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SPECIAL FEATURE
THE FUTURE OF AVIATION:
THE ONLY WAY
IS UP

Editorial

Cutting-edge research to lift the aviation industry back up into the skies, an amazing archaeological discovery and deploying Virtual Reality to fight domestic abuse

Welcome to this month's Research*eu magazine

For your editor, one of the eeriest sights to behold at the beginning of the COVID-19 pandemic in March 2020 was the deep, deep blue skies above his home back in that rather warm and pleasant (if we strictly only refer to the weather of course) spring. Your editor lives only a couple dozen kilometres from one of Europe's major international airports and so the skies above him are usually always criss-crossed with the white streaks of aircraft exhausts. Almost in the blink of an eye, they were gone and nothing but pure, uninterrupted blue lay above. Suffice to say, it was unnerving and perfectly drove home the enormity of the catastrophe that had struck us.

Indeed, aviation is a strong contender for the unenviable distinction of being the most disrupted industry as a result of COVID-19. With the sudden drop in passenger numbers (up to 90% at the peak of the first wave), many already struggling international airlines, including some of Europe's prominent flag carriers, suddenly and urgently required financial support from governments to stay afloat. At the beginning of 2021, demand is still a fraction of pre-COVID times and it's likely that we'll be well into 2022 before a sustained recovery begins on the back of mass vaccination programmes.

But when that recovery does get into gear, the aviation industry will still be an important strategic industry for the EU as it is likely to eventually regain the economic importance that it had (contributing EUR 300 billion to the EU economy and supporting nearly 5 million

jobs) prior to 2020. Aviation is a focus of several key EU policy initiatives, from ensuring that the industry is safer, more efficient and better serves EU citizens, to the ambitious goal of making the EU carbon-neutral by 2050, with a greener airline industry being an important component of the European Green Deal. Aviation is also a keen focus of EU-funded research under Horizon 2020, through initiatives such as Clean Sky, and this will continue into the new programme, Horizon Europe.

In other news, **Life After** reintroduces you to **VRespect.Me**, a truly fascinating project that has utilised cutting-edge Virtual Reality technology to combat domestic violence. We catch up with them to see how they have progressed since the end of their EU-funded phase and how they have been promoting their solution further. Then in **Project of the Month**, we celebrate an EU-funded researcher who undertook an expedition into the Colombian Amazon and unearthed the world's largest collection of prehistoric art, since dubbed the 'Sistene Chapel of the ancients'. Finally, we bring you **EU Agenda** looking at the latest upcoming digital and in-person events, but as always, we advise you to regularly check the status of any event you're interested in!

Remember, 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.

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

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ISSN 2599-7912 (Printed version)
ISSN 2599-7920 (PDF)
ISSN 2599-7939 (HTML)
Catalogue No ZZ-AG-21-001-EN-C (Printed version)
Catalogue No ZZ-AG-21-001-EN-N (PDF)
Catalogue No ZZ-AG-21-001-EN-Q (HTML)

Luxembourg: Publications Office of the European Union, 2021

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Monitoring the risks in neonatal intensive care

A high proportion of preterm infants become infected while in hospital leading to significant morbidity and mortality. A new decision support system aims to reduce sepsis risk while monitoring newborn cardiorespiratory and neurobehavioural maturation.

Nearly 8% of babies are born prematurely every year, requiring hospitalisation in the neonatal intensive care unit. This increases the risk of infection, but prompt diagnosis is difficult since microbiological and biological data are unreliable, while clinical signs have no diagnostic value. As a result, physicians usually administer a large amount of broad-spectrum antibiotics.

A SYSTEM FOR ASSESSING SEPSIS RISK AND NEWBORN MATURATION

The EU-funded project Digi-NewB (Non-invasive monitoring of perinatal health through multiparametric digital representation of clinically relevant functions for improving clinical intervention in neonatal units) aimed to support decision-making by assisting the detection of nosocomial infections and the quantification of newborn maturation. The project combined expertise from the fields of engineering, big data and medical sciences. “Our system uses artificial intelligence (AI) to integrate physiological, clinical and biological data in real time to assess sepsis risk and assist in healthcare and treatment decisions,” explains Patrick Pladys, Digi-NewB coordinator.

The system captures and analyses a full set of data from the newborn, such as cardiac and respiratory rhythms,

clinical signs, and movements, thanks to video recordings. Then, it calculates and displays a sepsis risk score. By doing so, it enables clinicians to monitor the evolution of this sepsis risk score in time. They can also view selected parameter trends and replay video recordings. Importantly, this new system is easy to use and install, and can be operated by hospital staff.

This data-driven project provided many technological and scientific innovations. In addition, it generated a big annotated database combining video, physiological signals and clinical data equivalent to 7 years’ recordings and the conception of several innovative signal processing algorithms some of which were patented. Significant effort was also devoted to the extraction and characterisation of movements from video and the spontaneous cry of preterm infants. These offer a quantification of the postnatal maturation of the heart and breathing rhythms, sleep and crying of premature infants.

CLINICAL PERFORMANCE AND FUTURE DIRECTIONS

To build and optimise the Digi-NewB system, project partners implemented a prototype at Rennes University Hospital, run in real time. Using a focused design methodology, outcomes of the scientific results were fed into the system to improve its technical readiness.

Although it remains to be validated in a large controlled clinical study, the Digi-NewB system successfully passed a proof-of-concept test during its development. This highlights the potential of AI-based monitoring to detect and treat sepsis in the perinatal period. Results have shown that the Digi-NewB system can identify sepsis 4 to 48 hours before standard tests or other approaches currently employed for the diagnosis of sepsis in neonatal

“Our system uses artificial intelligence to integrate physiological, clinical and biological data in real time to assess sepsis risk and assist in healthcare and treatment decisions.”



units. “We have demonstrated that in the very beginning of life the proposed multidimensional approach can lead to a better, coherent use of health data for clinical decision-making,” emphasises Pladys.

The project team is currently working towards a controlled clinical study to demonstrate that the real-time monitoring through the sepsis score generated by the Digi-NewB system can reduce morbidity and mortality associated with hospital-acquired neonatal sepsis. “The important thing about the Digi-NewB system is that it can adapt and improve as the amount of data included in the learning database increases, and by taking into account developments in neonatal care,” concludes Pladys.

Furthermore, partners have built a maturation chart that shows the correlation of cardiorespiratory and

sleep/neurobehavioural measures with age. Although its impact in clinical practice remains to be determined, this maturation tool will help measure deviations from the expected optimal postnatal trajectory, enabling decision-making with respect to ventilatory support and hospital discharge.

DIGI-NEWB

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- Coordinated by GCS HUGO (Hôpitaux Universitaires Grand Ouest) in France
- Funded under H2020-HEALTH
- cordis.europa.eu/project/id/689260
- Project website: digi-newb.eu
- ▶ bit.ly/3qBAtyv

Better understanding of pathogen evolution takes us closer to one-time vaccines

Flu presents a paradox: while strains adapt to increased host immunity, strain diversity during an epidemic is limited. UNIFLUVAC successfully developed an influenza antigenic thrift model in pursuit of a one-time vaccine – useful against other pathogens, including COVID-19.



Key to our immune system is the production of protein antibodies which recognise and bind to antigens or molecules on the outside of pathogens, blocking or destroying them.

In flu, caused by the influenza virus, these antigens constantly evolve. This process, known as ‘antigenic drift’, makes it harder for the immune system to recognise the antigens and so fight them. This means that widespread flu immunity is never established in populations.

But ‘antigenic drift’ does not explain why single or limited numbers of flu strains dominate each season, when an infinite number is theoretically possible. So the EU-supported DIVERSITY project developed a theory that specific antigenic parts recognised by the immune

system, called epitopes, do not vary as widely as previously believed.

The UNIFLUVAC (A novel universal influenza vaccine targeting epitopes of limited variability) project, supported by the European Research Council, has subsequently been successful in identifying such epitopes of limited variability in several influenza subtypes.

“We have shown that these epitopes cycle between a limited number of variations as they evolve. So we can target them with a vaccine that protects against all past and present human influenza strains, as well as potentially against pandemic strains too,” says project coordinator Craig Thompson from the University of Oxford, the project host.

Crucially, the research, as well as the tools and techniques developed, could be applied to other pathogens, including COVID-19. Indeed, the Oxford group, alongside the Scottish National Blood Transfusion Service, have used project techniques to track the spread of COVID-19 in Scotland.

The team are currently preparing for a phase I human trial of the influenza vaccine with adults aged 18-65 and have partnered with an American start-up Blue Water Vaccines to commercialise it, once ready.

FLU’S LIMITED REPERTOIRE

UNIFLUVAC’s alternative ‘antigenic thrift’ model is based on the hypothesis that epitopes cycle through their repertoire of limited variants in response to population immunity changes. The project’s antigenic model was able to look for

patterns in annual flu evolution to make predictions about its development which could be tested in the lab.

The team identified epitopes of limited variability in avian and other zoonotic (H1, H3 and influenza B) influenza viruses, which typically only had between three and four variations. The location of these mutated epitopes also makes them highly likely to produce a protective immune response.

The model was combined with structural bioinformatic analysis to design a vaccine which was trialled on mice for effectiveness against all influenza strains. These strains, with similar epitopes, were chronologically distinct – separated in time with one strain, an ancestor of another, but with multiple mutations in between.

The mice were found to successfully produce antibodies against these strains, showing protection when infected with them. These results were also replicated by the team in human sera, taken from young children for a previous hepatitis B vaccine trial.

TOWARDS A ONE-TIME VACCINE

Vaccinating against all past and present epitope variations should mean not only higher levels of protection against flu but also the end of annual vaccinations.

“ We also plan to use the technology to develop other vaccines, COVID-19 or a pan-coronavirus vaccine being an obvious candidate. ”

As the vaccines can be made using current manufacturing methods, using inactivated or attenuated influenza, this will help keep prices down. This could make the vaccines attractive to pharmaceutical companies, while the reduced number of doses required to confer immunity will also be appealing to healthcare providers.

“Our flu vaccine is probably 5 to 10 years away from being commercially available. We also plan to use the technology to develop other vaccines, COVID-19 or a pan-coronavirus vaccine being an obvious candidate,” explains Thompson.

UNIFLUVAC

- Hosted by the University of Oxford in the United Kingdom
- Funded under H2020-ERC
- cordis.europa.eu/project/id/812816

HEALTH

A perfect cage-like nanostructure could ship drug molecules into cells

EU-funded scientists created a tiny, nano-sized polyhedron structure that could act as a container slipping inside cells and releasing therapeutic agents. The achievement of this complex, yet elegant arrangement, just 10 nm across, could one day help in the fight against cancer.

Nanotechnology offers a promising way to deliver and control the release of new drugs and a tremendous opportunity to overhaul old treatments by improving their safety and efficacy. Functional nanoparticles encapsulating drug molecules can selectively reveal their therapeutic action close to the target tissue or cell without flooding the bloodstream with medicine.

HELPING NANOPARTICLES DELIVER ON THEIR PROMISE

The aim of the NanoIntra (Multitasking Nanoparticles for Intracellular Bioimaging and Biosensing) project, which received funding under the Marie Skłodowska-Curie Actions programme, was to clear a key hurdle to making

nanoparticle drug delivery a reality. Besides achieving a fine control and release of therapeutics on the nano level more accurately, we need to understand where the drug is trafficked once the nanoparticle is taken up inside the cell. In particular, drug molecules can be rendered completely ineffective if they remain in the endosomes.

Merging expertise from different fields, such as chemistry, biology and physics, NanoIntra scientists created several innovative nanoparticles including luminescent semiconductor quantum dots, plasmonic metal nanocrystals and silica nanoparticles for accurate bioimaging and biosensing analysis. In a second step, they functionalised their surface with organic ligands to promote their cellular uptake (endocytosis) and their subsequent escape from the endosomes.

“An important part of the work was geared toward investigating the interaction between the hybrid nanomaterials and cells. We ultimately devised a new surface functionalisation approach using zwitterionic ligands. By carefully tuning the ligand density, we managed to strike a good balance between high colloidal stability and efficient cellular uptake,” explains Tangi Aubert, NanoIntra coordinator.

A SUPERLATTICE GUIDING NANOPARTICLE SELF-ASSEMBLY

One of the most remarkable project findings was that silica nanoparticles formed a nanocage structure with well-defined dodecahedral symmetry under special conditions. “Studies have shown that tiny silica particles can easily and safely pass through the body and be excreted in the urine, rather than getting stuck in the liver. Perhaps such silica nanocages could be used as containers for anticancer drugs or as vehicles that carry diagnostic molecules,” notes Aubert.

“Perhaps such silica nanocages could be used as containers for anticancer drugs or as vehicles that carry diagnostic molecules.”

The scientists used a relatively simple technique to create this polyhedral structure. For a template, they immersed soap molecules in an aqueous solution. The molecules formed tiny balls called micelles. Then, they added a silica precursor into the mix. Gradually the negatively charged silica clusters formed by the precursor were attracted to the positively charged micelle template surface, building up a cage-type structure. To the surprise of scientists, this process happened without any intervention – the nanoparticles self-assembled around the micelles.

“From a fundamental perspective, nanocages offer a unique opportunity to investigate the early stages of the growth mechanisms of ordered mesoporous materials. Observing the self-assembly of nano building blocks into 2D superlattices of silica cages is an additional step in this direction,” adds Aubert.

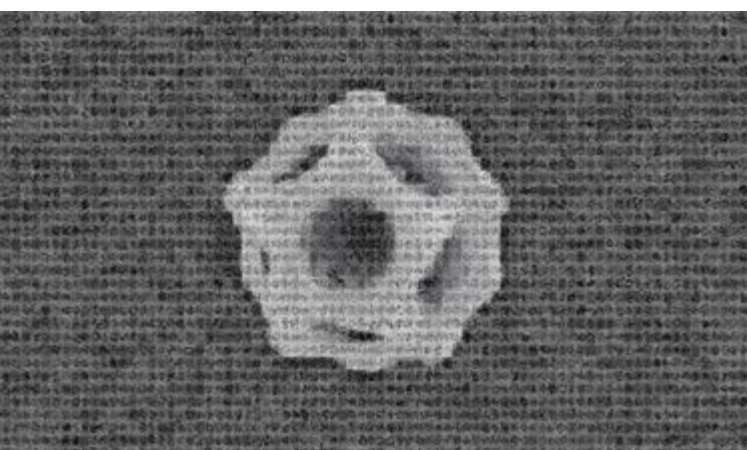
To get a glimpse of these elusive nanocages, scientists used cryogenic electron microscopy. After analysing all different structure orientations by using machine learning algorithms, they reconstructed a perfect dodecahedron.

3D PRINTING SPONGE-LIKE NANOPARTICLES

Porous nanoparticles have enhanced surface areas that render them highly useful for ‘guest-host’ applications, such as biosensing. They also have better control of the release of therapeutic molecules. By functionalising the silica nanocage with photoresponsive ligands, NanoIntra scientists succeeded in printing mesoporous materials with high surface area and arbitrary shapes. “By placing ligand functionalised silica cages at the desired places of the final printed mesoporous material, we can build highly efficient bioanalytical platforms,” concludes Aubert.

NANOINTRA

- Coordinated by Ghent University in Belgium
Funded under H2020-MSCA-IF
- cordis.europa.eu/project/id/702300
- Project website: bit.ly/NanoIntra





Labour uncertainty in Spain makes men less likely to have children

Southern European countries have some of the lowest fertility rates in the world. While most studies focus on why women are having fewer babies, demographers in Spain have taken a look at how economic security or the lack of it affects the fertility of Spanish men.

