was created to address this gap in knowledge with an innovative advertising platform.

"We use redeemable ads, a new kind of ad unit, to replicate with paid media what already exists with owned media: the single merchant loyalty programme. It's all based on a barcode that can be scanned in-store and associated with paid media. Consumers receive the online offer and can redeem it by scanning the barcode or their bank card at participating shops. Since we are connected to in-store point-of-sale (POS) systems, we can provide item-based offers which are very interesting for brands," Wallart explains.

So say you're a brand manufacturer or a retailer. All you need to do is create a consumer benefit such as a discount or cashback offer in the AD-TO-STORE campaign manager and customise it to your needs: permanent or one-time, item-based or related to total order value. Once you're all set, you can pick the publishers you want to work with from two categories: display marketing (banners on external websites) and third-party customer bases provided by banks, insurance companies, mobile operators, retailers, etc.

CLOSING THE ATTRIBUTION LOOP

All in all, Browse&Go provides a one-stop shop to tell the same story across all advertising channels and track offline sales at product level. It enables instant discounts for customers and, most importantly, generates reliable feedback on return on investment (ROI) for the money spent on online advertising.

"We're basically closing the attribution loop," Wallart points out. "e-Merchants are granted access to a pay per sales model, which is the more profitable for them and effectively put online and offline commerce on an equal footing."

'Equal footing' might even be an understatement. In a COVID-19 context where physical shops are increasingly challenged by pure players in e-commerce, Browse&Go provides an appealing purchase option to customers most wary about privacy. Retailers are not required to

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share their customer data, and shoppers are completely anonymous. Moreover, AD-TO-STORE retailers get access to intent marketing for the first time. Intent marketing consists in giving people exactly what they want: product marketing is based on consumers' intent to purchase or consume, which has been proven to deliver a far higher conversion rate than conventional online advertising.

Browse&Go is currently in its expansion phase. The company initially launched pilots with small-sized retail chains (from three to 30 stores), and the next step will consist in adapting the system for medium- and large-sized ones. "In order to test the attractiveness of our redeemable ads at a large scale, we have also launched a prepaid e-voucher marketplace where e-vouchers issued by retailers are sold with a discount to publishers. It's a huge success which proves that, despite the prepayment constraint, redeemable ads can bring consumers to physical shops. The top 40 French retailers are already connected to our marketplace," Wallart notes.

From a technology development perspective, Browse&Go now intends to focus its efforts on a POS network capable of connecting physical shops to ad spaces in real time.

AD-TO-STORE

- Coordinated by Browse&Go in France
- Funded under Horizon 2020-SME, Horizon 2020-LEIT and Horizon 2020-Societal Challenges
- cordis.europa.eu/project/id/889764
- Project website: browseandgo.fr

FOOD AND NATURAL RESOURCES

Giving artisanal butchers a competitive edge over industrial producers

New meat processing equipment aims to help local butchers produce high-quality products at an affordable price.

For decades, the meat processing industry has been dominated by large industrial players. Using chemical preservatives, they have produced sausages, burgers and other meats that benefit from a long shelf life.

But this is starting to change.

Although people are still barbequing their burgers and enjoying their charcuterie platters, they are now more aware of the health risks of consuming preservatives. As a result, consumers are looking for natural alternatives. As an extension of this, the farm to table trend is also resulting in people looking for locally produced options.

All of this represents a big opportunity for local and artisanal butchers. But meeting this demand requires new technological solutions – which is where the EU-funded BioMainca (Innovative and cost-effective 100 % natural sausage/burger/processed meat producing machine) project comes in.

"Our goal is to provide artisan butchers the machinery they need to lower costs and extend the shelf life of their high-quality products," says Jordi Vila González, an engineer at MAINCA, a meat processing equipment manufacturer and lead partner of the BioMainca project.

CUT COSTS AND INCREASE PRODUCTIVITY

The project developed a number of solutions, each of which aims to help small producers of sausages, hamburgers and other processed meats become more competitive. For example, one new piece of equipment allows producers to automate production of natural products at a constant temperature of 2 °C without sacrificing their local, traditional taste.

According to Vila González, the BioMainca solutions will allow small producers to increase productivity by at least 45 %. "It is very exciting to have demonstrated that it is possible to lower production costs, improve product appearance, and increase organoleptic properties," explains Vila González. "All this while maintaining the product's quality and local differentiators."

AN OPPORTUNITY FOR EVERYBODY

Thanks in part to the BioMainca project, artisanal butchers worldwide will soon have an opportunity to produce high-quality products at an affordable price.

"The local butcher has been struggling to compete against the extreme low prices of industrial meat processors," adds Vila González. "Our machines give these small producers an opportunity to gain market share and everybody the opportunity to enjoy healthier, high-quality products."

> *"Our machines give these small producers an opportunity to gain market share and everybody the opportunity to enjoy healthier, high-quality products."*

According to Vila González, the company plans to begin testing prototypes at a nearby local butcher soon. The team is also conducting tests to certify their machines' ability to lower the percentage of preservatives used in meat products.

BioMainca

- Coordinated by Equipamientos Cárnicos (MAINCA) in Spain
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/882215
- Project website: mainca.com

FOOD AND NATURAL RESOURCES

Fire can be a useful tropical forest management tool

When it comes to tropical forests, fire has been viewed as both a hazard by some conservationists and also a land management tool for farmers. Learning lessons from India, EARNEST shows that a balanced approach will yield food production and conservation results.

Tropical forests face competing demands. Expanding agricultural frontiers, natural resources extraction and industrial development are some of the human activities that threaten these landscapes. Effective management is essential in order to meet these demands while still protecting biodiversity and ecosystems.

Ecological models are useful management tools. But a limitation with many is the emphasis they place on re-establishing pristine or still-intact forest ecosystems. More realistic models have to represent the impact of changing ecological and social dynamics together.

"Taking a long-term view, practices often considered damaging to tropical forests can be more constructively viewed as being simply part of the complexity inherent to them," says EARNEST (Examining the Agroforestry Landscape Resilience in India to inform Social-Ecological Sustainability in the Tropics) project coordinator Shonil Bhagwat from The Open University, the project host.

> *The lesson here for tropical ecosystem management is that fire need not be problematic, if managed well.*

The principal focus of the EU-supported EARNEST project was on the impact of fire. Looking at the Western Ghats region of India, the project found that anthropogenic fires have been common in this landscape for millennia. The team found that these low-intensity fires, used to replenish the nutrients in agricultural fields, are not detrimental to biodiversity in the Western Ghats.

"The lesson here for tropical ecosystem management is that fire need not be problematic, if managed well," adds Bhagwat.

THE COEXISTENCE OF SOCIAL AND ECOLOGICAL SYSTEMS

Partly driven by the greening agenda and the Clean Development Mechanism, India's National Agroforestry Policy has ambitious reforestation plans. However, this is not always the complete answer for tropical landscapes. Planners often prefer fast-growing, exotic trees, but they should also explore native alternatives – some fast-growing, others slow-growing for an appropriate blend.