Temporary work is all too common in Spain. In 2017, over 26% of Spanish jobs offered fixed-term contracts according to the OECD employment database. This is the second highest figure of the 34 OECD countries. Spain has also experienced a marked decline in fertility since the late 1970s, joining others, such as Italy, as countries with some of the lowest fertility rates in the world during the 1990s.

Researchers based at the Spanish National Research Council (CSIC) decided to examine, as part of the project SEU-FER (Southern Europe and low fertility: micro and macro determinants of a crucial demographic and cultural

revolution), the links between these two characteristics by investigating how temporary employment and unemployment affect men's decisions to have a child. This initiative, undertaken with the support of the Marie Skłodowska-Curie Actions, is part of a broader attempt to examine the determinants of changing fertility in Southern Europe over time.

STUDYING MEN IS INNOVATIVE

Demographers interested in fertility usually study women. "Scholars have paid less attention to men's fertility until





Spain has experienced a marked decline in fertility since the late 1970s

now, but we believe it cannot be ignored if you wish to understand the dynamics of fertility today,” says SEU-FER’s main researcher Stanislao Mazzoni.

Using data from the 2018 Spanish National Fertility Survey, the SEU-FER team reconstructed biographies for 2619 men born between 1962 and 2000, including educational attainment and the types of job contracts they held.

For one analysis, they studied the biographies from the age of 15 until the conception of a man’s first child. Using unemployed status as the reference, they then calculated what impact a man’s employment status had on the time it took him to become a father.

UNCERTAINTY DELAYS FATHERHOOD

“We see that in comparison with someone unemployed, a man with a fixed-term contract enters fatherhood a little earlier, but that the difference is not statistically significant,” explains Mazzoni.

“But when we compare an unemployed man with someone with a permanent job, we see that the permanent job

“Scholars have paid less attention to men’s fertility until now, but we believe it cannot be ignored if you wish to understand the dynamics of fertility today.”

really does facilitate entering fatherhood – it comes 30% faster in comparison with someone unemployed.” Thus experience of temporary contracts is shown to increase a young man’s feelings of uncertainty and has the effect of slowing down some of his fundamental life choices.

These findings may be of interest to many outside the field of demography. “This is really relevant because we are in the middle of a pandemic and a recession and we need to have the tools to predict what will happen,” adds Diego Ramiro, project coordinator and director of the CSIC’s Institute of Economics, Geography and Demography.

He notes that major studies on the effects of the COVID pandemic on the health of European populations are already under way, but this is not the case when it comes to the impact on fertility.

Reality often confounds expectations according to Ramiro. “Everyone was expecting that during March–April this year, we would have a baby boom, but what happened was a baby bust, completely the opposite. Since age at first birth is already high, if a couple delay having their first child, many will end up childless with all the consequences this has for society,” he notes.

SEU-FER

- Coordinated by the Spanish National Research Council in Spain
- Funded under H2020-MSCA-IF
- cordis.europa.eu/project/id/799123
- Project website: seu-fer.eu

Textiles could answer big questions about lost civilisations

Textiles have been an integral part of everyday life since ancient times. In the absence of any relevant historical texts, the textile artefacts of Meroe – an ancient city on the Nile’s east bank – could shed more light on the historic societies and their components of Sudan and Nubia.

Around 200 km from the Sudanese capital, Khartoum, the remains of Meroe stand in the desert – a collection of nearly 200 ancient pyramids. These tall, slender structures as well as the impressive displays of royal power on the walls of Meroe’s temples are some of the few remnants of the history of this wealthy city, which served as the seat of power of the Nubian kingdom of Kush.

Most aspects of Meroe’s history still remain in the shadows. “Our goal was to use textiles and clothing as a ‘key’ to unlock new information on the ancient Sudanese and Nubian societies,” notes Marie-Louise Nosch, coordinator of TexMeroe (Archaeology of Textile Production in the Kingdom of Meroe – New approaches to cultural identity and economics in ancient Sudan and Nubia), funded under a Marie Skłodowska-Curie Actions Individual Fellowship. TexMeroe focused on the Meroitic and post-Meroitic periods (from 350 BCE to 550 CE) – periods of great transformation as they saw the political organisation of the kingdom in the Middle Nile Valley changing from an Antique to an Early Medieval state.

“The dry sands of Sudan and Nubia offer favourable conditions for the preservation of organic materials. Thousands of textiles and tools have been unearthed on funerary and settlement archaeological sites, offering a particularly rich context for textile archaeology,” adds archaeological expert Elsa Yvanez.

LIGHT AND FLEETING REMNANTS OF THE PAST TEACHING HISTORY

Textile artefacts are powerful tools that help reveal prominent, yet seldom recognised, aspects of past economies and deeply embedded social and cultural behaviours.

A single piece of textile can represent an interwoven network of information on craft, agriculture, economic



systems, trade, fashion, power structures, cultural identity, ethnicity, gender and social belonging. Despite their potentially fragile and unappealing appearance, “ancient textiles are a truly fantastic gateway to the diversity and complexity of past societies. Archaeologists need only pull a thread to unravel entire sides of history – sides that are not fixed to bricks and monuments, but are very close to the people, projecting their identity,” explains Yvanez. “Deemed unimportant, textiles remained ‘a female affair’, associated with needlework and ‘frivolous fashion concerns’. Textile production can thus document a side of the economy that has long been downplayed or ignored.”

A FOCUS ON PROJECT ACTIVITIES AND HIGHLIGHTS

TexMeroe examined the whole spectrum of material development: from biochemical analyses, to weaving and clothing pattern reconstruction, to industrial and agricultural developments in towns and larger regions, all the way down to the technique and product transfer across borders. The fellow conducted detailed technical analyses

“Ancient textiles are a truly fantastic gateway to the diversity and complexity of past societies. Archaeologists need only pull a thread to unravel entire sides of history – sides that are not fixed to bricks and monuments, but are very close to the people, projecting their identity.”

on more than 200 textiles with a focus on the fibre type and spinning, thread diameter, weaving, decorative devices, cuts and sewing. The colours and dyes were investigated through high-performance liquid chromatography combined with mass spectrometry. Experimental tests increased understanding of unique openwork patterns.

In partnership with excavation teams, the fellow also plotted different textile tools on a map, localising textile activities in a single site, a larger region, and the entire

Meroitic territory. The study revealed patterns of textile production within the kingdom and different modes of industrial organisation.

A significant project highlight has been the identification of changing dress practices from 350 to 400 CE, especially well visible within the elite members of Nubian society. This period marked the slow disappearance of the Meroitic state and its transformation into smaller, yet powerful kingdoms.

TEXMEROE

- Coordinated by the University of Copenhagen in Denmark
- Funded under H2020-MSCA-IF
- cordis.europa.eu/project/id/743420
- Project website: texmeroe.com

SOCIETY

The ethics of designing smart devices

By helping technology designers and developers think and talk about ethics, a group of researchers hope to improve society's trust of smart devices.

Although smart technology is now a well-ingrained, ubiquitous part of our daily lives, much of society remains rather apprehensive – even distrustful – about it.

“There is a lot of discussion about the need for ethical and responsible design of data-intensive technologies and services,” says Irina Shklovski, a professor of communication and computing at the University of Copenhagen. “However, how to actually do that in practice is much less clear.”

This is where the EU-funded VIRT-EU (Values and ethics in Innovation for Responsible Technology in EUrope) project comes in. Led by Shklovski, the project created practical tools to help technology developers think and talk about ethics in new and productive ways. “In a nutshell, we wanted to find practical ways to help the people developing technology think about ethics while they do their work,” adds Shklovski.

A THEORY-DRIVEN SET OF TOOLS

According to Shklovski, although there are a lot of ethical principles, guidelines and statements, there is a lack of practical methods for implementing them. “To fill this gap, we brought together a truly interdisciplinary team of legal scholars, ethnographers, computer scientists, designers and social scientists in order to figure out what ethics means in practice,” she explains.

The result is what Shklovski calls a practical theory of ethics – a theory-driven set of tools and concepts to help developers think and learn about ethics in ways that could help them make better design decisions. “Rather than providing yet another checklist, the VIRT-EU toolkit offers a way for technology developers to gain the necessary language, structure and authority to convene and engage in conversations about ethics,” remarks Shklovski.

This toolkit, which can be accessed via the project website, includes a unique questionnaire that helps developers and designers assess the privacy, ethical and social impact of their work. Another feature is the Ethical Stack, a series of tools designed to help creators of new connected technology reflect on the potential ethical and social consequences of their products. The toolkit includes offline resources designed to ask difficult questions and challenge assumptions or uncertainties. There is also an animation about ethics within the internet of things and a short ethics primer.



“ We wanted to find practical ways to help the people developing technology think about ethics while they do their work. ”

THE NEW STANDARD

This toolkit established VIRT-EU as the new standard for engaging with designers and developers about ethics. “Instead of blaming designers and developers for the failings of data-intensive technologies, we recognised that the tech community itself is experiencing anxiety and uncertainty about their decisions,” concludes Shklovski. “Our tools are designed to help people manage these uncertainties together rather than face them alone.”

While the project is still in the process of finalising some of its academic reporting, many of the consortium partners are already incorporating the toolkit into new initiatives.

VIRT-EU

- Coordinated by the IT University of Copenhagen in Denmark
- Funded under H2020-LEIT-ICT
- cordis.europa.eu/project/id/732027
- Project website: bit.ly/virt-eu-project
- ▶ bit.ly/VIRT-EU



INTRODUCING CORDISCOVERY, THE BRAND NEW CORDIS PODCAST, AVAILABLE NOW!

CORDIS is proud to announce the launch of CORDIScovery, the latest addition to the CORDIS editorial portfolio, coming to you every month with our first episode already available to listen to right now!

Each month, CORDIScovery will bring you an engaging panel discussion with up to three distinguished guests, taking a deeper and more intimate look at some of the key burning issues facing our societies that are currently being addressed by innovative EU-funded research.

Our first episode takes an in-depth look at the drive to maintain healthy ecosystems and biodiversity preservation, introducing you to three EU-funded scientists who are making valuable contributions to this cause.

You can listen to Episode One of CORDIScovery by going to cordis.europa.eu/podcast, and as always, we'd love to hear your feedback, so do please send it to us at editorial@cordis.europa.eu



Celebrating the discovery of one of the world's largest collections of prehistoric rock art

A researcher funded through the European Research Council (ERC) was a key part of the team that made the startling discovery in the heart of Colombia's Amazon rainforest. Amazingly, the collection consists of tens of thousands of paintings of humans and animals created on a canvas of cliff faces stretching around 12-13 kilometres and has invoked imaginations across the world.



© Jose Iriarte

“ For Amazonian people, non-humans like animals and plants have souls, and they communicate and engage with people through rituals and shamanic practices. These earliest Amazonian artists' expressions likely represent the origins of this distinct relationship. ”

José Iriarte, ERC grantee

Dubbed the 'Sistine Chapel of the ancients', the artwork is thought to date back around 12 500 years and clearly portrays both Ice Age animals that are now extinct, such as the mastodons, horses, camelids and a giant sloth, as well as a huge array of fish, turtles, lizards, porcupines, monkeys, birds, bats, among many others. Other paintings show scenes of people dancing, performing rituals and holding hands together.

Originally unearthed in 2019, the discovery was kept secret until December 2020, when it featured in the documentary series 'Jungle Mystery: Lost Kingdoms of the Amazon' on Channel 4, a major British public broadcaster.

The ERC grantee in the LASTJOURNEY (The End of the Journey: The Late Pleistocene-Early Holocene Colonisation of South America) project is José Iriarte, professor of Archaeology at the University of Exeter, who is a world expert

on the Amazon and its pre-Columbian history. His team also included his valuable Colombian colleagues, Javier Aceituno and Gaspar Morcote-Rios. In total, Iriarte has been funded through three ERC projects, **PAST**, **FUTURES** and **LASTJOURNEY**, the latter being his current grant that will run until September 2024.

For more information, please see:

exeter.ac.uk/research/news/articles/newlydiscoveredamazonrock.html

LASTJOURNEY

→ Hosted by the University of Exeter in the United Kingdom

→ Funded under H2020-ERC

→ cordis.europa.eu/project/id/834514

→ Project website: astjourney.exeter.ac.uk

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!



Energy Hub could help businesses forge a more sustainable future

What if businesses could curb energy consumption and help drive down carbon emissions while boosting their own bottom lines? 'Energy Hub', a turnkey integrated solution PowerSines recently unveiled, could assist businesses in doing so.

The EU aims to be climate-neutral by 2050 – an economy with net zero greenhouse gas emissions. This objective is at the heart of the European Green Deal and in line with the EU's commitment to global climate action under the Paris Agreement. Forging a more sustainable future requires action by all sectors of the economy – it would actually be impossible without businesses and organisations committing to action. The Green Deal should be on the radar of every business that wants to build up competitiveness.

The EU-funded SuperEH (Super Variable Vector Combination Energy Saving Hub) project supports businesses and organisations in better managing their resource usage and curbing energy costs. The project unveiled Energy Hub, an integrated solution that harnesses the Internet of Things (IoT), advanced data analytics, machine learning algorithms, sophisticated power and voltage control, and loads control to enable organisations to monitor and manage their energy consumption. "Our Energy Hub offering could help organisations reduce costs by up to 15-25 %, enabling a swift return on investment – within 3 years," notes Haim Guz, SuperEH coordinator and PowerSines CEO.

CUTTING COSTS AND CARBON EMISSIONS THROUGH VOLTAGE OPTIMISATION

The concept behind voltage optimisation is simple. Power from the grid is supplied at a higher voltage than necessary because of the old electrical distribution networks in place. As a result, the voltage supplied is greater than the voltage at which equipment is designed to operate most effectively. Voltage optimisers are essentially transformers that largely improve power quality by balancing overvoltage and phase voltages, and filtering harmonics and transients from the supply.

PowerSines' voltage optimiser is based on patented technologies that provide optimised and pure sinusoidal voltage to the load. "The 'ComEC' is a voltage stabilisation system that is composed of several transformation cells and controlled by a microprocessor. Each transformation cell utilises the PowerSines Induced Negative Voltage (INV™) technology for dynamic voltage optimisation.



Connecting and disconnecting transformation cells enables different voltage reduction levels and stabilisation of the output voltage,” explains Guz.

Another technology patented by PowerSines is the ‘Voltage Vector Combination’. The technology controls the voltage supplied to electric motors and other heavy loads by utilising the space vector and the voltage magnitude of three-phase electric power systems. It does so, while keeping a pure sinusoidal waveform without harmonics. This voltage optimisation topology was evolved to the ‘Super Variable Vector Combination’ that reduces the number of transformers and boasts smaller dimensions, weight and price without compromising on performance.

ENERGY HUB APPLICATION FEATURES

An advanced cloud-based platform allows managers to determine the consumption patterns across multiple sites, as well as smartly and automatically manage loads according to advanced rule-engine algorithms. Dashboard-based analytics enables energy comparison between different sites, normalised by square metres, number of people and more. Additionally, machine learning algorithms help identify anomalies and patterns in data sets.

“ Our Energy Hub offering could help organisations reduce costs by up to 15-25 %, enabling a swift return on investment – within 3 years. ”

Guz sees three crucial factors driving market demand for his company’s latest offering. First, government regulations and incentive programmes, including commitments as part of the Paris Climate Accords, have businesses and organisations looking for innovative energy efficiency solutions. Second, advances in technology, including IoT, have made solutions such as the Energy Hub highly cost-competitive. Finally, as businesses increasingly see their competitors adopting sustainability and energy-efficiency initiatives which help their bottom lines, the market itself will act as a powerful accelerant.

SUPEREH

- Coordinated by PowerSines Ltd in Israel
- Funded under H2020-ENERGY, H2020-LEIT-ICT and H2020-SME
- cordis.europa.eu/project/id/783458
- Project website: powersines.com/energy-hub

ENERGY

How households can accelerate the transition to renewable energy

How are households shaping the energy landscape? Could changes to everyday practices make a difference? Through an ‘Energy Living Labs’ approach, an EU-funded project developed and tested options for a bottom-up transformation of energy use in households and communities throughout Europe.

The European Commission is promoting several ambitious climate and energy targets with the goal of reducing greenhouse gas emissions and decarbonising the economy, also evident in the European Green Deal. However, results are not materialising at the pace and scale needed to accelerate the energy transition. There needs to be a greater change, which requires cooperation between governments, businesses, communities and households.

FROM CLIMATE CHANGE AWARENESS TO ACTION

Challenging social values, perceptions and habits regarding energy usage at home is playing a pivotal role in reducing energy consumption. The EU-funded ENERGEISE (European Network for Research, Good Practice and Innovation for Sustainable Energy) project carried out

“Our study proves that reductions in energy use are possible when people are given the time, space and means to reflect on their usual practices. Experiments can challenge tacitly accepted norms and assumptions that underpin current practices and encourage people to do things in new ways.”

an experiment to reduce energy consumption in more than 300 households in eight countries. The goals were to lower indoor temperatures to a maximum of 18 °C and halve the amount of washing cycles over a 4-week period for each challenge.

“The results from our Energy Living Labs approach indicated that reducing indoor temperatures by 1 °C in winter results in an energy saving of around 6%. One less laundry wash per week for households in Switzerland for 1 year would save around 13 million m³ of water, 10 million litres of laundry products and the equivalent annual electricity consumption of 90 000 households. A key finding is that all these savings are possible without compromising convenience and comfort,” notes project coordinator Gary Goggins. In certain cases, reductions were even more significant, and changes in the pattern of energy behaviour were maintained for 3 months after initiating the challenges.

“Our study proves that reductions in energy use are possible when people are given the time, space and

means to reflect on their usual practices. Experiments can challenge tacitly accepted norms and assumptions that underpin current practices and encourage people to do things in new ways,” adds Goggins.

PLACING PEOPLE AT THE CENTRE OF ‘SMART TECHNOLOGY’ APPROACHES

Study findings also suggest that people are more likely to react positively to energy savings by retaining their influence on their thermal comfort rather than counting on smart buildings or invisible heating systems that allow limited human interventions.

Similarly, washing machines need to be designed in a way that allows transparency on the energy and water use of programmes. Users need to navigate easily between programmes and thus feel they can influence their environmental footprint.

A LONG-LASTING AND MEANINGFUL IMPACT

The project’s work will be instrumental in the design of policies and programmes that aim to facilitate the transition to a low-carbon society. Increasing awareness of climate change and its negative impacts or simply creating more efficient energy technologies are not enough to spur people into action. ENERGISE demonstrated that engaging and empowering people to do things in new ways has a meaningful impact on their energy consumption.

“Designing an initiative that dealt with diverse households in different countries with different cultures, social norms and expectations, and different energy systems and material arrangements was challenging but also extremely interesting. It revealed how things that are taken for granted or considered ‘normal’ in one place might be ‘alien’, radical or unacceptable somewhere else,” concludes Goggins.

ENERGISE

- Coordinated by the National University of Ireland Galway in Ireland
- Funded under H2020-ENERGY
- cordis.europa.eu/project/id/727642
- Project website: energise-project.eu
- ▶ bit.ly/2VNyDNa





New modelling suggests that 92 % of Alpine glaciers could disappear by the end of this century

Climate change adaptation depends on accurate modelling. CHANGE has modelled the environmental equilibrium-line altitude of valley glaciers across the European Alps for more accurate predictions of water storage and run-off.

Water supplies in the European Alps are being threatened by receding glaciers, an effect caused by climate change. Water management in the region demands accurate data that captures a dynamic situation and can forecast likely scenarios.

The CHANGE (Climate, Hydrology, and Alpine Glaciers) project, supported by the Marie Skłodowska-Curie Actions, has discovered that Alpine glacial response to climate change will be highly variable – information that is crucial for evidence-based policymaking.

In a paper submitted for publication, the team outline their use of glaciological field techniques and numerical modelling of environmental equilibrium-line altitudes (ELAs). This led to the suggestion that climate change will result in the loss of between 69% and 92% of Alpine glaciers by the end of this century.

“Until their disappearance, glaciers will continue to contribute to the hydrology of their individual basins, but in more varied ways. Most are likely to contribute more to run-off in the short term but, over time, the run-off will decline. Others will sharply decline in run-off and some may already have passed their peak run-off,” explains project coordinator Neil Glasser from Aberystwyth University, which hosted the project.

CHANGE also found that the degree of permeability of the bedrock plays an important role in how meltwater is stored and then routed beneath the glaciers.

MEASURING GLACIAL HEALTH

The team developed a new approach to simulate scenarios for the future ELA – the altitude at which accumulation and ablation of water on a glacier are equal and so can be thought of as balanced.



They started by analysing the Randolph Glacier Inventory to locate and identify individual Alpine glaciers. Researchers put these into a geographic information system and applied different climate change scenarios to forecast the impact of climate change on the ELA of all the Alpine glaciers.

The scenarios were based on Representative Concentration Pathways from the EURO-CORDEX project which projected different emissions scenarios.

The results cover the entire European Alps region, based on 200 years of climate records and forecasts covering 1901 to 2100. The team also used a separate numerical glacier model to analyse the influence of different ice-bed geology on the subglacial drainage system and glacier motion.

They ran numerical experiments looking at varying bedrock permeability to see how the water was stored, and how it flowed under the glaciers over a year. The model was first tested using a theoretical glacier surface, then modified and run with empirical data.

Lastly, fieldwork conducted at two sites with the help of drones allowed the team to perform detailed geomorphological analyses of glacier forefields.

“While we still have to analyse the results, we anticipate that they will support our modelling of the characteristics of subglacial groundwater flow. This, we believe, will show that the flow can remove the seasonal variation of glaciers on a carbonate bedrock, such as well-karstified limestone,” says Glasser.

“*Until their disappearance, glaciers will continue to contribute to the hydrology of their individual basins, but in more varied ways.*”

LOCAL TO GLOBAL IMPLICATIONS

CHANGE's findings provide insights relevant to similar mountain glaciers globally. The results contribute to a better understanding of how glaciers in the European Alps are responding to a changing climate, and of their effect on river run-off, ecosystems, tourism and hydroelectric power generation.

“As the biggest impact of receding glaciers is on local populations, we made and exhibited 3D models at the EuroScience Open Forum in Trieste, Italy to illustrate glacier changes. Hopefully these will become a permanent exhibition,” adds Glasser.

CHANGE

- Coordinated by Aberystwyth University in the United Kingdom
- Funded under H2020-MSCA-IF
- cordis.europa.eu/project/id/793403
- Project website: bit.ly/CHANGE_project

CLIMATE CHANGE AND ENVIRONMENT

Microbes' response to climate change offers a glimpse into the future of the Arctic

An EU-funded network is advancing understanding of how the microbes found in the Arctic respond to their warming environment and regulate biochemical cycles. Just like other critical environmental processes, the smallest players have the most powerful impact on the eventual outcome.

The Arctic plays a pivotal role in balancing the world's climate. Changes in this polar region will have ripple effects that can be felt in lower altitudes. The worrying

news is that the permafrost contains roughly twice as much carbon as Earth's atmosphere. As the permafrost gets warmer, the microbes in the soil 'wake up' and

contribute to processes that stimulate the release of carbon deposits as greenhouse gases – CO₂ and methane.

Funded by the Marie Skłodowska-Curie Actions programme, the MicroArctic (Microorganisms in Warming Arctic Environments) project was established to advance understanding of the ability of microbial communities to adapt to the fast-warming Arctic and their feedbacks with biogeochemical cycles. The programme trained 15 early-stage researchers in microbiology and biogeochemistry to be able to respond to the need for governance and leadership in public, policy and commercial interests in the region.

Project researchers conducted several measurements of temporal and spatial variations of microbial communities in several Arctic habitats (soil, glaciers and air) and examined microbe interaction with the local climate. Furthermore, they performed stratigraphic analyses of microbial community structures and functionalities on a molecular level and geochemical and mineralogical measurements in glacier forefield chronosequences and permafrost deposits. “Exploring the dynamics of individual populations and responses to climate change is critical to evaluating habitat plasticity and resilience to a warming climate. It also helps devise strategies that help reduce the damage to the high-biodiversity Arctic ecosystems,” notes Alexandre Anesio, MicroArctic’s coordinator.

“Exploring the dynamics of individual populations and responses to climate change is critical to evaluating habitat plasticity and resilience to a warming climate.”

ANCIENT SOIL MICROBES AFFECT ARCTIC CLIMATE AND UNLEASH DISEASES

Global warming is accelerating the thawing of permafrost, causing large amounts of the potent greenhouse gas methane to be released into the atmosphere. Project researchers demonstrated that this direct methane release can occur from microbial communities (frozen organic matter) formed in permafrost thousands of years beforehand. As a result of global warming and thawing permafrost, scientists predict large releases of methane from these ancient microbes.

Scientists also investigated potentially pathogenic bacteria isolated from diverse habitats in Spitsbergen, Norway. “Secreted by a variety of organisms, haemolysins (lipids and proteins) cause lysis of red blood cells by disrupting the cell membrane. They could largely contribute to determining viruses in animal models. Haemolysis was observed in 32 out of 78 bacterial species isolated from Arctic habitats,” adds Anesio. This project finding is reported in the *Environmental Earth Sciences* journal in an article entitled ‘Potentially pathogenic bacteria isolated from diverse habitats in Spitsbergen, Svalbard’.

MICROBIAL ACTIVITY DOES NOT CEASE IN WINTER

The beginning of the summer season is a critical period for stimulating higher microbial activity and nutrient cycling. MicroArctic identified ionic pulses of nutrients during the first melt of the summer season that boost algal blooms on the surface of the Greenland ice sheet. They also appear to be speeding up glacier melting, in a process not accounted for in current climate change models.

Although biological processes slow down in winter, MicroArctic showed that microbes could remain active at temperatures much lower than previously thought. “Through laboratory simulations, we demonstrated that microbial activity and active biogeochemical processes can take place even during the dark and colder periods of the winter. This finding could enable microbe sampling



operations to be conducted throughout the year and not only during the Arctic melt season,” explains Anesio.

Species interactions and plasticity help Arctic microbes to adapt, survive and grow under harsh conditions. Increased knowledge about their biodiversity and interactions reinforces the need to protect the Arctic environment for the future generations.

MICROARCTIC

- Coordinated by Aarhus University in Denmark
- Funded under H2020-MSCA-ITN
- cordis.europa.eu/project/id/675546
- Project website: microarctic.eu

CLIMATE CHANGE AND ENVIRONMENT

Sampling ancient seafloors to comprehend climate change and recovery

Analysing metal isotopes sampled from sediments beneath the seafloor is giving researchers a better idea of how the Earth has responded to global warming events in the past.

In a year of raging wildfires and increasingly extreme weather globally, all fuelled by climate change, scientists are scrambling to refine their climate models. One solution is to compare different warming events from eons ago, to understand how the Earth responded to different carbon emissions scenarios.

“Studying past climate change is like a fascinating puzzle. Everything that happens in the Earth system – the atmosphere, hydrosphere, biosphere and lithosphere – is related,” explains Matthew Clarkson, coordinator of the EU’s EnvironMetal (How does the Earth stop global warming? Using metal isotopes to understand climate recovery processes) project, hosted by the ETH Zurich – Swiss Federal Institute of Technology.

“So, understanding the connections requires detailed study and the quantification of seemingly independent processes.”

OCEANIC ANOXIA

Climate change leads to many damaging responses. This project focused on understanding the loss of oxygen from the oceans, also known as the development of oceanic anoxia.

“In the past we see that anoxia directly drives the extinction of seafloor organisms,” adds Clarkson, who has a doctorate in geochemistry and geology, from the University of Edinburgh.



“*Our uranium proxy let us estimate the global extent of oceanic anoxia during a major global warming event that occurred around 55 million years ago.*”

“But over hundreds of thousands of years, anoxia increases the preservation of carbon in the sediments, removing it from the atmosphere and helping the climate to return to cooler conditions.”

EnvironMetal, which was supported by the Marie Skłodowska-Curie Actions programme, used new chemical tools developed over the last decade, to trace global-scale environmental change. Thanks to these tools, past climate change can be viewed from multiple angles with a new perspective.

GATHERING NEW METAL ISOTOPE DATA SETS

Key to the project was the measurement of trace metal isotopes, particularly uranium, in samples of seafloor sediments previously collected under the International Ocean Discovery Program from the Pacific, North Atlantic and Southern Oceans.

“The most exciting result was from one Pacific site; our uranium proxy let us estimate the global extent of oceanic anoxia during a major global warming event that occurred around 55 million years ago, the Palaeocene Eocene Thermal Maximum,” notes Clarkson.

This is an important parameter as it can be used as a key element in climate models simulating past change events to shine a light on future scenarios.

Clarkson acknowledges that studies of past climate change often indicate a bleak outlook for what we might expect in the future, such as the expansion of oceanic anoxia. But he says the way forward is to proactively prevent the problem from getting any worse by taking immediate action.

The team made over 400 isotope measurements on modern and ancient seafloor samples, and the work is ongoing, although the funding period has ended. The focus now is on publishing the results and combining them with other data sets.

Clarkson concludes: “We can use the new metal isotope data sets to fill in pieces of the global puzzle. The next steps are to understand the connections between all these different data sets and make comparisons between different case studies of past global warming.”

ENVIRONMETAL

- Coordinated by the ETH Zurich – Swiss Federal Institute of Technology in Switzerland
- Funded under H2020-MSCA-IF
- cordis.europa.eu/project/id/795722
- Project website: bit.ly/EnvironMetal



SPECIAL FEATURE

THE FUTURE OF AVIATION: THE ONLY WAY IS UP

Editorial

“When once you have tasted flight, you will forever walk the Earth with your eyes turned skyward” – Leonardo da Vinci

When COVID-19 caused the world to stand still in March 2020, one of the industries hit hardest was without a doubt the aviation industry. According to the International Air Transport Association (IATA), passenger air transport measured as revenue passenger kilometres (RPKs) was down 90% year-on-year in April 2020 and was still down 75% in August 2020. The shock that came so suddenly to the industry resulted in many airlines – including some of Europe’s most prominent flag carriers – requesting substantial economic support from governments.

Will the industry take to the skies again? As the world begins to feel the impact of large-scale vaccination campaigns, the situation should improve over 2021 but IATA still forecasts heavy losses. 2022 is more likely when the real recovery can begin, a year that several prominent economists have predicted will herald the start of a new ‘Roaring Twenties’ as the world celebrates and indulges after the shadow of COVID has receded. For many people, an enthusiastic return to international travel and tourism will be at the top of the list when it becomes possible to do this safely again. So yes, aviation will live to fly another day.