"This applies to Europe as well, where trees are sometimes planted to make landscapes greener, without necessarily respecting the cultural landscapes that have been in existence for millennia," explains Charuta Kulkarni, a Marie Skłodowska-Curie Actions fellow.

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To develop their social-ecological model, EARNEST conducted a literature review to quantify the drivers of change, including rainfall and human activities such as land burning practices, in the Western Ghats' ecosystems.

Additionally, to capture biodiversity information, the team fed into the model field survey results which identified hundreds of species of forest trees calculating how many existed in particular areas of the ecosystem.

These models were then tested against actual long-term ecological datasets holding information from fossilised pollen grains collected from sediment cores from regions of past agroforestry. This data shed light on previous plant diversity and fire prevalence, extrapolated from the quantities of charcoal particles, going back thousands of years.

"Our analysis allowed us to make recommendations to protect biodiversity while meeting social needs, some of which are relevant for Europe. For example, pastoral burning can be a useful land management tool and indeed has already been revived within the past 30 years in some regions such as the French Pyrenees," adds Walter Finsinger, from project collaborator CNRS.

THE INTERNATIONAL DIMENSION

Aside from the transferrable knowledge that EARNEST offers European forest custodians, prudent management of tropical forest ecosystems and agricultural landscapes globally impacts the EU because much of the food it consumes is imported from tropical countries.

"The EU's relationships with these tropical countries, including trade in agricultural products, will influence these landscapes. Here, our results could be relevant to the EU's international strategy," notes Bhagwat.

The data from EARNEST is currently awaiting publication and will be made available to the wider scientific community interested in the management of tropical forests.

EARNEST

- Coordinated by The Open University in the United Kingdom
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/795557
- Project website: bit.ly/earnest-project

INDUSTRIAL TECHNOLOGIES

A scalable solution for the factories of the future

A flexible, automated and scalable production system will allow manufacturers to quickly react to changing production demands.

Most of today's manufacturing lines are grossly under-optimised. That's because most manufacturing machinery is fixed, meaning factories don't have the flexibility to adapt the factory floor to meet specific demands. This method is not only inefficient, it is ill-suited to today's trend towards on-demand and small-batch production.

What factories need are scalable solutions, which is exactly what the EU-funded ScalABLE4.0 (Scalable automation for flexible production systems) project intends to provide.

"Our goal was to develop scalable automation solutions that could be easily adapted to current production needs," says Germano Veiga, a researcher at INESC TEC and ScalABLE4.0 project coordinator.

THE SWEET SPOT OF AUTOMATION AND FLEXIBILITY

Researchers set out to both develop and demonstrate an open scalable production system (OSPS). "An OSPS is a framework that enables the optimisation and maintenance of production lines 'on the fly'," explains Veiga. "It does this through visualisation and virtualisation of the line itself."

To accomplish this, researchers established use cases at the manufacturing sites of two of the project's partners. The use case at the PSA site was installed with an over-automation system with limited flexibility to adapt to product changes, while the use case at the Simoldes site was fitted with an under-automated system. By approaching the challenge from polar opposites, researchers hoped they would be able to easily identify the 'sweet spot' in terms of automation and flexibility.

"Our integrated, multidisciplinary approach, which is rather unique for this type of project, combined developments from the shop floor to top management decision-making," adds Veiga. "This allowed us to push the boundaries of advanced robotic systems, digital twin and vertical integration, manufacturing execution systems, and simulation and decision support."

Out of this work came the blueprint for an integrated digital production system that is flexible, robotised and human-aware. "Now, when production needs change, manufacturers can immediately visualise how best to adapt the factory floor, robots and human labour and act accordingly," notes Veiga. "This all happens with minimal downtime, meaning increased efficiency and production."

REWRITING THE PRODUCTION LINES OF THE FUTURE

Unfortunately, due to the COVID-19 pandemic, the project was unable to finalise its test sprints at the two manufacturing sites or present at the AUTOMATICA trade fair. "I think the response to this challenge and the implementation of contingency plans were handled brilliantly by the team," says Veiga. "We quickly adjusted to this new reality and were able to conduct full laboratory demonstrations of the ScalABLE4.0 solution."

Despite these challenges, the project succeeded in showing that it is possible to integrate enterprise information systems, automation equipment and open application programming interfaces (APIs) to achieve system optimisation. "In doing so, ScalABLE4.0 is helping to rewrite the standards for the production lines of the future," concludes Veiga.

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Our goal was to develop scalable automation solutions that could be easily adapted to current production needs.

Several end users have already shown interest in industrialising the project's main results. Furthermore, the project's results led to the creation of the RiACT spin-off.

SCALABLE4.0

- Coordinated by the Institute for Systems and Computer Engineering, Technology and Science (INESC TEC) in Portugal
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/723658
- Project website: scalable40.eu
- bit.ly/ScalABLE40

Pushing the envelope of vacuum-insulated panels

A Europe-wide consortium experimented with new materials, processing and a 'pizza box' to create improved insulation for domestic and industrial applications.

Vacuum-insulated panels (VIPs) are a type of thermal insulation created by wrapping a low-density core material in a foil envelope and removing the air. VIPs are used for a wide range of insulating applications, including domestic fridges and freezers, refrigerated shipping containers, and buildings.

Compared to traditional insulating materials such as polyurethane, VIPs are thinner and lighter for the same insulating power. The EU-funded INNOVIP (Innovative multi-functional Vacuum-Insulation-Panels (VIPs) for use in the building sector) project sought to develop this technology to make these panels cheaper and more efficient.

LOW-DENSITY POWDER

Typically, the core in a VIP is perlite or fibre silicon, strengthened with support fibres and then pressed into shape. "We make use of microporous materials, as a material is a very effective insulator if it has very small pores," explains Christoph Sprengard, project coordinator of INNOVIP. "Unfortunately, this very small pore size material is rather expensive."

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Working at FIW München, Sprengard led a consortium of 13 industry and research groups across Europe to develop new innovations in VIPs. They developed a new core fill without support fibres, which offers the same thermal resistance at a lower price. "When you only have the powder, the VIP will perform better, but you cannot press a board out of it," says Sprengard. "So we replaced the compressed board with a new approach."

Sprengard and his colleagues changed the production process from using a stiff compressed core to a loose powder in the envelope. Unfortunately, this had one key disadvantage – because the powder was not compressed, it did not form a sharp edge.

PIZZA BOX SOLUTION

A rectangular shape is crucial for building applications, where the VIPs need to conform to the space being constructed. The team tried to form edges by injecting polyurethane into the envelope, but this proved too difficult and expensive. Instead, the group came up with a 'pizza box' approach, placing the low-density fill into a cardboard box which then went inside the envelope.

A second element of the innovation process was the improvement of the envelope structure. This has three effects: reducing the overall cost of manufacturing VIPs and reducing the thermal bridging effect and the

> *"The technologies we developed will be on the market soon."*

permeation of air and moisture through the envelope over time, improving its insulation quality.

The cover layers were also stiffened to provide more structural support to the VIP and make it easier to handle. This was done using materials such as expanded polystyrene, gypsum board and polyurethane, depending on its intended application.