For the EU, aviation is a strategically important industry, where pre-COVID it contributed EUR 300 billion (or around 2.1% of GDP) to the European economy, as well as supported close to 5 million jobs. And because it’s such a strategic industry, the EU is very much invested in the future of aviation. In particular, the EU’s Aviation Strategy is a milestone initiative to generate growth for European businesses, foster innovation and let passengers profit from safer, cleaner and cheaper flights. At the same time, with the EU’s ambitious plans to

be carbon-neutral by 2050 through the European Green Deal, there is also much interest in further transitioning aviation into a truly greener industry, for example through the proposed revision of the Emissions Trading System (ETS) Directive, planned for 2021.

Finally, the EU recognises cutting-edge innovative research to help achieve a greener, safer and more efficient aviation sector overall. The 2011 Flightpath 2050 vision (which several of the projects showcased in this special feature reference) set out key research policies to be achieved by 2050, including how to preserve Europe’s global leadership in the sector, as well as cutting CO₂ emissions by 75% by mid-century. Horizon 2020 has been an important pillar in driving aviation research forward towards meeting these goals, with one prominent example being the Clean Sky Joint Undertaking, a public-private partnership between the European Commission and the European aeronautics industry that coordinates and funds projects to deliver significantly quieter and more environmentally friendly aircraft.

The seven projects featured in this month’s special feature highlight clearly and positively how the aviation industry can and will evolve over the coming years, guided by excellent EU-funded research and in spite of the pandemic that effectively brought the industry to a grinding halt in 2020.

Indeed, the only way is up...

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

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Flightpath 2050 goes global

The vision for European aviation in 2050 and the related strategic roadmaps could easily appeal to other countries beyond the EU. With this in mind, the EU-funded ICARe consortium recently provided recommendations for international cooperation in aviation research and innovation.

Aviation is inherently an international matter, and even the most elaborated vision of the sector's future can only work with international support. ICARe (International Cooperation in Aviation Research) findings in this regard are limpid: more than 100 research projects currently foreseen to help Europe reach its Flightpath 2050 objectives are of interest also to other countries. These represent a potential cost topping EUR 500 million, which could be considerably reduced should the European Commission decide to reach out to potential partners on the global scene.

ICARe, which was tasked with providing the Commission with recommendations for future international collaboration in aviation research and innovation, identified eight areas of common interest. These cover: environment and energy; materials and structures; safety and security; engineering methodologies and technologies for the future; interoperability; new configurations and optimisation design; supersonic and high speed; and regulation and certification.

"For each topic, ICARe partners have identified essential information to facilitate decisions on future technical partnerships. We provide: the shared domains of interest for each country; the associated technical topics; the estimated impacts on the environment and European competitiveness; the scheduling of the topic in the Horizon Europe timeframe; the rough order of magnitude (ROM) costs; and the estimation of the achieved technology readiness level (TRL). This information has been provided to the European Commission to prepare the next calls for proposals in Horizon Europe," says Patrick Haouat, manager of Erdyn and coordinator of ICARe.

Perhaps unsurprisingly, the team found that energy and environment are the most important domains for collaboration, especially when it comes to reducing noise, emissions and fuel consumption. The project team



conducted a full mapping of technologies and areas of interest for this and other topics. The outcome of this screening is an online technology database which can serve as a basis for deeper and new international cooperation.

A RECIPE FOR SUCCESSFUL PARTNERSHIPS

The project team also shares non-technical findings that work as a recipe to successful international collaborations. Beyond expected recommendations such as the prioritisation of win-win and equitable partnerships, the respect of intellectual property rights and emphasis on standardisation and certification, the team also points out key factors making success more likely. They notably recommend working at a low TRL, an optimum project duration of 2 to 3 years, and the shaping of a balanced consortium bringing no more than 10 partners from industry, research institutions, academia, SMEs and agencies.

“We also have other recommendations,” Haouat points out. “While the aviation sector is the focus for the development of new key technologies, interaction with other sectors (such as digital technologies, artificial intelligence, alternative fuels, energy storage) could benefit from international cooperation. Likewise, we found that multilateral research synergies can result in cost-efficient technological advancements, and that interpersonal links with representatives of Canada, China, Japan, Russia and the United States should be kept alive to continue the dialogue in an already fertilised ground. Finally, links should also be established beyond these five countries.”

“ While the aviation sector is the focus for the development of new key technologies, interaction with other sectors (such as digital technologies, artificial intelligence, alternative fuels, energy storage) could benefit from international cooperation. ”

The project was completed in May 2020, but Haouat says there is still much to be done. “The main results of ICARE are just a screenshot of the current situation and they should be updated in the future. Meanwhile, established links with third countries should be kept alive. This handover needs to be discussed with the European Commission, but involving the ACARE INCO group – whose role is to assess how international collaboration could support the development of technologies listed in the Strategic Research and Innovation Agenda (SRIA) – could be a good option. This group had already worked on international cooperation before ICARE and some of its members have contributed actively to the open platforms and identification of win-win opportunities.”

ICARE

- Coordinated by Erdyn Consultants in France
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/769512
- Project website: icare-h2020.eu

Keeping Europe's aviation industry on the path towards competitiveness and sustainability

The EU-funded PARE project provides the research and analysis that Europe's aviation industry needs to achieve the vision set out in the Flightpath 2050 initiative.

Aviation plays a big role in Europe, both in terms of society and economically. The continent is home to over 448 airlines and 701 commercial airports, which serve well over 600 million passengers a year. Not only does the industry generate EUR 600 billion in annual revenue, it also supports 8.7 million jobs.

"The European aviation industry's vital contribution to Europe's economic growth and cohesion is well recognised," says Luís Braga Campos, a researcher at Técnico Lisboa. "The challenge, however, is to ensure that the industry is able to meet society's increasing demand for air travel while remaining competitive and sustainable."

In 2001, the EU established the Advisory Council for Aeronautics Research in Europe (ACARE). This public-private partnership aims to maintain Europe's leadership role in global aviation by improving the industry's competitiveness and sustainability. To achieve this vision, in 2011, ACARE published Flightpath 2050, a collection of 23 ambitious goals for improving air travel by 2050. These include, for example, reducing CO₂ emissions by 75%, positioning Europe as a centre of excellence in sustainable alternative jet fuels, and ensuring that European air transport has less than one accident per 10 million commercial flights.

At the heart of these goals is a commitment to research and innovation, which is where the EU-funded PARE (Perspectives for the Aeronautical Research in Europe) project comes in. "The main objective of the project was to assess the progress towards achieving these goals, identifying any gaps, and

suggesting measures to close them," explains Campos, who serves as the project coordinator.

THE CURRENT STATE OF AVIATION IN EUROPE

The PARE project developed 35 objectives and 58 recommendations for supporting the Flightpath 2050 goals, with the recommendations being classified into a hierarchy of four levels of priority.

"One of the listed priorities is to strengthen the global competitiveness of the European aeronautical industry, not only for long-haul transport, but also in sectors where it currently leads, such as helicopters, and where it lags behind, such as drones," remarks Campos. "Another priority focuses on strengthening institutional cooperation in aeronautical clusters covering all stages of development, from basic research to product innovation, market penetration and operational utilisation."

These objectives and recommendations are discussed in detail in the project's three annual reports. According to Campos, these are extensive documents that thoroughly examine the evolution of aviation in Europe over the past 20 years. "The reports provide an in-depth overview of the current state of aviation, along with a forecast for what lies ahead," he adds. "These reports serve as the baseline document supporting all PARE activities."

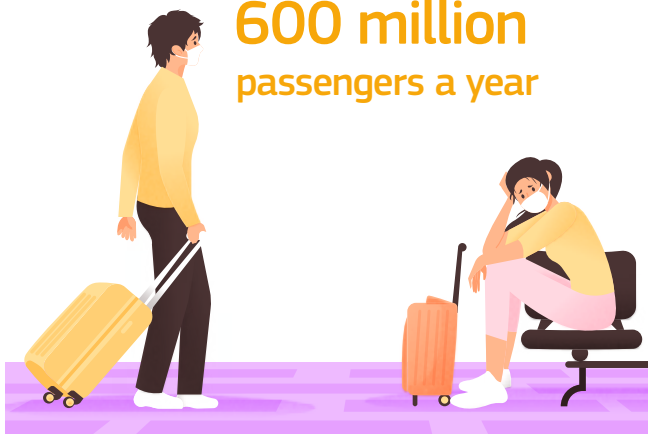
REACTING TO THE UNEXPECTED

During the course of the project, three unexpected events occurred: the grounding of the Boeing 737 MAX, the COVID-19 pandemic and the launch of the European Green Deal. "As each of these impacted the aviation sector, we had to take them into account," notes Campos.

In reaction to these crises, the project was extended for 3 months. During this time, researchers added six new chapters to the latest report and organised three webinars that covered sustainable aviation fuels, decarbonisation and the effects of COVID-19 on aviation.



Europe is home to 701 commercial airports, which serve well over 600 million passengers a year



Once the project is complete, researchers plan to publish a comprehensive article in the International Journal

of Sustainable Aviation and a book on efficient and environmentally friendly aviation.

“The methodology developed by this project can also be applied to other sectors, such as space and road, rail and maritime transport,” concludes Campos. “It could also prove useful to emerging technologies used by aviation, such as sustainable fuels, composite materials and additive manufacturing.”

PARE

- Coordinated by Técnico Lisboa in Portugal
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/769220
- Project website: pareproject.eu

Clever composite materials store energy and make aircraft more fuel-efficient

Aircraft could one day be made of composite materials capable of storing electrical energy and distribute it where needed. A promising path to greener planes? The SORCERER consortium believes so, and they are currently working on several demonstrators.

Imagine a high-performance material capable of not only carrying the mechanical load of an airplane, but also storing the electrical energy needed to power its cabin and systems. The result? A new generation of aircraft less reliant on fuel, with twice the flying range of its predecessors.

Whilst we are not quite there yet, the EU-funded SORCERER (Structural pOwer CompositEs foR futurE civil aiRcraft) project has already developed revolutionary structural supercapacitors and structural batteries that can be combined to further the electrification of next-generation aircraft. Emile S. Greenhalgh, Royal Academy of Engineering chair in emerging technologies, discusses the new technology, its potential and its path to commercialisation.

Besides early prototypes and R&D by manufacturers, electric aircraft still seem like a distant dream. Would you say otherwise? What are the main remaining obstacles to get there?

Emile Greenhalgh: I think fully electric large passenger aircraft are a long way off – the principal hurdles being the very high energy densities required. Even if those are achieved, the safety issues associated with containing huge amounts of

energy in a small volume would remain. I think this is why companies are now moving towards H₂ as a route for clean energy.

But that doesn't mean more electrification is not achievable. The cabin and aircraft systems, which conventionally draw energy from the engines, could very well benefit from new electricity-based energy production technologies. There we are targeting structural power. Besides, smaller aircraft and drones are a much more realistic option for the electrification of propulsion. I actually anticipate market growth in these areas.

Your project focuses specifically on energy-storing composite materials. Why are these important and what technological gaps did you aim to close exactly? Also, what made your consortium particularly well equipped to tackle these challenges?

Structural power is a very elegant way of addressing the double challenge of reducing aerostructures' weight and providing energy storage solutions. We know that traditional electrochemistry is pursuing ever-higher energy densities, but



Emile S. Greenhalgh
Royal Academy of Engineering
chair in emerging technologies.
© Emile S. Greenhalgh

“ *We’ve demonstrated that, in an air taxi like the City Airbus, replacing the conventional batteries and structures with our multifunctional materials for a given energy density will more than double the range of the aircraft.* ”

© Skycolors, Shutterstock

as I mentioned earlier, these are going to present enormous challenges from a safety perspective. Structural power offers an alternative that addresses the electrification of aircraft while not requiring ridiculously high energy densities.

To give you an example, we’ve demonstrated that, in an air taxi like the City Airbus, replacing the conventional batteries and structures with our multifunctional materials for a given energy density will more than double the range of the aircraft.

Our consortium consists of world-leading groups in the development of structural supercapacitors (Imperial and IMDEA Materials) and structural batteries (Chalmers and KTH), so we are best placed to move this technology forward. Imperial, Chalmers and KTH have been pioneering this technology for over 10 years.

What would you say makes your project particularly innovative?

We have a completely new approach to using structural materials. Multifunctional materials tend to be considered as having multiple physical functions (electronic and optical for instance), but rarely additional functions that include mechanical function. This is because combining a mechanical function with additional physical functions imposes conflicting demands on the material. For instance, achieving high mechanical stiffness calls for rigid constituents. Yet, to enable transport phenomena (such as ionic flow), they need to be soft. Our approach has been to provide means to tailor the microstructure of the material in order to control the balance between different functions.

What are the project’s main outcomes and achievements so far?

Initially we aimed to reach performance targets for our structural supercapacitors and batteries, as well as to demonstrate them in a final component. From the perspective of structural supercapacitors, we have achieved 1.4 Wh/kg and 1.1 kW/kg energy and power

densities, respectively. We are also building an aircraft door demonstrator.

IMDEA demonstrated their structural supercapacitors as part of the casing for a systems box. For the structural batteries, we are producing a composite laminate with multifunctional cells. The project ends in January 2021, and we anticipate being able to show the demonstrators by then.

By the time the project ends, how close will we be to actual use in aircraft?

Quite far actually, because this is such a revolutionary technology. It will take a lot of development to be airworthy. Aerospace is traditionally a very conservative sector, but I anticipate that in non-critical applications and perhaps on smaller vehicles (such as drones), structural power could be adopted relatively soon – maybe within the next 5 years?

What are your follow-up plans?

From a personal perspective, I’ve just been awarded the Royal Academy of Engineering chair in emerging technologies, which means I have funding to work on this for the next 10 years. From the perspective of the consortium, we are still talking to Airbus about a future project in this area. We did not receive funding from the EU to take structural power forward, but we hope to be awarded funding in the future in this area.

SORCERER

- Coordinated by the Imperial College of Science, Technology and Medicine in the United Kingdom
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/738085
- Project website: sorcerer.eu

EU researchers: “Expecting to reduce noise disturbance only by operating quieter aircraft is a dead end”

The future of aviation has become highly unpredictable since COVID. But should the sector simply pick up where it left off before the pandemic, noise disturbance is likely to remain a concern. The ANIMA project approached it from a new angle. It considers aspects beyond improvements in engineering.

ANIMA (Aviation Noise Impact Management through Novel Approaches) brings about a whole new, coherent and consolidated perspective on the problem of aircraft noise disturbance. The findings touch upon various points that can reduce noise-related annoyances, and also the importance of following suit. We already knew that noise in the direct vicinity of airports could cause health issues ranging from fatigue and mental health problems to hypertension and stroke. But this is the first time that such findings arise from a group of researchers that includes engineers, urban geographers, psychologists, sociologists and regulation experts.

Together, ANIMA partners set out to evaluate scenarios for the future of aviation in light of the noise disturbance issue and its impact on health. They engaged in dialogue with airports and affected communities in the cities of London (Heathrow), Amsterdam (Schiphol), Marseille, Ljubljana, Frankfurt, Budapest, Iasi and Kiev.

“We found that any intervention intending to reduce annoyance must be first scoped through guidance and structured exchanges with communities. You cannot imagine how many goodwill interventions failed just because the preconceived ideas of their promoters did not

fit with the actual expectations of the communities. Or even because structured exchanges weren’t based on fair, transparent and understandable information provided to communities,” says Laurent Leylekian, European Affairs Officer at ONERA and coordinator of ANIMA. Likewise, he explains: “Measures pertaining to a so-called ‘balanced approach’ of the International Civil Aviation Organisation (ICAO) must be enforced as soon as possible and not only once the threshold of 50 000 movements a year is reached. What policymakers must remember is that aviation noise is less and less a technical issue and more and more a social, regulatory and political issue.”

TOOLS FOR SMALLER AIRPORTS

Besides its set of findings and recommendations, ANIMA provides useful tools. There is first the ‘Noise Management Toolset’ – an application for airports or local authorities to compute noise maps and an awakening index. With this information, they can test the impact of different scenarios with various fleet compositions and flights. The tool may incorporate new types of aircraft, new types of engines, demographic changes or insulation schemes in order to test the impact of these elements. Then, the team created a mobile application that may help airports and authorities to dynamically capture expressions of annoyance amongst travellers.

Such tools may be especially useful to smaller airports. “Some small airports like those in central and eastern Europe may be very interested in reducing noise disturbance, but what should they do? Where do they start and how do they deal with the enormous number of regulatory texts? We are confident that ANIMA’s outcomes – that will soon be available on our website – will help them take the first steps. For example, we had very positive feedback from some locations in which the dialogue between the airport and the neighbouring communities used to be interrupted. ANIMA actually helped resume this dialogue,” Leylekian points out.



While ANIMA is indeed a great step forward, Leylekian admits how it doesn't mean that we know all about aircraft noise-related annoyance or that research must be stopped. If anything, he rather sees opportunity in the EU's forthcoming Green Deal. "The idea would be to help airports to implement recipes and use tools developed in ANIMA in a broader environmental context: local noise issues and global decarbonisation issues may come hand-in-hand. We must depart from the idea that gaining on the one side would necessarily mean losing on the other." He even envisions a form of 'Airasmus' for the future: a kind of Erasmus of Airports in which experts from more advanced airports could bring their environmental experience and know-how to those willing to start the journey.

“What policymakers must remember is that aviation noise is less and less a technical issue and more and more a social, regulatory and political issue.”

ANIMA

- Coordinated by ONERA in France
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/769627
- Project website: anima-project.eu
- ▶ bit.ly/3oMtrpD

LH₂-powered aircraft are coming, but when?

Liquid hydrogen fuel for aeroplanes has returned to favour, with Airbus hoping to have the first commercial LH₂-powered aircraft take off as early as 2035. The ENABLEH2 project falls within this approach while also developing technologies that will exploit the new fuel's full potential further down the line.

On paper, liquid hydrogen (LH₂) is a great solution to reduce the environmental footprint of aviation. It could enable a complete decarbonisation of the sector. It is potentially a formidable heat sink, and its combustion would come with considerably lower NO_x emissions than standard jet fuel. But there are two problems: LH₂ production is expensive, and the switch requires a major technology shift that market forces are unlikely to undertake without a helping hand or a push from public authorities.

The ENABLEH2 (ENABLING cryogENic Hydrogen based CO₂ free air transport) consortium was given such a hand, almost 20 years after the European Commission's last

attempt to ramp up LH₂ research and development under the Cryoplane project.

"At the time, the costs associated with LH₂ introduction were seen as prohibitive," Bobby Sethi, ENABLEH2 coordinator, recalls. "But we've seen a drastic change over the past 2 years. Not only did our project help revitalise interest, but the urgent need to reduce the impact of anthropogenic activities on the environment has also raised enthusiasm for LH₂ research in the civil aviation sector. The costs are now seen as justified due to both environmental and employment benefits."

Airbus's recent announcement of three zero-emission concept aircraft – codename ZEROe – is a logical outcome of this change of heart. By 2035, the European aircraft manufacturer hopes to enable LH₂-powered flights. ENABLEH2 is widely considered as the flagship project that can allow this to happen.

UNLEASHING THE FULL POTENTIAL OF LH₂

"ENABLEH2 concentrates on maturing technology for fuel system heat management, as well as technology providing a more attractive combustion process called micromix combustion," Sethi explains.



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The project's first objective is to exploit the full heat-sink potential of LH₂. To do so, the project consortium has been maturing technologies for: compressor-integrated cooling; intercooling and variable cooling concepts; fuel pumps; heat exchangers; turbines for expander cycles; cryogenic cooling for turboelectric distributed propulsion; and LH₂ fuel tank design and integration. They developed a suite of models to evaluate LH₂-fuelled aircraft with regards to energy efficiency, life-cycle CO₂ emissions and costs, and compared benefits and economic viability with projections for Jet A-1 fuel, biofuels and LNG. The project team even provides best-practice safety guidelines for LH₂, as well as comprehensive roadmaps for its introduction to the market.

Micromix combustion, on the other hand, enables superior fuel and air mixing without risking auto-ignition and flashback. It therefore generates ultra-low NO_x emissions and is being matured through a combination of numerical modelling and experimental research.

LOOKING TO THE FUTURE

Although the project won't be completed before August 2021, the team is already thinking about the future. "We are engaging with our partners to discuss the research needed beyond ENABLEH2. We have submitted or are in the process of submitting a number of proposals

“The costs are now seen as justified due to both environmental and employment benefits.”

for follow-on projects building on the lessons learnt in ENABLEH2," says Sethi.

The first commercial LH₂-fuelled aircraft could enter into service in the 2035-2050 timeframe. However, Sethi underlines that the first aircraft may not yet tap into all the potential benefits of LH₂. Fully optimised, synergistic designs incorporating advanced heat exchangers, along with turboelectric distributed propulsion technologies that would exploit the heat-sink potential and other unique properties of LH₂, may not come until the second half of the century.

But the work of ENABLEH2 will definitely bring us a step closer to them.

ENABLEH2

- Coordinated by Cranfield University in the United Kingdom
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/769241
- Project website: enableh2.eu

Getting an accurate glimpse of aviation's environmental impact

International governmental organisations are introducing a range of rules and regulations aimed at reducing the aviation sector's environmental impact. But will they actually achieve their intended goals? To find out, one project is thoroughly evaluating the effectiveness of these policies through to 2050.

Although today's aircraft are leaner, greener and safer than ever before, there's still room for improvement. With the environmental impact of aviation being a major public concern, international governmental organisations such as the European Union and the International Civil Aviation Organisation are introducing new rules and regulations intended to reduce the sector's environmental footprint.

Part of the EU's Clean Sky 2 Technology Evaluator initiative, the EU-funded GLIMPSE2050 (Global Impact Assessment of Regulations and Policies for Sustainable Aviation by 2050) project evaluates how effective these potential regulations

are at reducing aviation's environmental impact. Based on this evaluation, the project makes recommendations to targeted stakeholders, such as Clean Sky 2, EU and national governments, and the aviation sector.

"By thoroughly evaluating currently discussed policies, we can provide decision makers with an accurate 'glimpse' at aviation's environmental impact at a global scale up to the year 2050," says Michel van Eenige, R&D manager at the Royal Netherlands Aerospace Centre (NLR) and GLIMPSE2050 project coordinator.



OVERCOMING CHALLENGES

The project focuses on estimating the noise and emission reductions that can be achieved through the new regulations currently being discussed. In Clean Sky 2, researchers are also working to evaluate to what extent new technologies can help aviation achieve the environmental goals set out in the EU's Flightpath 2050.

"We are currently in the process of quantifying the environmental impact of the selected regulations and policies at a global scale up to 2050," explains van Eenige. "Although it's too soon to make a definite statement on what the most important results are, I strongly believe that this quantification will have a positive impact on the aviation industry."

This work required researchers to overcome several challenges. For example, an early challenge was conducting a focused literature review of the myriad of relevant regulations and policies. "By first clearly defining the scope of our work, we were able to conduct a systematic and structured literature review," adds van Eenige.

With the literature review complete, researchers then faced the challenge of modelling and data collection. "Here we leveraged NLR's vast experience of working on a number of EU framework projects, our expertise in

“By thoroughly evaluating currently discussed policies, we can provide decision makers with an accurate ‘glimpse’ at aviation’s environmental impact at a global scale up to the year 2050.”

addressing environmental challenges, and our carefully cultivated international networks,” remarks van Eenige.

TOWARDS THE GREEN DEAL

With the project set to end in the spring of 2021, researchers are busy finalising their quantifications. "When all is said and done, I hope the project serves as the basis for further research on opportunities for improving, developing and harmonising aviation regulations and policies," notes van Eenige. "In doing so, aviation can become a true partner in achieving the European Green Deal ambitions for net-zero emissions."

Van Eenige says that the project plans to organise a dissemination workshop at the end of the project. "This will be an outstanding opportunity to discuss the project's results with key stakeholders and plan a path forward regarding the exploitation of these results," he concludes.

GLIMPSE2050

- Coordinated by the Royal Netherlands Aerospace Centre in the Netherlands
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/865118

Box wing design for more efficient aircraft

Double, separated wings have been the standard in aeronautics for a long time. But that doesn't mean alternatives don't exist. The PARSIFAL project proves it by resurrecting a 100-year old idea that would create more efficient airplanes with one wing... shaped like a box.

We're in 1924. Ludwig Prandtl, a German engineer considered as the father of aerodynamics, introduces the world to a new idea of his: the box wing. Compared to the conventional airplane with two separate wings we've all come to know and board, the box wing is supposed to maximise the span efficiency of airplanes. And the more span efficiency, the less drag and fuel consumption.

Almost 100 years later, box-winged airplanes are still nowhere to be found despite years and years of extensive

research and development. But the potential benefit has been confirmed. According to some of the latest research efforts by the University of Pisa, the box wing could reduce fuel consumption per passenger by 22 %.

"The PrandtlPlane (PrP), which received its name from the University of Pisa in honour of Prandtl, can act as a force multiplier in the search for climate-neutral solutions. If it can reduce fuel consumption by almost one fourth with today's propulsion systems and fuels, one can only imagine the

benefits for hybrid-electric or hydrogen propulsion systems,” says Vittorio Cipolla, assistant professor at the Civil and Industrial Engineering Department of Pisa University and coordinator of PARSIFAL (Prandtlplane ARchitecture for the Sustainable Improvement of Future AirPLanes).

PARSIFAL embodies the continued commitment of the research community to turn Prandtl’s dream into reality. From May 2017 to July 2020, the project team assessed the impact of introducing PrP to aircraft like the Boeing 737 and Airbus A320, which fall into the C category of ICAO requirements for aircraft.

A THOROUGH BENEFIT ASSESSMENT

The project assessment was conducted from the standpoint of technical feasibility, by means of design activities and high-fidelity analyses focusing on aerodynamics, flight mechanics, structures, propulsion systems, as well as impact studies. The latter specifically focused on how the replacement of conventional wings by PrP could impact CO₂ and other atmospheric emissions, global warming potential, perceived noise levels, ground operations and return on investment for airlines. To ensure an accurate comparison between box wing and standard design, the project team implemented all of their analysis models into a multidisciplinary design framework suitable for both conventional and PrP architectures.

“The box-wing configuration enables us to generate more lift within the same wingspan limit, which is the necessary requirement to transport a larger number of passengers per flight without exceeding ICAO class requirements. The estimated fuel per passenger-kilometre reduction, evaluated by adopting the same high-fidelity approaches to both conventional and PrP architectures, ranges from 10% to 22% depending on mission requirements. Similar analyses are ongoing for the regional aircraft sector within the Italian research project ‘PROSIB’, where the PrP is combined with the hybrid-electric propulsion,” Cipolla explains.

Besides the reduced fuel consumption, PARSIFAL partners found that PrP would reduce the global warming potential of class C airplanes by about 17% in 20 years. Moreover, the increased passenger capacity of PrP airplanes (an additional 100+ seats) means fewer flights and less overall noise. Passengers’ wallets stand to gain, too: According to Cipolla, the cost per available seat-kilometre would be reduced by up to 12%.

Although the project has come to an end, Cipolla and his team continue to investigate specific design aspects related to PrP. Initially, they did hope that the first PrP would take off as early as 2035. But, as with so many things, COVID-19 is likely to delay the outcome.

PARSIFAL

- Coordinated by the University of Pisa in Italy
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/723149
- Project website: parsifalproject.eu
- ▶ bit.ly/PARSIFAL-video



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A better ventilation system for aircraft cabins

EU-funded researchers are evaluating innovative new aircraft cabin ventilation concepts for efficiency, air quality and passenger comfort.

As aircraft look to become even safer and more energy-efficient, some are turning their attention to the cabin. “Today’s aircraft use mixing ventilation (MV) as a means

of providing a mixture of outside air and recirculated air filtered through a high-efficiency particulate air filter to the cabin,” says Daniel Schmeling, team leader of Vehicle



© DLR

“Just looking inside this mock-up with its 100 thermal manikins and the large cabin cross-section is amazing.”

Ventilation and Air Conditioning at the German Aerospace Center (DLR) in Göttingen. “However, due to such factors as higher seating densities, the use of personal electronic equipment, and increasing expectations for comfort, standard MV systems have reached their limits of effectiveness.”

According to Schmeling, designing new ventilation concepts requires many adjustments to the aircraft’s cabin. “Alternative ventilation concepts that offer enhanced heat removal and local ventilation efficiency first require one to reconsider the ratio between outside and recycled air in the aircraft cabin,” he explains.

This is where the EU-funded ADVENT (Advanced ventilation techniques for modern long-range passenger aircraft to promote future energy management systems) project comes in. Part of the EU’s Clean Sky initiative, the project is evaluating innovative new ventilation concepts for long-haul aircraft cabins. “These concepts are being evaluated in terms of thermal passenger comfort, energy efficiency and local air quality,” adds Schmeling, who serves as the project’s coordinator. “Furthermore, new ventilation architectures with improved airflows could enable enhanced industrial manufacturing processes based on modularisation.”

A TWO-PRONGED APPROACH

To evaluate the proposed ventilation concepts, the project took a two-pronged approach. First, an evaluation was conducted using numerical computational fluid dynamics in a simplified geometry. Next, experiments were conducted in a state-of-the-art long-range cabin mock-up, complete with thermal-enhanced passenger manikins.

“The ADVENT project designed and built this mock-up from the ground up,” remarks Schmeling. “Offering realistic thermal boundary conditions, it was shown to be an indispensable tool for researching the static and dynamic temperatures of all cabin surfaces during all phases of a flight.”

Initial testing of a ceiling-based microjet ventilation system in the mock-up has already proved its operational readiness. Based on this, researchers not only confirmed the numerically predicted advantages of this concept over standard MV systems, they also highlighted the challenges of implementing such a system.

AN AMAZING MOCK-UP

Despite some delays due to the COVID-19 pandemic, the project succeeded in numerically investigating several preselected ventilation concepts – with one already filing for a patent.

However, according to Schmeling, the project’s key outcome remains the mock-up. “Just looking inside this mock-up with its 100 thermal manikins and the large cabin cross-section is amazing,” he says. “Thanks to its use of the latest in optical and sensor-based measuring techniques, this new research facility has the proven ability to dynamically analyse the capabilities of future ventilation concepts.”

Once the project is over, the new mock-up will be made available for use by the European aerospace research sector.

With the project now expected to run through 2022, researchers are planning to study additional ventilation concepts, including crown-integrated and floor-integrated systems.

“The net result of our work will be a new generation of cabin ventilation concepts and tools that will serve as a breath of fresh air for aircraft designers and passengers alike,” concludes Schmeling.