MULTIFUNCTIONAL SURFACTANTS

Lastly, the group developed additional functionality in the form of nano-coatings that can be applied to the products. The different coatings aim to enhance different elements of the performance such as reduced flammability and antibacterial properties.

The work was supported by the Horizon 2020 programme. "This was a great opportunity to further develop ideas out there, and generate new ones," adds Sprengard. "The technologies we developed will be on the market soon in a variety of products," he says, adding that some aspects have already been commercialised.

INNOVIP

- Coordinated by FIW München in Germany
- Funded under Horizon 2020-LEIT-ADVMANU and Horizon 2020-LEIT-ADVMAT
- cordis.europa.eu/project/id/723441
- Project website: innovip-h2020.eu
- bit.ly/INNOVIP

INDUSTRIAL TECHNOLOGIES

Prototype developed to monitor the temperature of metal cutting tools

The heat distribution of metal cutting tools generated as they work is hard to measure, making it difficult for industry to decide on the best machining strategies. MoMenT used sensors and algorithms to make more accurate calculations.

A challenge with the metal cutting tools used in manufacturing is the heat they generate. The high temperatures travel throughout the body of the tool and can result in diminished cutting performance, reducing the quality of machined surfaces. This makes the accurate monitoring of tool temperature during machining vital.

While the temperature of tools can be estimated from the colour of fillings and shavings known as chips, monitoring temperature distribution accurately is problematic. Direct measurement using sensors is almost impossible because of the challenging environment, with high pressures and cutting fluids risking sensor damage.

The solution developed by the EU-supported MoMenT (Modelling and Measurement of Thermal Phenomena in Metal Cutting) project was to create a combined cutting and monitoring tool, which incorporated carefully spaced sensors. "Our prototypes and algorithms allowed us to accurately gauge the temperature in the cutting zone based on the sensor readings," explains Rachid M'Saoubi, R&D expert at Seco Tools, the project host, and supervisor of Marie Skłodowska-Curie Actions fellow Vyacheslav Kryzhanivskyy.

MODULES TO MONITOR HEAT DISTRIBUTION

When temperatures and the thermophysical properties of tools are known, heat fluxes can be determined. To get around the problem of not being able to obtain readings from the cutting zone itself, MoMenT's sensors measured temperatures at several points beneath the cutting insert. Algorithms then extrapolated from these

readings to calculate the temperature for any point in the tool.

A 'Thermal Resistance' module used a Light Flash Apparatus (LFA) to collect information about the thermal resistance of the tool assemblies, alongside a modelling algorithm which calculates cutting temperature. This is complemented by a 'Temperature Distribution' module containing the MoMenT cutting tool prototypes equipped with thermocouple and thermistor sensors. This module also used modelling algorithms to calculate the heat distribution or flux.

Finally, the 'Coating Investigation' and 'Cooling Investigation' modules quantified the effect of coatings on heat fluxes flowing to the tool and measured the coefficient of heat exchange, depending on the cooling strategy adopted.

"Testing demonstrated that our system was able to narrow the range for effective machining strategies, helping industry to quantify the thermal effects of different tool coatings, materials and cooling strategies," adds Kryzhanivskyy.

TOWARDS INDUSTRY 4.0

More efficient machine cutting technology offers increased productivity for manufacturers, alongside improved product quality for consumers. Tools carrying thermal sensors will be of particular interest for the automation of traditional manufacturing and industrial practices using modern smart technology or Industry 4.0.

"Testing demonstrated that our system was able to narrow the range for effective machining strategies, helping industry to quantify the thermal effects of different tool coatings, materials and cooling strategies."

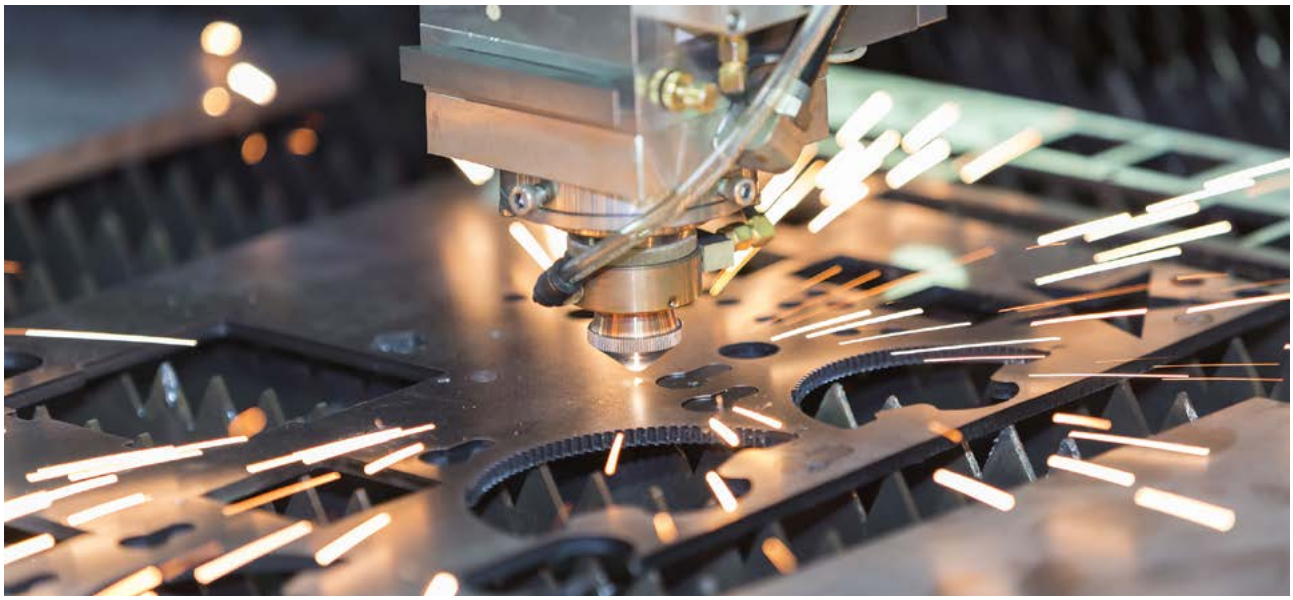
"A widely available tool with thermal sensors capable of online monitoring of the temperature in the cutting zone is a distant prospect. For now we are improving and further testing our prototype," notes Kryzhanivskyy.

The team have already integrated wireless signal transmission into their temperature sensors. The next step is to further integrate the system so that decisions about cutting conditions (speed, feed, depth) could be based on temperature distribution within the tool body in real time.

This ongoing work is being undertaken in conjunction with the ToolSense project (with VINNOVA and the Eureka cluster funding). It has been set up to develop, upscale and commercialise sensors for online measurement and monitoring of forces, vibrations and temperatures in machining processes.

MoMenT

- Coordinated by Seco Tools in Sweden
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/797328
- Project website: bit.ly/MoMenT-project



DIGITAL ECONOMY

Faster, more efficient industrial robots with real-time motion planning

Automation and robotics are set to change the landscape in office spaces and factories in the coming decades. Achieving high levels of coordination between interacting robots and between humans and robots was the ultimate goal of the EU-funded Co4Robots project.