ADVENT

- Coordinated by the German Aerospace Center in Germany
- Funded under H2020-TRANSPORT
- cordis.europa.eu/project/id/755596
- Project website: bit.ly/ADVENT-project



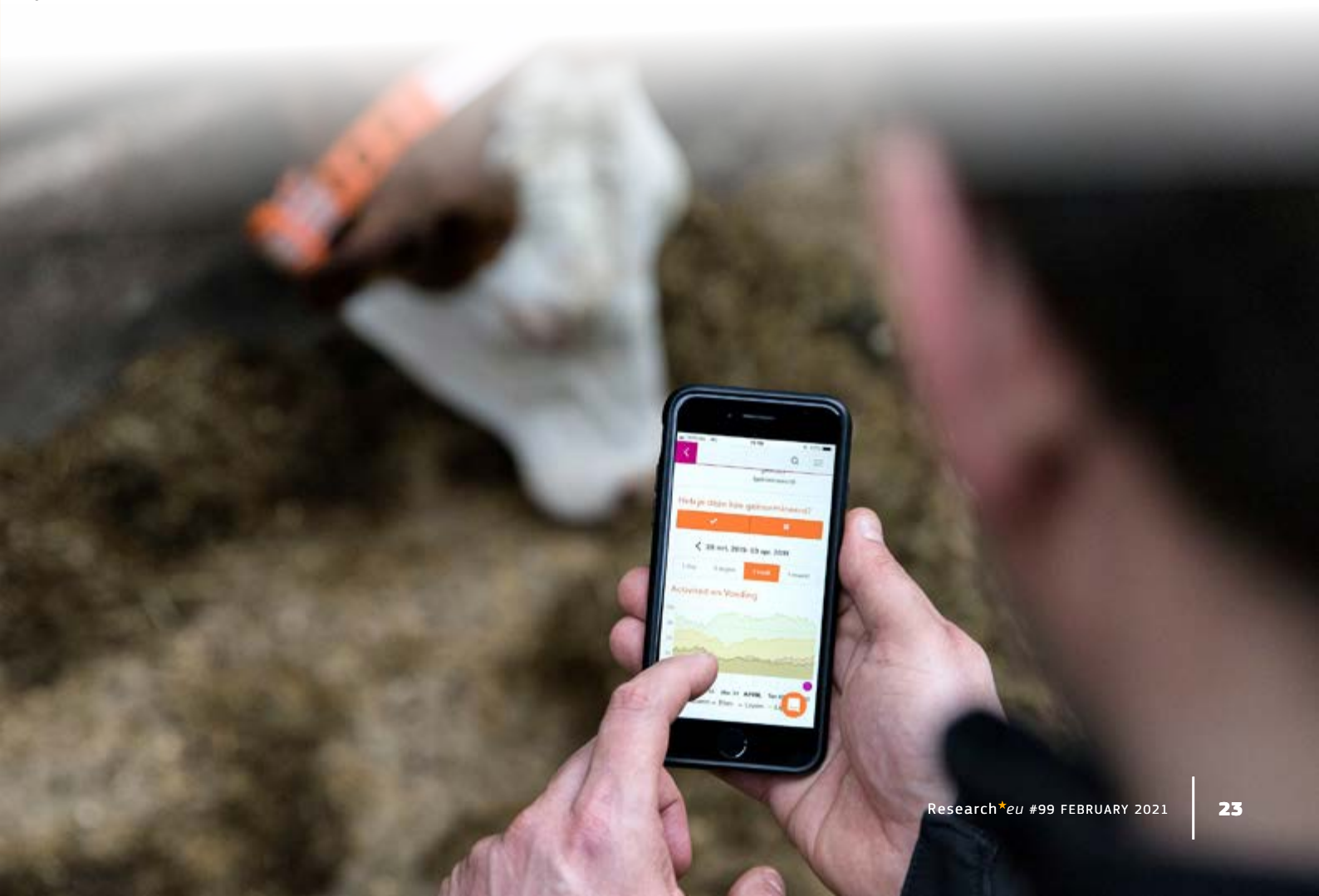
Healthy cows, healthy farm, healthy environment: Artificial intelligence for efficient, greener farming

Improving productivity without simultaneously increasing environmental impact is a key challenge for contemporary farming. A European agritech company has found a solution to help dairy farmers run their farms more efficiently and keep their cows healthy for the good of the environment and the dairy industry.

Milk production represents a significant proportion of the value of EU agricultural output. However, concerns about global warming and biodiversity degradation have made it clear that the sector must become more efficient to feed the world's growing population without causing further harm to the environment.

Technological innovation has the potential to provide key solutions for improving the efficiency of dairy farms, enhancing animal productivity and reducing the sector's

environmental impact – all at once. Ida (The AI-based intelligent assistant for dairy farmers), developed by agritech company Connecterra, is one such example. Using artificial intelligence (AI) to monitor and learn the behaviour of each cow in a herd, Ida is a 'digital assistant' that provides actionable insights for the farmer. An EU-funded project of the same name allowed Connecterra to develop Ida's technology through trial cases and expand its commercial adoption.



“*By empowering farmers with the right technology, we believe our project can help address the growing demands for food and the changing climate.*”

EARLY DETECTION OF ILLNESS LEADS TO SIGNIFICANT REDUCTION IN ANTIBIOTICS

During the project, improvements were made to Ida's sensor and algorithms, leading to a 30% increase in farm efficiency and animal productivity. While these are all important improvements, there is one particular feature of Ida that project coordinator Marjolein van Hage emphasises as a key added value for the dairy farming sector. "Ida detects health issues 2 days before they become apparent to humans, contributing to a 50% reduction in use of antibiotics," she explains.

Timely detection and quick recovery of sick cows is key for animal health and reducing the use of antibiotics, a key priority of the EU's From Farm to Fork Strategy, part of the European Green Deal. According to a recent report from the Food and Agriculture Organization of the United Nations, ensuring animal health is also a key way of improving efficiency and reducing emissions: Healthier animals are more productive, thus reducing emissions per unit of output.

Based on input from a sensor fitted around the neck of a cow, cloud computing and AI technology enable Ida to analyse a cow's movements and spot early signs of anomalies in behaviour, often the first signs of sickness. Ida then deduces the disease the cow is prone to get and alerts the farmer. Ida's ability to significantly reduce antibiotic treatment was studied as part of the Horizon

2020 Internet of Food and Farm project and peer-reviewed by Wageningen University.

LONG-TERM TESTING KEY TO SUCCESS

Guaranteeing users' satisfaction with the platform's performance was a key priority for the project. Ida therefore conducted long-term testing in real farm settings with fewer farms in the pilot programmes than originally envisioned. "This turned out to be a successful strategy," says van Hage, "as we see a positive operational impact and high levels of satisfaction from our current customers. We are also becoming a trusted resource within the dairy industry for ongoing research and collaborative projects."

The positive outcomes of the Ida project make it possible to expand Ida's commercial presence beyond the initial test markets and enter partnerships with a focus on bringing sustainability management technologies to farmers. "By empowering farmers with the right technology, we believe our project can help address the growing demands for food and the changing climate," van Hage concludes.

IDA

- Coordinated by Connecterra in the Netherlands
- Funded under H2020-Societal Challenges, H2020-SME and H2020-LEIT
- cordis.europa.eu/project/id/812312
- Project website: ida.io
- ▶ bit.ly/ida_project

New product dramatically improves the capabilities of food packaging

Keeping food longer on shelves will become an absolute priority for feeding the planet as the rise in temperature reduces crop yields. An EU initiative introduced an innovative product to significantly extend the life of packaged food.

The entire food industry supply chain is facing several challenges. More novel eco-friendly packaging solutions are needed because current environmentally friendly materials have poor shelf life protection properties. Food waste is another concern. According to the UN's Food and Agriculture Organization, prolonging shelf life is the most effective way to reduce food waste. Safer packaging is also needed to safeguard consumers and their changing consumption habits. The demand for smaller portions and packed and ready-to-eat food is increasing. A longer shelf life means less contaminated, safer food.

BRINGING NEW TECHNOLOGY TO THE MARKET

The EU-funded Cronogard (High Performing Advanced Material Platform for Active and Intelligent Food Packaging: Cronogard™) project developed a patented technology that gives birth to a product family for treating raw materials used in the food packaging industry. This product line extends foods' shelf life by up to 200%. "We transformed a laboratory proof of concept into a series of industrialised products that are ready for the market," notes coordinator Célia Gavaud. "Starting from lab tests on substances capable of extending shelf life in a natural way, we worked hard on application techniques and finally delivered products that can be directly used in packaging manufacturers' processing lines without needing special machinery or changes to the consolidated processes."

Traditional polymeric materials for packaging food protect it from attack by external agents but are not very effective at preventing the development of biofilm. The project's innovation reduces the formation of biofilm by as much as 50% on packaging surfaces. The protective and antibacterial activity inhibits the agents responsible for decay from forming inside the package. It is based on a compostable, recyclable filler developed to work with both plastics and cellulose, greatly enhancing these materials' protective properties. The product preserves food even after the consumer opens the package thanks to its tray's reclosable lid.

PRESERVING THE INTEGRITY OF FOOD

The family of products are fully compliant with European regulations on food contact and packaging-permitted substances and processes. "This is noteworthy, considering



“The Cronogard™ product improves shelf life while preserving the characteristics of fresh food, keeping the colour, flavour and texture intact.”

that in recent years many new shelf life extension methods could not proceed to the commercialisation stage because they failed to match regulatory constraints,” explains Gavaud.

The entire value chain stands to benefit. Packaging manufacturers add value to their products, usually considered commodities. Retailers and food manufacturers increase the quality of packaged food and decrease waste. Thanks to a reduction in food waste and in the use of non-recyclable and eco-unfriendly substances, consumers enjoy safer, high-quality products.

Project partners have signed several memorandums of understanding with Italian and global leaders in the packaging sector to develop pilot productions according

to their specific needs. “The application of fruit and vegetables on cardboard trays has successfully passed the final tests on behalf of a packaging manufacturer and a large retailer, and we expect that it will soon be adopted commercially,” adds Gavaud.

“The Cronogard™ product improves shelf life while preserving the characteristics of fresh food, keeping the colour, flavour and texture intact,” concludes Gavaud. “It meets the needs of both the fresh food and the food packaging industries.”

CRONOGARD

- Coordinated by Nicefiller in Italy
- Funded under H2020-LEIT-ADVMANU, H2020-LEIT-ADVMAT, H2020-SME and H2020-LEIT-NANO
- cordis.europa.eu/project/id/783696
- Project website: cronogard.com/en/about-cronogard
- ▶ bit.ly/3bCmRvS

FOOD AND NATURAL RESOURCES

Connecting farmers and apiculturists to the Internet of Bees

A smart system which listens to the buzz of a colony can help beekeepers maintain healthy and productive hives.

The EU beekeeping industry supports 600 000 beekeepers, who collectively manage some 16 million hives. Honeybees play a crucial role in our agricultural system, pollinating around a third of crops that end up on our dinner tables. Commercial beekeeping requires the frequent moving of hives from farm to farm, which can result in the loss of colonies.

The EU-funded Pollenity (Introducing the Internet of Bees: A Smart Beehive System) project developed a smart beehive system that allows beekeepers to more closely monitor their hives and receive advance warning of threats that can harm these colonies.



“We want to arm beekeepers with data about the health and productivity of bee colonies.”

LISTENING IN

“The bee mortality rate in highly industrialised regions has been rising for the last 20 years, and is quite devastating,” notes project coordinator Sergey Petrov. “We want to arm beekeepers with data about the health and productivity of bee colonies, collected by Internet of Things sensor devices.”

Pollenity offers two main products. The first is the hiveBase, an electronic scale which transmits readings wirelessly, letting beekeepers know how much honey the hive has produced.

The second is Beebot. “This is proprietary tech we developed from scratch – a small computer that collects data on temperature, humidity and movement, and analyses vibrations from bee buzzing,” explains Petrov.

Bees communicate with each other using these vibrations, so the buzzing of bees is associated with particular events in the hive. “Beebot records those vibrations and, using a formula called Fourier transform, analyses this directly,” adds Petrov. “This shrinks the size of the file so that the data then transmitted is not so heavy.”

MISSING BEES

The data lets beekeepers understand what is going on inside the hive without opening it, which disturbs the bees.

The Beebot can forewarn about events such as swarming, where the colony abandons the hive to look for a new place to live. “We are able to pick up on this event 5 days prior to physical clues,” says Petrov.

The Beebot can also warn beekeepers if a hive is being raided by wasps or hornets, offering an opportunity to defend it, while also alerting beekeepers if the queen goes missing. To present this data, Pollenity offers a user interface called BBoard, which also collects relevant data from third-party sources, such as those that issue weather warnings.

The project was supported through the EU’s Horizon 2020 programme. “This allowed us to pinpoint the best geographical markets to serve,” he notes. “We identified customers most likely to jump on board, not necessarily the largest customer base.”

LIVING SENSORS

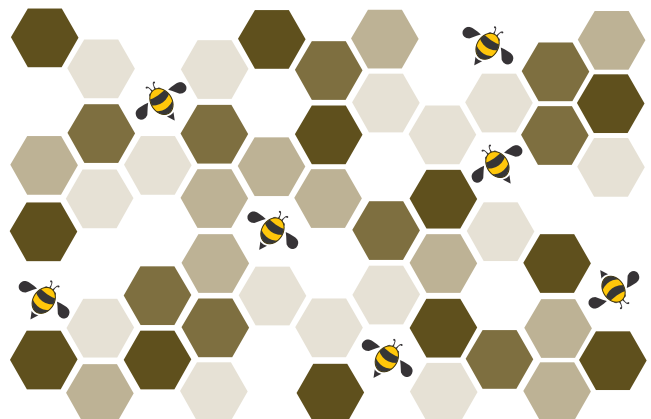
The company has now grown into a separate venture, as a commercial partner in the EU-funded Hiveopolis. This project aspires to turn bees into environmental detectives using a counter that can track bees leaving and returning to the hive.

“We want beekeepers and farmers to be able to track what is entering a beehive, whether a bee, a bee bringing pollen, a bee bringing nectar, a drone, a queen, a hornet or a wasp,” says Petrov. “Being able to do that helps a number of interested stakeholders – beekeepers, farmers, citizens. Anyone who wants to understand how polluted an area is could use a beehive as a sensor.”

POLLENITY

- Coordinated by BII Smart Technologies in Bulgaria
- Funded under H2020-Societal Challenges, H2020-SME and H2020-LEIT
- cordis.europa.eu/project/id/887791
- Project website: pollenity.com

The EU beekeeping industry supports
600 000 beekeepers,
who collectively manage some
16 million hives





INDUSTRIAL TECHNOLOGIES

A sustainable solution to stainless steel's pickling problem

New technology demonstrates its ability to remove all environmentally hazardous waste from the pickling process.

The pickling process, used to remove impurities from the surface of stainless steel, is environmentally devastating. Not only does pickling cause water, soil and air pollution, it also wastes valuable resources such as nickel, chrome and iron, among others.

Each of these resources must be mined, processed and shipped around the world, producing more pollution and using vast amounts of energy.

Facing increasing environmental regulations, the stainless steel industry is desperate for a sustainable solution to its pickling problem. That solution could be REGMAX (An innovative and sustainable process for reducing the environmental impact of stainless steel production, enabling impressive recovery rates and cost savings).

"When installed adjacent to an existing pickling line, REGMAX enables a total recovery of all wasted acids and

metals," says Fabian Storek, CEO at SUSTEC, the Austrian sustainable technology company behind REGMAX.

Now, with the support of EU funding, SUSTEC has validated REGMAX in real operating conditions.