Conjure up the image of smart factories that deploy intelligent robots that can learn, think and act like humans. This inevitably entails high levels of robotic automation: robots that can perform tasks that are not so meticulously pre-planned, take decentralised decisions and perform real-time motion planning. This was the vision of Co4Robots (Achieving Complex Collaborative Missions via Decentralized Control and Coordination of Interacting Robots): Factories of the Future with multiple robots and humans working together safely and productively on common tasks, such as item pickup, transport and delivery. The main challenge Co4Robots addressed was the efficient coordination of robots with different actuation, manipulation and perception capabilities.

CENTRALISED VERSUS DECENTRALISED CONTROL AND COORDINATION

Robots moving as a cohesive unit, while also splitting tasks, is difficult to achieve in real time. The supervision and coordination of this heterogeneous system call for a decentralised framework integrating high-level task planning, low-level motion control and robust, real-time robot perception.

Robotic team coordination typically relies on offline, centralised planning. The related tasks are prepared in advance and are performed in a predefined manner. “Assigned paths and actions cannot help unlock the vast

© PAL Robotics

potential multi-robot systems can show when carrying out operations in a dynamic environment. Any sudden change in the environment or the type of assigned tasks would require higher levels of coordination and would thus cause the system to halt and ask for human intervention," explains Dimos Dimarogonas, Co4Robots coordinator.

Co4Robots addressed the need for real-time, automated task (re)-planning in the absence of a central ordering influence of a centralised system. "Our main focus was on improving collaboration between different types of interacting robots and between robots and humans. Examples include force-controlled transport, human gesture recognition, and dynamic task decomposition and allocation," adds Dimarogonas.

PROJECT MILESTONES

Researchers demonstrated three scenarios to test interactions between different agents in a changing environment.

The first scenario involved a human and a robot collaborating on transporting a load. The human let the robot know what it should be doing using a hand gesture. The second scenario involved a fixed and a mobile robotic entity interacting with each other and with humans, again for grasping an object. In the third scenario, multiple robots and humans worked in a shared space. The tasks included the periodic check of assembly stations for finished products, product delivery to the next production station, and monitoring of the assembly station for supply requests.

To realise these scenarios, researchers pioneered, amongst others: the development of distributed methodologies for real-time motion control of multi-agent systems in a dynamic environment; control schemes for collaborative load transportation; perception algorithms; and object or agent detection and tracking.

> *Our main focus was on improving collaboration between different types of interacting robots and between robots and humans. Examples include force-controlled transport, human gesture recognition, and dynamic task decomposition and allocation.*

The new decentralised approach for real-time motion planning was based on linear temporal logic (LTL) and metric interval temporal logic – a fragment of LTL. LTL is just like writing down the commands needed to complete a certain task. This automated planning entails three steps: first, efficient decentralised methods translate each agent's motion capabilities and dynamic interactions into a discrete representation; second, the initial task is decomposed into local tasks; and third, a high-level task plan is obtained.

Another project highlight was the development of software architecture that supports human-robot collaboration as well as adaptation and coordination of single- and multi-robot systems in a decentralised fashion. The Co4Robots results are also presented in more than 80 publications.

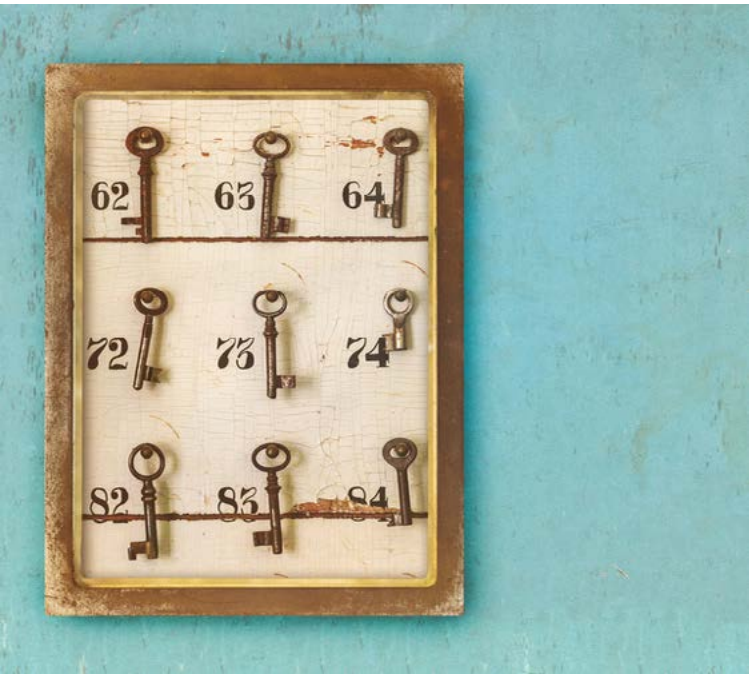
Co4Robots

- Coordinated by the KTH Royal Institute of Technology in Sweden
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/731869
- Project website: co4robots.eu
- bit.ly/Co4Robots

Independent hotels now have a digital platform to manage all their services

Major hotel chains and, more recently, the might of platform-based accommodation marketplaces are formidable competition for independent hotels. An EU-funded initiative has developed an app that helps such hotels focus on their business rather than grappling with tech challenges to survive market pressures.

Özgür Zan, coordinator of the project Home2nite (An innovative guest engagement platform that aims to empower the independent hotels as AirBnb did for the travel hosts), sums up the hotel industry challenge: "Chain brands that have hundreds or thousands of hotels can provide digital solutions for all their individual hotels so that they can manage direct booking (from web or mobile application), a central customer relationship management database and loyalty for their repeat guests." Independent hotels, often family-owned, may not have the wherewithal needed to acquire and maintain such technology. They most likely are also not able to offer a loyalty solution.



Smaller, independent lodging facilities make up more than half of Europe's hotel market share. "They provide dynamism to the economy and employment, and they also reflect the cultural heritage, past and social diversity that needs to be protected to have sustainable growth," Zan emphasises.

Despite their important standing in European tourism overall, they are beset by a particular set of problems, including limited technological know-how and resources as well as challenges to managing operating income. They are also under pressure to increase engagement with potential customers and manage their online reputation.

CHECK OUT THE SOLUTION

"Home2nite combines independent hotels under one platform so that they can share standards, digital experience and engagement, and customised service aligned with guest preferences and loyalty," Zan notes. The digital platform includes a mobile application and cloud applications with numerous functionalities, starting with searching and browsing and direct booking. It allows communication for pre-stay requests (such as transportation) and preferences (smoking/non-smoking rooms) as well as fast and touchless check-in.

Once they're settled in, guests can use the platform to relay requests for services such as housekeeping and dining reservations. With compatible hardware on the part of the hotel, patrons can enter their rooms using the application instead of keys or magnetic cards. All these no-touch capabilities also ensure safety measures when contact needs to be kept to a minimum, such as during

health crises. Finally, Home2nite has the option of earning and burning loyalty points.