CLOSING THE PICKLING LOOP

REGMAX is a patented two-step process that starts with a gentle drying of the liquid waste acids produced during pickling. The metal salts that are dried during step one undergo a pyrohydrolysis process in step two, where they are transformed into oxides and gaseous acid and then recovered.

According to Storek, REGMAX closes the pickling loop as the acid is reused in the pickling line and the recovered metals are used to produce new steel. "All waste from the



pickling process is eliminated by REGMAX and turned into entirely fresh resources,” he explains.

“In doing so, we are able to solve the environmental problem of pickling, eliminating toxic waste and pollution, protecting the environment, and enabling a circular economy.”

A FULL DEMONSTRATION

Having proven its technology on a small scale, SUSTEC needed to build an industrial pilot plant to convince future customers. With the support of EU funding, they were able to do exactly that.

“Our project partner is a global player in the stainless steel industry,” remarks Storek. “The company has been looking for a sustainable solution to deal with the waste acids produced during pickling and they were happy to see if REGMAX could do the trick.”

The project built a fully operational REGMAX plant next to the steel producer’s pickling line. The plant is designed to run 24/7 unattended, with only periodic supervision needed. “We demonstrated that our complex, automatic system works very well, ensuring a safe and stable operation in the plant,” adds Storek.

In addition to installing the complete acid and metal recovery process, researchers also implemented a heat recovery system. “Not only will the plant recover more than 10 million litres of toxic waste acid every year, it also drastically reduces the REGMAX plant’s energy consumption,” concludes Storek. “The result is a win-win for the environment and the manufacturer.”

With the pilot project having proved the technology at an industrial scale, REGMAX is now available on the market.

REGMAX has been certified by the Solar Impulse Foundation as meeting several UN Sustainable Development Goals. The Swedish Environmental Protection Agency has confirmed the system’s CO₂-equivalent saving, and Mission Innovation named REGMAX as one of the 100 solutions that can significantly contribute to creating a carbon-neutral world.

REGMAX

- Coordinated by SUSTEC in Austria
- Funded under H2020-Societal Challenges, H2020-SME and H2020-LEIT
- cordis.europa.eu/project/id/811514
- Project website: sustec.com

INDUSTRIAL TECHNOLOGIES

Artificial sand provides green solutions for the construction sector

An EU-funded initiative has taken an unwanted by-product of the power industry to provide a valuable alternative to an imported overexploited resource.

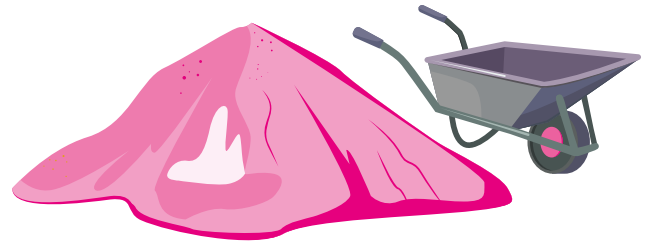
An ever-growing population and a continuing trend towards urbanisation mean that around 40 billion tonnes of sand are mined each year to meet the world’s increasing demand for construction materials. Because sand from the desert is unsuitable as a building material, it must be mined or dredged from rivers, deltas, and coastal and marine ecosystems, resulting in environmental damage.

One solution is to use ash, a by-product of coal-fired power stations and waste-to-energy (WTE) incineration plants. Although the sustainable disposal of fly ash

can prove challenging due to the metals it contains, the material also possesses valuable properties that make further processing worthwhile.

The EU-funded SMARTSAND (Transforming fly ash waste from coal-fired power plants into lightweight engineered sand for multiple applications) project developed Lypors™, an advanced engineered, artificial sand material manufactured from fly ash for use in the construction industry. “It is a superior and cost-effective alternative to natural sand, crushed stones and lightweight fine

Around **40 billion tonnes of sand** are mined each year



aggregates, for use in the manufacture of advanced building material derivatives such as concrete, mortars, roof tiles, tile adhesives, façades, etc. It can also be used in certain niche applications like horticulture and hydroponics,” says Abbas Khan, founder and managing director at ZaaK Technologies, an innovation and technology development start-up focused on recycling industrial wastes into high-value products.

IMPROVED PHYSICAL PROPERTIES

According to Khan: “Lypors™ involves a combination of mechanical, chemical and sintering processes in a simple, novel and highly scalable production process. The technology is easily integrated into the power station or WTE’s existing infrastructure and properties such as size, shape, porosity and density tailored to meet different applications or usage.”

Lypors™ is not just a substitute for sand, as it has superior properties that can revolutionise the building and construction industry. For example, the material is up to 55 % lighter than normal construction sand, which means a significant reduction in transport costs and fuel savings, and increased efficiency in load distribution of buildings, resulting in savings of energy-intensive materials such as cement and steel.

Furthermore, buildings made of Lypors™ can have a thermal insulation factor up to five times higher than a building using natural sand. “It also has a superior and consistent quality with zero organic impurities as opposed to natural sand, leading to a longer lifespan of mortar and concrete made of it,” notes Khan.

ECONOMIC, ENVIRONMENTAL AND SOCIAL BENEFITS

ZaaK Technologies successfully designed, installed and commissioned an integrated pilot plant in Grossbeeren, Germany. “We now have a great showcase to encourage investors and customers to build industrial ‘Smart Sand’ plants in Europe, Asia and the United States. This will bring a unique building material to the market, with a positive impact on the environment due to its employment of waste material in the form of fly ash, thereby conserving the natural resource of sand,” Khan observes.

Smart Sand developments will benefit stakeholders throughout the value chain – from fly ash producers who no longer need to pay disposal costs to the construction industry that now has access to high-quality construction sand material. Building end users will benefit from the increased thermal and acoustic insulation and reduced environmental impacts.

In addition, the processing of fly ash and the corresponding expansion of the plants’ value chain will create new jobs. This can help to mitigate the consequences of the phasing-out of coal usage in the fight against greenhouse gas emissions and climate change. “Hence, Smart Sand supports not only economic and environmental but also political goals,” concludes Khan.

SMARTSAND

- Coordinated by ZaaK Technologies in Germany
- Funded under H2020-ENVIRONMENT and H2020-SME
- cordis.europa.eu/project/id/738759
- Project website: zaaktechnologies.de





Taking research experiments to another level with superior data management services

The most demanding, data-intensive research experiments in Europe and beyond require services that are capable of operating at an unprecedented scale. An EU initiative developed scalable technologies to meet the challenge of supporting petascale data management in modern e-Infrastructures.

For many years, managing extremely large and growing volumes of data has been a challenge for scientific experiments that use distributed e-Infrastructures for their computing needs. New features and functionalities need to be developed and made available to the research community to cope with the dynamic nature and flexibility of these powerful resources.

MANAGING DATA IN HIGHLY DISTRIBUTED COMPUTING ENVIRONMENTS

The EU-funded XDC (eXtreme DataCloud) project developed and released enhanced data management services that can be coherently harmonised with current and next-generation e-Infrastructures deployed



“XDC delivered important and innovative services that have been proposed as candidates for inclusion in the EOSC-hub Service Catalogue.”

throughout Europe, such as the European Open Science Cloud (EOSC) and the Worldwide LHC Computing Grid coordinated by the European Organization for Nuclear Research. These open, interoperable and easy-to-use services will help to build global infrastructure for distributed computing.

XDC team members improved existing federated data management services by adding missing functionalities. “New users mean new requested functionalities,” comments project coordinator Daniele Cesini. “Significantly extending the provided functionalities is of utmost importance in building infrastructures that can be exploited by user communities different from those that historically founded their computing models on distributed systems.” Team members enhanced user experience in accessing such data management services by providing more user-friendly interfaces.

The scientists provided adaptable functionalities to address modern e-Infrastructures’ increasing dynamic nature and flexibility. “Due to the advent of virtualisation techniques, cloud computing paradigms, and Infrastructure as a Service and Platform as a Service orchestration tools, resources once identified as ‘sites’ in e-Infrastructures have become ‘liquid’ and highly dynamic,” Cesini explains. Sites can be created, destroyed, attached and detached from infrastructure with a few mouse clicks in a time period that was inconceivable just a few years ago.

Furthermore, the resources created or attached can be heterogeneous in nature, without a predefined architecture. “However, when it comes to data management, a high dynamicity poses huge challenges with respect to efficiency, transparency and reliability,” he adds. XDC delivered data management solutions to dynamically extend a computing centre to a remote

site that provides transparent bidirectional access to data stored in both locations. It also offered solutions to dynamically include sites with limited storage capacity, thus providing transparent access to data stored remotely.

OPEN-SOURCE PLATFORMS AVAILABLE FOR WIDESPREAD USE

To facilitate interoperability, standardisation and adoption, the XDC architecture uses open standards and protocols available on state-of-the-art distributed computing ecosystems to guarantee that the released components can be easily plugged into European e-Infrastructures and cloud-based computing environments overall. Project partners created two open-source software releases that can be deployed on public and private cloud infrastructures: XDC-1 (code name Pulsar) and XDC-2 (Quasar). Both are based on existing production quality services that were enriched with new functionalities and usability improvements to make complex infrastructures exploitable by an increasing number of user communities. They organised these building blocks in a coherent architecture and provided several contributions. A catalogue describes the services and the new related functionalities developed and enhanced during the project.

“XDC delivered important and innovative services that have been proposed as candidates for inclusion in the EOSC-hub Service Catalogue,” concludes Cesini. The EOSC-hub project simplifies access to a comprehensive suite of products, resources and services supplied by major pan-European and international organisations.

XDC

- Coordinated by the National Institute for Nuclear Physics in Italy
- Funded under H2020-INFRA
- cordis.europa.eu/project/id/777367
- Project website: extreme-datacloud.eu
- ▶ bit.ly/36AbaFy

Bridging the divide between big data innovation and privacy-aware data protection

New technologies for securing user consent and enabling the trustful sharing of personal data could help expand the use of big data.

With an estimated value of EUR 739 billion in the EU alone, big data is big business. “Big data has the potential to redefine how we do business, how we conduct research, and how we live,” says Sabrina Kirrane, a researcher at Vienna University of Economics and Business. “However, this potential will remain largely untapped if we don’t address the data protection issues associated with it.”

Addressing this disconnect between big data innovation and privacy-aware data protection is the focus of the EU-funded SPECIAL (Scalable Policy-aware linked data architecture for privacy, transparency and compliance)

project. “Our goal was to develop a technical framework that allows citizens and organisations to share more data while guaranteeing data protection compliance,” explains Kirrane, who serves as the project’s scientific coordinator. “In doing so, we are helping create valuable new insights from shared data.”

TRUSTFUL USAGE AND SHARING

Using semantic web technologies and linked data principles, the SPECIAL solution secures user consent at the time of the data collection. It also records both data and metadata (e.g., consent, event data, context) according to user-specified policies.

“SPECIAL enables the trustful usage and sharing of personal data even across company boundaries,” remarks Kirrane. “It does this by using technical specifications and automated compliance checking to support the EU General Data Protection Regulation’s consent and transparency requirements.”

Other key features of the SPECIAL solution include its user consent interface and feedback-enhanced dashboard. Both features ensure that privacy in big data remains comprehensible and manageable for data subjects, controllers and processors.

“During the course of this project, we clearly demonstrated the solution’s robustness in terms of performance, scalability and security – all of which are necessary to support privacy-preserving innovation within big data environments,” adds Kirrane.

Many of the SPECIAL solutions, which can be accessed via the project’s website, are already being considered by a number of industry partners and private organisations.



“Big data has the potential to redefine how we do business, how we conduct research, and how we live.”

AN ONGOING IMPACT

Although the project is now finished, work continues. In addition to presenting its results at numerous international conferences on big data and data protection, the project has also inspired several spin-off research projects. These include the EU-funded TRAPEZE follow-up innovation action and the KnowGraphs and MOSAICrOWN fundamental research projects, amongst others.

“The SPECIAL project has had a significant impact on a wide variety of domains, including legal informatics, big data, privacy and computer science,” concludes Kirrane. “This impact will only continue to multiply via the efforts of these spin-off projects and the ongoing work of our consortium partners.”

SPECIAL

- Coordinated by GEIE ERCIM in France
- Funded under H2020-LEIT-ICT
- cordis.europa.eu/project/id/731601
- Project website: specialprivacy.eu

DIGITAL ECONOMY

Rethinking architecture in the digital era to bring real change to design and planning

Digital technologies are revolutionising the way architecture is thought of, designed and made. An EU initiative explored what the culture of building will be like in the future.

The building industry is entering a new era of advanced modelling guided by new concepts in big data computing, cloud-based collaboration and steered robotic fabrication. Questions that arise concern the ways in which the sector will collaborate, how knowledge across the design change will be communicated and fed back for a more informed and materially sensitive practice, and what the future of automation in architecture will be.

ACADEMIA AND INDUSTRY JOIN FORCES TO INNOVATE

To address these questions, the EU-funded InnoChain (Building Innovation in the Extended Digital Chain) project trained a new generation of 15 interdisciplinary researchers with a strong industry focus that can make real changes to the way we think, design and build our physical environment. The project's network fostered a unique opportunity for knowledge sharing, synergy and real innovation. To do so, it built on the research

competence of six world-leading academic centres and 14 pioneering innovation industry partners from architecture, engineering, design software development and fabrication.

“InnoChain's overarching achievement was challenging our thinking of how the practices of design, analysis and fabrication can intersect – the perspective was purposefully wide-ranging,” explains project coordinator Mette Ramsgaard Thomsen. By engaging the entire design chain and its disciplines, project partners asked how opportunities for advanced computation, integrated simulation, performance evaluation, human-computer interaction and robotic fabrication can create tangible differences in the way architects build. “What is at stake here is, on the one hand, the future of the design model and the collaborative nature of building practice, and on the other, the way we understand our fabrication culture and the material systems with which we build.”

“ *InnoChain has created a strong network of researchers who will continue to push the boundaries of how building culture is shaped, what technologies and materials it can incorporate and how it can be imagined.* ”

To help answer the building profession's pressing questions, the young designers, architects, engineers and IT specialists worked on the cutting edge of computational design across the building practice. Their research focused on three main axes of design innovation: communication, simulation and materialisation. The results successfully developed a new collaborative practice enabled by computational advances that radically reassess what the digital chain can be. They demonstrated the development of foundational methods and technologies needed for a sector-wide change in reshaping how a wider partnership within the building practice can work.

DRIVER OF INNOVATION AND GROWTH ACROSS ALL BUILDING INDUSTRY LEVELS

InnoChain is globally recognised for giving a fresh impetus to industry and its beneficiaries. The outcomes were

presented at industry-related events and showcased on various European dissemination platforms. In addition, the European Commission highlighted InnoChain as a success story amongst projects co-financed by Horizon 2020. The project also received the German Design Award 2018 in the architecture category and the Association for Computer Aided Design in Architecture's 2017 Autodesk award for emerging research.

“InnoChain has created a strong network of researchers who will continue to push the boundaries of how building culture is shaped, what technologies and materials it can incorporate and how it can be imagined,” concludes Ramsgaard Thomsen. This research was undertaken with the support of the Marie Skłodowska-Curie Actions programme.

INNOCHAIN

- Coordinated by the Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation in Denmark
- Funded under H2020-MSCA-ITN
- cordis.europa.eu/project/id/642877
- Project website: innochain.net



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LIFE AFTER...