ENSURING BUSINESS LONGEVITY

Globally, chain hotels have shared standards independent of their country of operation. In contrast, most independently owned hotels operate in just one location and both are influenced by the surrounding culture as well as reflect and affect it. The project's solution bridges the two realities. "Some tourists like globally shared standards, some want more local experiences," Zan says. "Home2nite creates shared standards and digital experience and provides this in a cost-effective manner to contribute to local hotels."

With the support of SME Instrument Phase 2 funding, Home2nite succeeded in developing all its originally planned digital solutions. The platform is fully commercial, and new features align with industry needs and conditions. For example, and with specific reference to the COVID-19 outbreak, Zan mentions touchless check-in and food and beverage ordering through digital catalogues.

> *Home2nite combines independent hotels under one platform so that they can share standards, digital experience and engagement, and customised service aligned with guest preferences and loyalty.*

"Hotels that are involved in Home2nite have provided us great feedback, and we are growing," Zan concludes. "We will continue to include more hotels and accelerate our growth, and at the same time we have taken some strategic action to provide Home2nite as a destination platform for sustainable tourism."

Home2nite

- Coordinated by Done Information & Communication Systems in Turkey
- Funded under Horizon 2020-SOCIETY and Horizon 2020-SME
- cordis.europa.eu/project/id/778533
- Project website: home2nite.com

DIGITAL ECONOMY

Machine learning unlocks secrets hidden in a whole Earth catalogue

A hyperspatial and multispectral map of Earth contains more data than human brains can comprehend, necessitating the development of an AI that can see the bigger picture.

The EU's Earth Observation Programme Copernicus pulls together continuous, automated and rich data on the planet's health from a wide array of sources, including satellite imagery, as well as ground- and air-based sensors.

While the data is incredibly valuable for everything from disaster response to environmental planning, the sheer volume of it means that there is too much for any single person to examine.

MACHINE LEARNING

Artificial intelligence (AI) can automate some analysis, sifting through petabytes of data to elucidate relevant and important information. The EU-funded PerceptiveSentinel (BIG DATA knowledge extraction and re-creation platform) project developed an intermediate Earth Observation service to unlock the value of the Copernicus data for downstream users.

"Machine learning is a well-established field however, these tools are not fine-tuned for the complexity of Earth Observation data," says project coordinator Grega Milcinski.

"The computer vision technologies are optimised for identifying human faces, and cats on social media, not multispectral and multitemporal data from satellites."

By integrating data processing workflows and well-known tools such as Google's TensorFlow and Microsoft's LightGBM, Anze Zupanc, scientific lead, and colleagues created eo-learn. This open-source software combined machine learning with Earth Observation and was designed for the scale and complexity of the Copernicus data.

COMMERCIAL SECTOR

Even before the end of the project, Dutch satellite navigation firm TomTom adopted some of the work and used it in their own internal research. Using this software, Milcinski says they: "single-handedly processed a couple billion square kilometres of satellite data in order to create a global product for their users."

In fact, PerceptiveSentinel is already generating income based on use of the eo-learn software, with revenue expected to exceed EUR 1 million in the financial year ending 2021. Principal customers are data scientists, in both research and the commercial sector.

The project has had over 26 000 downloads and more than 182 developers have created their own branch of eo-learn.

© Sinergise

> *"Using this software, TomTom single-handedly processed a couple billion square kilometres of satellite data."*

"We obviously do not know all the users, as the software is available in an open-source manner so anyone can take it and use it however they want, without informing us," explains Milcinski. "There are also lots of users, whom we cannot name due to confidentiality."

TIGHT COOPERATION

PerceptiveSentinel was supported by the Horizon 2020 programme and coordinated by the Sinergise Laboratory for Geographical Information Systems in Slovenia. "The funding helped us to put the best resources available into it and push on," adds Milcinski.

"The partners were essential as well, as they provided contributions going beyond our expertise. This kind of tight cooperation would probably not have happened without the project."

He says the public funding also motivated the team to release the software as open-source, to great success. This kick-started a community around the eo-learn software, which continues to grow, many of whom develop into paying customers.

Work continues on eo-learn, by both the PerceptiveSentinel team and thousands of third-party users who contribute to the open-source project. "We are confident that the results will live on for many years," concludes Milcinski.

PerceptiveSentinel

- Coordinated by the Sinergise Laboratory for Geographical Information Systems in Slovenia
- Funded under Horizon 2020-LEIT-SPACE
- cordis.europa.eu/project/id/776115
- Project website: perceptivesentinel.eu

SPACE

Geology unlocks secrets to Mars's watery past

Geological findings suggest that surface water on Mars existed for a lengthy period of time. This could have important consequences for finding traces of life and future landing sites.

Liquid bodies on the surface of Mars might have all disappeared, but evidence of a watery past is etched into the planet.

"Since the early 1970s, scientists have discovered large valleys and channels stretching for thousands of kilometres," explains Marie Skłodowska-Curie postdoctoral fellow Francesco Salese, who worked on the WET MARS (Hydrological processes on late Mars: water under the telescope and under the microscope) project at the Faculty of Geosciences at Utrecht University, the Netherlands. "These findings completely changed how we imagined Mars."

Recent discoveries have also shown that water is retained under the surface, close to the poles. It is also stored within ice and abundant water-rich materials such as clay minerals and sulfates.

RECREATING WET MARS

Building on these findings, the WET MARS project wanted to reconstruct the conditions that once existed on Mars, and further understand the hydrogeological cycle that produced the complex channel systems found on the planet's surface. This research was undertaken with the support of the Marie Skłodowska-Curie Actions programme.

Orbital data allowed the project team to examine, through detailed high-resolution architectural analysis, a large (1 500 m by 200 m) outcrop on the planet, and to make reliable palaeoenvironmental interpretations based on sedimentary-stratigraphic evidence.

Salese also participated in experiments at Utrecht University using frozen subsoil and numerical modelling. This enabled him to come up with new hypotheses for how late Martian fluvial systems were formed, as well as the role of thermal and mechanical erosion.

"From all this, I was able to identify some of the fluid dynamics related to Martian fluvial deposits," he says. "From the large outcrop of siliciclastic sediments on Mars, I found the first evidence of extensive rivers preserved in an exposed cliff face."

> *This could increase their chances of finding traces of life.*

The project also allowed the team to estimate the minimum lifespan of what was once the Jezero delta, a region of Mars that will be the landing site of the NASA Perseverance Rover, scheduled for early 2021.

BRINGING MARS TO LIFE

The WET MARS project has helped to bring the distant past of our neighbour planet back to life. "The evidence we found points to periods in Mars's past of prolonged water discharge," adds Salese. "This is consistent with a precipitation-driven hydrological cycle some 3.7 billion years ago."

This conclusion aligns with previous arguments for the prolonged presence of water on the Martian surface. Salese demonstrated sustained river deposition – where material transported by rivers is deposited – again, 3.7 billion years ago.

"Such perennially flowing rivers would require an environment capable of maintaining large volumes of water for extensive periods time," Salese continues. "This is more in line with slower climatic change, and less in line with catastrophic hydrologic events."

Evidence of a long-lived watery landscape, Salese believes, could prove critical in our search for ancient life on the planet. "Our results could help planetary missions to better understand fluvial activity and its duration on Mars," says Salese. "The NASA Perseverance Rover and the ESA Rosalind Franklin rover teams for example will have a better idea of what to look for. This could increase their chances of finding traces of life."

Following completion of the WET MARS project, Salese intends to continue his studies of Martian and Terrestrial sedimentary geology.

"This project provided a unique opportunity to take a serious sedimentological look at Mars," he notes. "I hope that what we've done will serve to emphasise even more the importance of geology in planetary exploration. One cannot be a good planetary geologist without first being a good terrestrial geologist."

WET MARS

- Coordinated by the University of Utrecht in the Netherlands
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/795192
- Project website: bit.ly/WET-MARS

SPACE

Characterising the solidification of the Moon's early magma ocean

When it comes to the Moon, some people think: 'Been there, done that, got the samples'. But with a return on the horizon, as MoonDiff shows, there is still much to discover about the Moon's origins and evolution.

The Moon was likely once covered with magma, which cooled and crystallised into the rocky material of today. Different minerals formed at different stages with some forming the Moon's crust, explaining the various rocks found on the surface. These offer clues about the Moon's evolution, while also providing an origin story for planets generally.

However, modelling lacks the varied samples necessary for high accuracy. The Apollo and Soviet Luna missions explored only a few square kilometres, and remote-sensing data indicates that these samples are not representative of the whole lunar crust.

The MoonDiff (Investigating the formation and early evolution of the Moon with a combined experimental and analytical approach) project, supported by the Marie Skłodowska-Curie Actions programme, traced the solidification of the Moon's magma ocean. "For the

> *For the first time, we have obtained radiogenic pair partitioning behaviour for minerals and lunar pressure and temperature conditions.*

first time, we have obtained radiogenic pair partitioning behaviour for minerals and lunar pressure and temperature conditions," says lead researcher Joshua Snape, from VU Amsterdam, which hosted the project.

Additionally, new lunar sample analyses provided the most precise ages available for samples collected during the Apollo missions, as well as some of the oldest known lunar volcanic rocks found in meteorites. These have supplied a new database of lead isotopic compositions in volcanic lunar rocks, complementing previous databases for other isotopes.

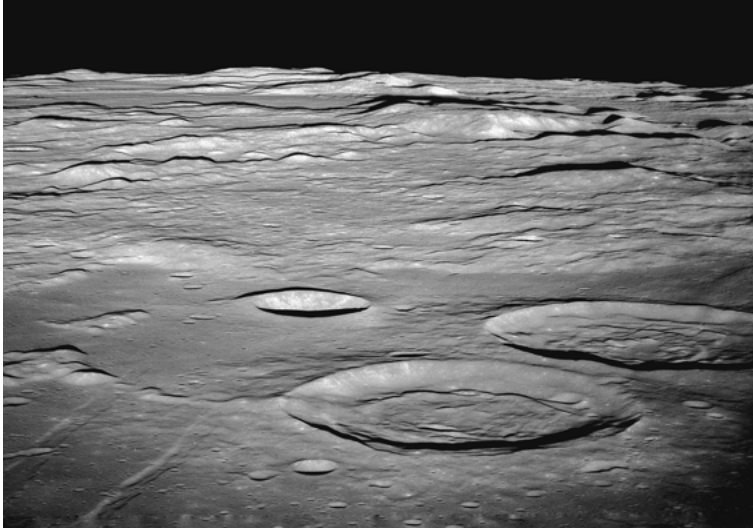
COMBINING ISOTOPIC ANALYSES WITH NEW EXPERIMENTAL CONSTRAINTS

MoonDiff had to work out where different elements would be in the lunar magma ocean. "The Moon provides a brilliant natural laboratory where ancient rocks from the first solid crust formed from the magma ocean, and have survived on the surface," adds Snape.

The team compared previous isotopic analysis with their own experiments. Isotopes are variants of a chemical element. Through the process of radioactive decay, isotopes of one element form isotopes of another. For example, through the decay chain uranium becomes lead and so the elements are said to be paired. Researchers use this process to determine the ages and origins of rocks, which informs modelling.

The MoonDiff experiments made powders of chemical oxides, to obtain a composition similar to the Moon's magma ocean. Traces of the elements under investigation – chiefly: uranium (U), lead (Pb), rubidium (Rb), strontium (Sr), samarium (Sm), neodymium (Nd), lutetium (Lu) and hafnium (Hf) – were then added.

After being melted into a glass and then crushed back into a fine powder, a piston cylinder press heated the mixture to 1 000-1 300 degrees Celsius and squeezed it at pressures of 1-2 gigapascals (10 000-20 000 atmospheres), simulating the Moon's interior.



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This formed crystals of the same minerals that would have formed in the young Moon. The crystals were measured for different trace elements, quantifying the so-called geochemistry (partitioning behaviour) of the mineral's crystal structure.

The results were fed into models which specified the proportions of different minerals likely to have formed at different stages of magma crystallisation. This limited the ratios of paired elements that would have been in different Moon locations. These were compared with calculations from actual sample measurements.

While the sample measurements of Rb/Sr and Sm/Nd ratios could be recreated, the U/Pb ratios remain harder to replicate. The natural samples indicate that the U/Pb ratios would have been much higher than anything experimentally generated or able to fit recent models.

"The Moon could be much younger, approximately 4.4 billion years old, than originally thought. Or if older, approximately 4.5 billion years old, large amounts of lead were either taken into the lunar core or lost into space after asteroid and comet bombardment," explains Snape.

The team will now explore how these bombardments could explain these anomalies.

MoonDiff

- Coordinated by VU Amsterdam in the Netherlands
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/794287
- Project website: bit.ly/3bl3RUR

FUNDAMENTAL RESEARCH

A new generation of experiments aims to answer the gravity-quantum question

Quantum physicists create a new platform for conducting macroscopic quantum experiments on a quantum object's gravitational field.

Quantum mechanics and the theory of gravity are two well-established theories used to describe a large part of the physical world. However, both theories rest on mutually exclusive principles, which begs the question, 'does gravity require a quantum description?'

"This is an experimental question, one that cannot currently be answered by experimental evidence," says Markus Aspelmeyer, a quantum physicist at the University of Vienna.

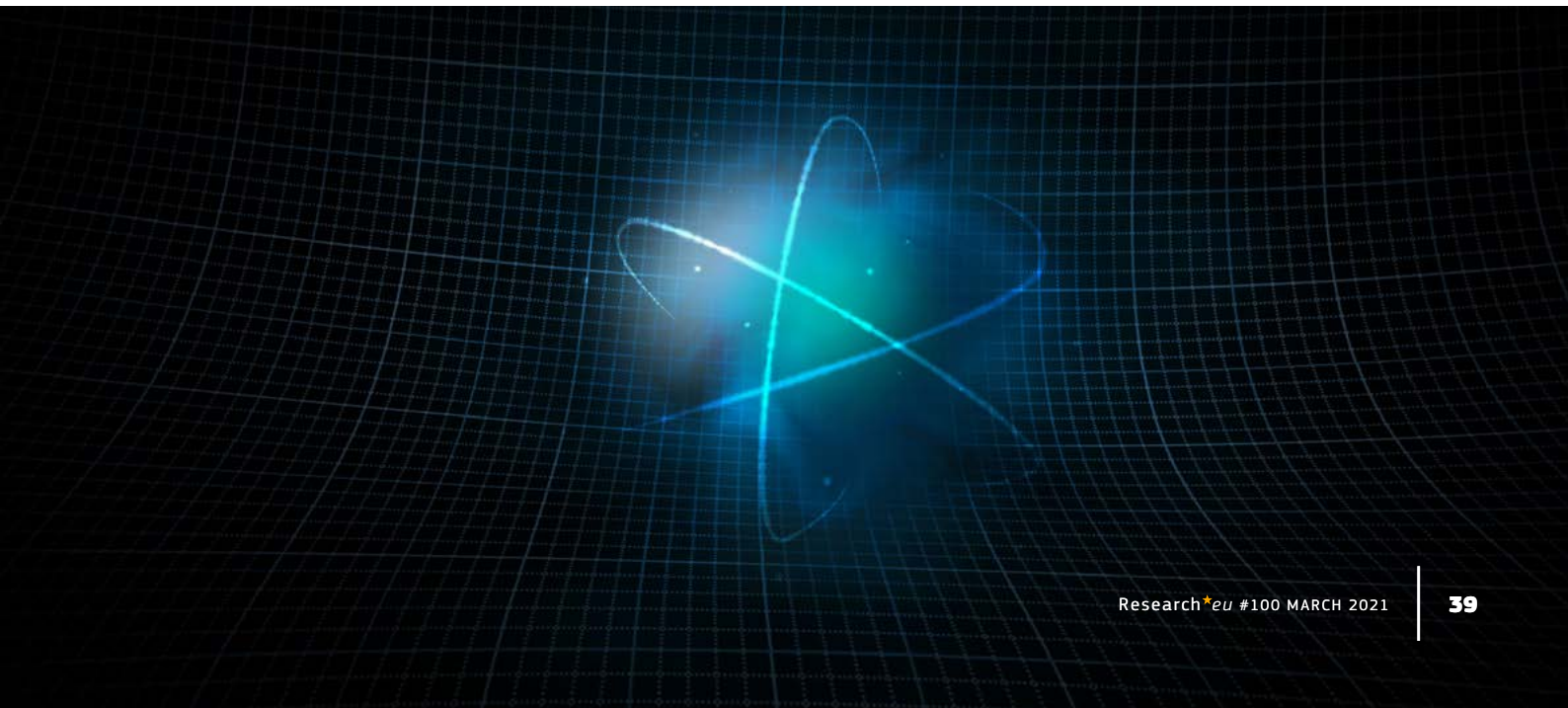
To help answer this question, Aspelmeyer is leading the EU-funded QLev4G (Quantum control of levitated massive mechanical systems: a new approach for gravitational quantum physics) project. The European Research Council-supported project aims to introduce a new experimental approach based on quantum controlling levitated solid-state particles. In doing so, researchers hope to lay the groundwork for conducting a new generation of experiments that will answer the gravity-quantum question.

"On the one hand, we wanted to see how small we could make an object and still measure its gravitational field," explains Aspelmeyer. "On the other hand, we wanted to go the opposite direction and see how massive we could make an object and still observe its quantum behaviour."

The answer to these questions will, in theory, lead researchers to experiments that allow them to probe the gravitational field generated by a quantum object.

SIGNIFICANT PROGRESS ON TWO FRONTS

According to Aspelmeyer, the project has made significant progress on both the quantum and the gravity fronts. "On the gravity side, we managed to measure the gravitational field of the thus far smallest source mass in an experiment: a tiny gold sphere of only 1 mm radius and 90 mg mass," he notes. "Whereas typical gravity experiments use masses that are at least 10 000 times larger!"



> *I hope that our work inspires others to take on the challenge of identifying and observing the gravity-quantum interface.*

On the quantum side, researchers used laser cooling techniques from atomic physics to produce the quantum ground state of motion of a 150 nm glass bead. "This is the first time a solid-state object of that size has exhibited quantum behaviour while sitting in a room temperature environment," adds Aspelmeyer.

According to Aspelmeyer, one surprise was the amazing sensitivity of the lab's gravity measurement apparatus. He says that his team kept seeing unexpected signals, which originated from the Vienna City Marathon finish line a mile away. They were also able to calibrate low-frequency noise using a signal that was generated by an earthquake in Turkey.

"We were awestruck when we discovered that our work was sensitive even to the gravitational field of the Vienna tram, which passed by about 70 metres from our lab," remarks Aspelmeyer.

A NEW PLATFORM FOR MACROSCOPIC QUANTUM EXPERIMENTS

The QLev4G project succeeded in establishing levitated solids as a new platform for macroscopic quantum experiments. "This work has brought us a step closer to experiments that probe the phenomena of gravitational quantum physics," concludes Aspelmeyer. "I hope that our work inspires others to take on the challenge of identifying and observing the gravity-quantum interface."

Researchers are currently working to measure gravity from even smaller masses. On the other end of the spectrum, they are creating as large a quantum state as possible for as massive objects as possible. The ultimate goal is to be able to isolate gravity as a coupling force between objects that can be controlled in the quantum regime.

QLev4G

- Hosted by the University of Vienna in Austria
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/649008
- Project website: aspelmeyer.quantum.at

FUNDAMENTAL RESEARCH

Unwinding the mechanobiology of the circadian clock

The circadian clock regulates how living organisms respond to the 24-hour oscillations of natural light. MECHADIAN has reverse-engineered how cell mechanics influence the processes involved.

The circadian clock enables a body to obtain the resources it needs at the optimum time, while scheduling organ, tissue and cell activity. In mammals, circadian rhythms are controlled by genes, with some proteins produced by genes themselves circadian. Given that these proteins are involved in crucial cell activities such as cell cycle and differentiation, if something goes wrong with the clock, it can have serious consequences.

There is increasing evidence that the mechanical environment of a cell influences its behaviour. For example, cell cycle progression depends on available

The circadian clock – regulates how living organisms respond to the 24-h oscillations of natural light

space, pressure exerted by neighbouring cells and the rigidity of the extracellular matrix. These factors also affect the differentiation of a cell during development, even determining if a cell dies or becomes tumorous.

Given that circadian cells within a tissue share a common microenvironment and are interconnected, with the support of Marie Skłodowska-Curie Actions, MECHADIAN (Mechanobiology of the cellular circadian clock) investigated for the first time how circadian clock maintenance is influenced by mechanics.

Looking at fibroblasts, the most important cells of connective tissue, the team learned that the mechanical environment strongly influences the performance of their circadian clocks. For example, when this environment was damaged by a wound, the circadian clock was severely impaired.

"By manipulating cells' environment, we found a new signalling pathway that regulates the circadian clock, prompting critical questions, like: What are the consequences of circadian clock impairment in an injured tissue?" says Marie Skłodowska-Curie Actions fellow, Juan Francisco Abenza, the principal researcher, from the Institute for Bioengineering of Catalonia.

TELLING THE TIME

Cells of the suprachiasmatic nucleus in the hypothalamus of the brain coordinate the daily pace of the biological components that make up mammals. This area receives information from the retina about the approximate time of day and sends endocrine and neurocrine signals to the body's cells to 'set their time'.

Through a feedback loop, genetic expression of these cells oscillates over a 24-hour cycle regulating hundreds of proteins and so impacting the genomic activity of every cell.

To better understand this process, MECHADIAN used confocal microscopy to study thousands of single NIH3T3 fibroblast cells. This was combined with microfabrication tools, such as for microprinting extracellular matrix proteins, alongside wound healing assays.

The team statistically evaluated the differences in the circadian gene expression of cells growing in different conditions – looking especially at the robustness of circadian clocks based on the expression of REVERBα, one of the core circadian proteins.

"A surprise was that after certain mechanical alterations, like a sudden change in cell density, the cells did not become circadian even after attempts to force them using hormonal shocks. This highlights how influential the mechanical context is," explains Abenza.

Another achievement was the discovery of the precise molecular connection between the circadian clock and cell mechanosensing – the way cells 'feel' the mechanical properties of their environment. The results are being compiled for publication.

TOWARDS CHRONOMEDICINE

MECHADIAN highlights the importance of considering both timing and mechanical environment when studying cell behaviour. These variables could help answer some unsolved biological puzzles, contributing to the emerging field of chronomedicine, which seeks to identify the optimum timing for drug ingestion or surgery.

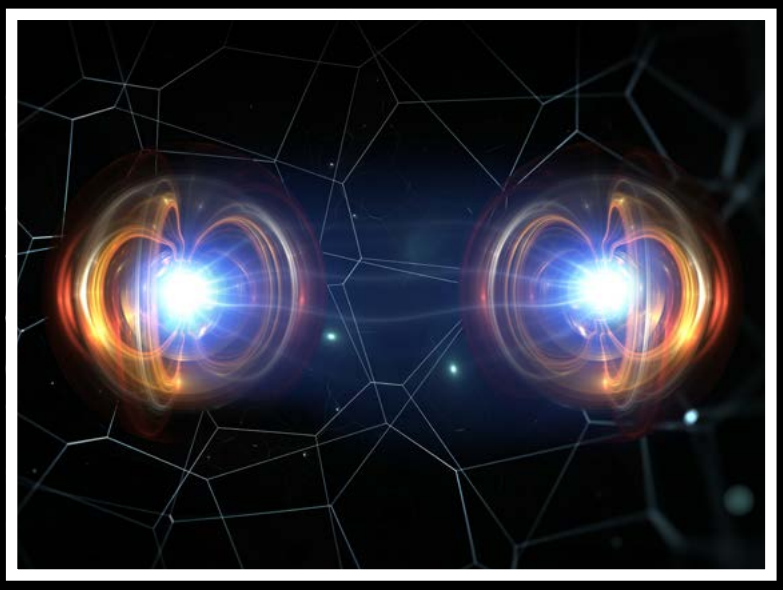
"As humans adopt schedules devoid of natural light, circadian rhythms are increasingly disrupted, risking physical and mental health," adds Abenza. "Having unveiled a connection between cell mechanics and the circadian clock in fibroblasts cultured in cells, we want to explore this in more complex systems, like 3D cultures, organoids or even in the body."

MECHADIAN

- Coordinated by the Institute for Bioengineering of Catalonia in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/750557

‘Quantum entanglement’ allows for better data readouts

Researchers working under the EU-funded QUARTET project have been able to greatly improve the readout of data from digital memories thanks to ‘quantum entanglement’ – why is this important? It could result in major applications for digital storage devices and allow for the construction of memories with higher capacities in next-generation computers.



> *“This is an experimental demonstration of quantum advantage directly at the core of a fundamental task in computer engineering and information technology.”*
>
> Stefano Pirandola, professor of Quantum Computing and QUARTET project cordinator

In an optical memory, bits are read by shining a laser beam over the reflecting surface of the disk. In the memory, each microscopic cell has one or two possible levels of reflectivity, representing the values ‘zero’ and ‘one’ of a bit. The laser beam reflected from the cell may be more or less intense depending on the value of the bit, with the intensity eventually being translated into an electrical signal.

However, a common problem is that when the intensity of the beam becomes too low, such as when the disc increases speed, energy fluctuations prevent the correct retrieval of bits, introducing errors.

The QUARTET (Quantum readout techniques and technologies) study showed that by utilising more sophisticated light sources and using quantum entanglement, this completely removes the unwanted fluctuations. However, their results potentially have even further applications than just digital memories. They say the same principle can be used in spectroscopy and the measurement of biological samples, chemical compounds and other materials.

For more information, please see:

→ bit.ly/37bsSyR

QUARTET

→ Coordinated by York University in the United Kingdom

→ Funded under Horizon 2020-FET

→ cordis.europa.eu/project/id/862644

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!

AGENDA

APRIL 2021

7 APR

WORLDWIDE
World Health Day

14 APR → 11 MAY

BRUSSELS, BELGIUM
'European Legumes in Transition' Webinars
→ legvalue.eu/conference

14→15 APR

ONLINE
SEAFOODTOMORROW Final Conference
→ bit.ly/seafoodtomorrow

20→22 APR

ONLINE
NanoTox 2021: 10th International Conference on Nanotoxicology
→ nanotox2021.org

22 APR

WORLDWIDE
International Girls in ICT Day

23→24 APR

RIGA, LATVIA
4th Baltic HPC and Cloud Computing Conference
→ bit.ly/4thBalticHPC

MORE EVENTS
cordis.europa.eu/news

20–22 APR

ONLINE

EUCAD 2021: 3rd EU Conference on Connected & Automated Driving

The European Commission intends to establish a new European Partnership on Cooperative, Connected and Automated Mobility (CCAM) under Horizon Europe. The partnership aims to align better public and private efforts through a common and long-term R&I agenda. It brings together political leaders from the European Commission and Member States with high-level representatives of industry, knowledge institutes and road authorities to exchange knowledge and experience on the most recent technological developments and policies in the area of CCAM.

→ bit.ly/EUCAD2021

Whilst at the time of writing all of these events were scheduled to take place, we advise all of our readers to regularly check the status of each event due to the continued uncertainty caused by the novel coronavirus epidemic in Europe – events may be cancelled, rescheduled or reformulated (e.g. switched to being a digital event only) at any time.

CORDIS RESULTS PACK ON CLIMATE SERVICES

This CORDIS Results Pack focuses on 10 EU-funded projects that have developed vital tools and expertise to help mitigate the impacts of a changing climate through the application of climate services.

Check out the Pack here:
cordis.europa.eu/article/id/422577

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