Catching up with VRespect.Me: Fighting domestic violence through an innovative VR solution

*Almost one third of women worldwide have experienced intimate partner violence. In Research*eu issue 88 from December 2019/January 2020, we covered VRespect.Me, a fascinating project that has truly seized the opportunities of the digital revolution to devise an innovative solution to combat domestic violence. We catch up with Charlie Pearmund, CEO of coordinating company Virtual Bodyworks SL, to find out more about their latest developments.*



with 2020 proving to be a very fruitful year for them.

“In 2020, a new project funded by the EU’s Rights, Equality and Citizenship Programme started called ‘VR per Genere’.” Pearmund explains. “In this project, VRespect.Me is being extended to not only the rehabilitation of abusers, but also the prevention of gender abuse amongst the young.”

different approaches,” Pearmund concludes. “And as the pandemic has shown us so starkly, it really is a very important health and societal issue. Immersive virtual reality will be just one method to really tackle this problem once and for all.”

Indeed, he and his colleagues continue to be dedicated to the further rolling out of VRespect.Me, with interest in the system now coming from many countries, including some as far away as Australia.

Alongside this, and based on preliminary results, VRespect.Me will be used with general populations in order to decrease victim blaming, another building block when increasing awareness of gender violence and aimed at prevention.

Then, of course, there’s the ever-present pandemic. “During the COVID-19 pandemic, a further increase in women victims of gender violence has been reported, particularly during periods of lockdown,” says Pearmund. “Therefore, an already endemic problem across the world has become a much larger problem.” Indeed, many governments have clearly stated that one of the only legitimate reasons to leave the house during lockdowns, alongside usual activities such as exercise and essential shopping, is to escape domestic violence.

“Gender violence is a multidimensional and complex matter that requires many

VRESPECT.ME

- Coordinated by Virtual Bodyworks SL in Spain
- Funded under H2020-SME, H2020-LEIT and H2020-Societal Challenges
- cordis.europa.eu/project/id/836707
- Project website: virtualbodyworks.com/products/vrespectme/



Charlie Pearmund,
CEO Virtual Bodyworks SL
© Virtual Bodyworks

“During the COVID-19 pandemic, a further increase in women victims of gender violence has been reported, particularly during periods of lockdown.”

© Virtual Bodyworks

The core of the VRespect.Me (Virtual Environments for Rehabilitation of Gender Violence Offenders) solution is to give someone the embodied perspective of being the victim of domestic abuse. When this is done with domestic abuse perpetrators, they can see, feel and hear for themselves how their actions impact their victim. This is achieved through the latest Virtual Reality (VR) technology, specifically a headset and the use of a virtual avatar.

When we last spoke to Charlie Pearmund, the regional Catalanian government – Virtual Bodyworks is based in Barcelona – had bought VRespect.Me for use in one of the region’s prisons. “The system is now used in six Catalanian prisons,” Pearmund tells us.

2020: A big year for VRespect.Me

Since the formal end of the VRespect.Me project, Pearmund and his colleagues have been extremely busy promoting their technology and their experience,



SECURITY

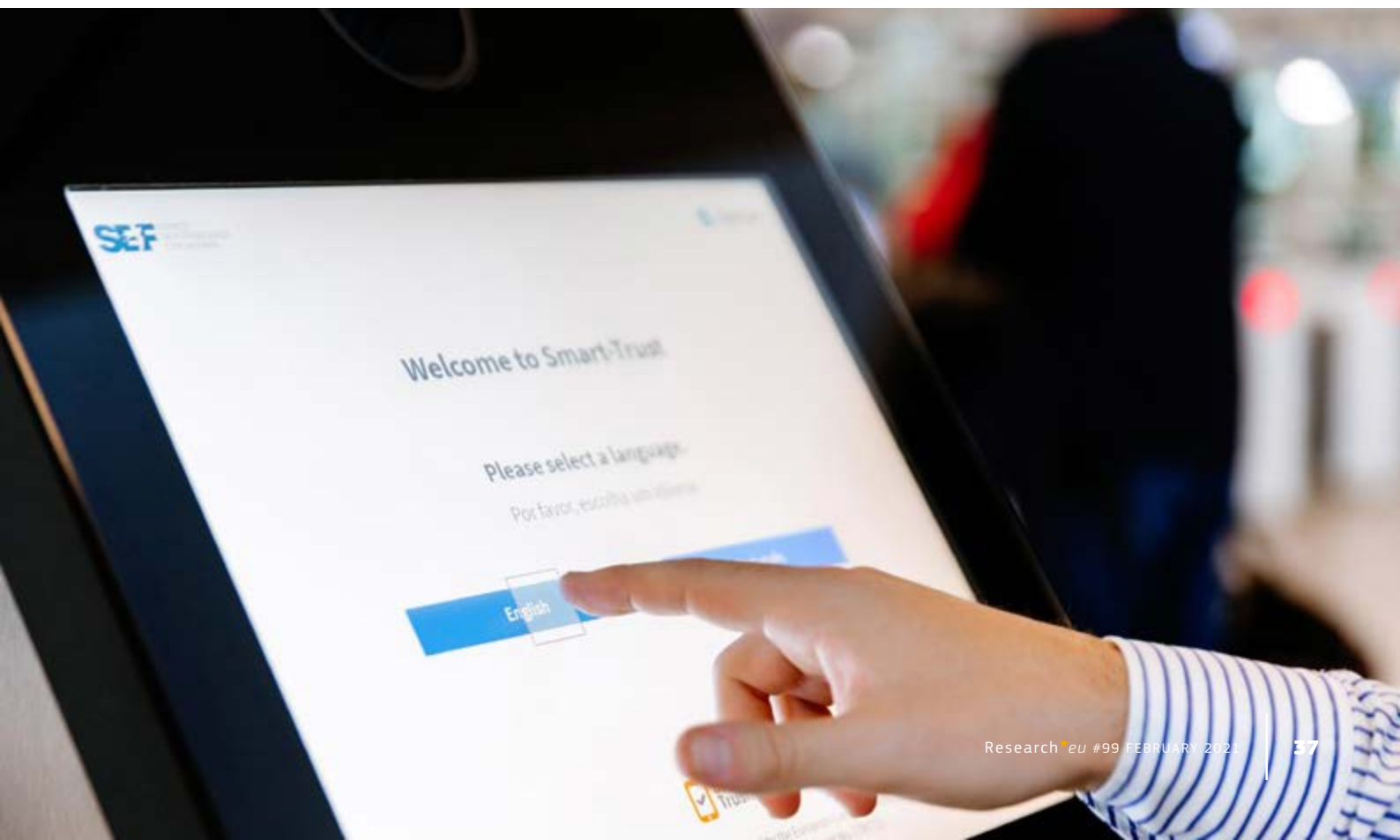
Border entry made easier, faster and more secure thanks to pioneering biometric technology

Whether at border controls or checkpoints, Europe is trying to enhance security while offering a seamless travel experience. An EU initiative delivered a new form of identity verification to help find the right balance between the two.

The EU-funded Smart-Trust (Secure Mobile ID for Trusted Smart Borders) project introduced a new technology enabler called 'Mobile ID' to leverage digital ID and biometric identification. It provides a self-serve, smooth clearance process. "Where mobile technology has changed the way people communicate, Mobile ID goes one step further by transforming the way people identify themselves," comments coordinator Elisabete Pires. "It creates an ecosystem enabling a hands-free digital ID authentication procedure that uses mobile devices to offer individuals, businesses and governments a complete paperless, contactless identification clearance option."

MOBILE ID BIOMETRIC TECHNOLOGY SCORES HIGH MARKS

After assessing the business needs of governments, airports, airlines and border officials, project partners established requirements and defined key performance indicators for these target groups. They integrated Mobile ID into airport and border control infrastructure, with experiments designed to measure the system's effectiveness in seamlessly identifying and clearing travellers. Face recognition was utilised as a test in a positive identification scenario at a typical airport



setting with users who were unfamiliar with biometric identification procedures. The evaluation involved 6 275 transactions over a 40-day period.

The results improved understanding of how individuals react to digital ID biometric verification on a user-friendly mobile platform that has not been widely adopted yet. The test pilot provided new insight into factors that affect the performance of established biometric technology that uses mobile devices and those that affect the travellers' reactions to this technology. More specifically, they include how the image quality is impacted by environmental conditions, and how realistic acquisition scenarios affect the behaviour of individuals when being processed through digital biometric ID applications.

In a satisfaction survey involving nearly 1 600 test subjects, 67% considered the process very quick and 70% easy to use, while 93% were interested in using the solution on their phone next time they travelled. "These combined results demonstrate to the European Commission the general capability and traveller acceptance of biometric technology within a controlled environment," notes Pires. "The outcomes will help in developing policy on biometric use at border control points and assist in assessing the applicability of Mobile ID and its potential benefits."

SEAMLESS EXPERIENCE FOR THE CONNECTED TRAVELLER

Mobile ID offers an agile, modular and highly configurable, open architecture platform with several robust, versatile and scalable core components. It employs 'Biometrics on the Move' technology for a non-stop identification

“Where mobile technology has changed the way people communicate, Mobile ID goes one step further by transforming the way people identify themselves.”

process by relying on digital ID electronic documents stored in individual mobile devices. It ensures that the personal data is secure with privacy-by-design protocol engineering that guarantees individual privacy. Mobile ID uses a highly secure biometric token to keep personal data private and confidential. Privacy-by-design only allows authorised actors to access the information they need, with permissions explicitly granted by the user. Together, these protocols enhance user privacy and reduce the likelihood of identity theft.

"Mobile ID considerably speeds up the identification and clearance process, increases the reliability and trust levels of identity verification at European borders and enhances EU countries' border security," concludes Pires. Ultimately, Smart-Trust will contribute to reconciling security and user experience while improving both at the same time.

SMART-TRUST

- Coordinated by Vision-Box in Portugal
- Funded under H2020-SECURITY and H2020-SME
- cordis.europa.eu/project/id/778571
- ▶ bit.ly/32EsxTx

SECURITY

A simpler way of preventing cyberattacks

A new solution uses situational awareness and semi-automation to help public administrations and SMEs detect, classify and react to cybersecurity risks.

Cybersecurity is increasingly being perceived as the greatest threat to every company and organisation in the world. While new regulations like the Network and

Information Security (NIS) Directive and the General Data Protection Regulation (GDPR) are trying to improve cybersecurity, compliance can be challenging. This is

“The sheer speed that such cyber-related information can be generated at is simply overwhelming, and neither the human brain nor basic screening systems are up to the task of processing big data incidents.”

particularly true for public administrations and SMEs, who often lack the resources to invest in the necessary state-of-the-art cybersecurity solutions.

To help public administrations, NGOs and SMEs better detect and protect themselves against cybersecurity threats, the EU-funded CS-AWARE (A cybersecurity situational awareness and information sharing solution for local public administrations based on advanced big data analysis) project has developed a suite of simple, cost-effective cybersecurity awareness solutions.

“CS-AWARE is a collection of innovative solutions that allow these entities to detect, classify and visualise cybersecurity incidents in real time, thus supporting the prevention and mitigation of cyberattacks,” says Juha Röning, a researcher at the University of Oulu in Finland and CS-AWARE project coordinator.

BUILT ON SITUATIONAL AWARENESS

At the heart of CS-AWARE is a cybersecurity situational awareness component that complies with current and forthcoming cybersecurity regulations. “Sharing information regarding cyberthreats is very beneficial to the entities receiving the information and is regarded as being one of the most important weapons against cybercrime,” explains Röning. “By taking advantage of existing shared cybersecurity-related information, not only does our solution enable and refine incident detection, it does so while meeting the information sharing requirements of the NIS and GDPR.”

Although important, simply identifying, extracting and storing information about cyberthreats and events alone is not enough. “The sheer speed that such cyber-related information can be generated at is simply overwhelming, and neither the human brain nor basic screening systems are up to the task of processing big data incidents,” adds Röning. “Knowing this, our solution uses complex decision-making algorithms to first identify the most probable threats and then automatically refer them to specialists and other automated systems for processing and mitigation.”

While CS-AWARE automates a significant part of the cybersecurity detection process, full automation is not yet possible. “Every local public authority has a different system, making it nearly impossible to create one-size-fits-all automated solutions,” notes Röning. “Instead, our solution uses dependency analysis based on soft systems thinking, which allows us to identify the most valuable parts of a particular system for monitoring.”

PILOTED AND VALIDATED SOLUTIONS

The CS-AWARE solution was piloted and validated at two real-world sites, one in Larissa, Greece, and the other in Rome, Italy. Through scientific publications and its public deliverables, the project has also contributed to the development of open source for specific cybersecurity technologies.

Most importantly, however, CS-AWARE put together a solid team of dedicated experts, many of whom are now working to commercialise the technology developed during the project through the newly established CS-Aware Corporation OÜ.

CS-AWARE

- Coordinated by the University of Oulu in Finland
- Funded under H2020-SECURITY
- cordis.europa.eu/project/id/740723
- Project website: cs-aware.eu





Fossil record reveals extent of diversity of past life on Earth

Carefully re-examining the fossil record has led to a rethink of how life evolved on land and a renewed appreciation of the role that mass extinctions played in catalysing change.

Estimates of the total number of species on Earth today range from 5 million to 100 million or more.

“The majority of those species – perhaps 75–95 % – live on land,” notes TERRA (375 Million Years of the Diversification of Life on Land: Shifting the Paradigm?) project coordinator Richard Butler, professor of palaeobiology at the University of Birmingham, United Kingdom.

“This is a paradox when you consider that land covers only a fraction of the Earth’s surface, and life has had longer to evolve in the sea than on land.”

The fundamental source of information on biodiversity is the fossil record. This has long been used to trace biodiversity change over long geological timescales. For example, there is a prevailing view that life on land today is much more diverse and complex than at any point in the geological past.

“Such narratives rely on us being able to accurately reconstruct past biodiversity,” says Butler. “The challenge is that the fossil record is severely biased and tends to

become better sampled and better understood in more recent time intervals.”

LIFE ON LAND

The TERRA project, supported by the European Research Council, sought to establish whether the hypothesis of ever-increasing biodiversity on land was correct, or an artefact of fossil record biases. The project used data from the Paleobiology Database, an online research resource that aims to summarise the entire fossil record of life on Earth.

“The database contains tens of thousands of records of land tetrapods, four-limbed vertebrates, with information on where they were found and how old they are geologically. We also carried out comparable analyses for marine animals, to understand similarities and differences in patterns across the two realms.”

Butler and his team found strong evidence that the hypothesis of exponential diversification on land is an artefact of sampling bias. They found that levels of diversity on land were relatively stable over long periods of geological time.





The majority of
Earth's species –
 perhaps 75-95 %
– live on land.

“This suggests that there were constraints on diversification,” he adds. “Perhaps competition for resources between species limited the total number of species that could occur within ecosystems.”

The project found similar patterns in the sea to on land. The fossil record also clearly shows that, on land and in the sea, mass extinctions played a critical role in disrupting this stability.

RECORDS OF THE PAST

These results could fundamentally change the grand narrative of how life has evolved on land over hundreds of millions of years.

“They challenge ideas that ecosystems today are vastly more diverse and complex than they were in, for example, the Cretaceous period,” says Butler. “And they demonstrate the role of mass extinctions in not only disrupting global ecosystems but also, potentially, catalysing an increase in diversity. This they do through creating opportunities for new groups of animals to diversify.”

The team are currently digging deeper into questions of how environmental change drives biodiversity patterns through geological time. This work is being carried out in collaboration with climate modellers. “We’re applying this initially to dinosaurs, but this has potential to yield insights with many different types of fossil data,” he explains.

Butler believes that this work will drive further detailed examination of the patterns and drivers of diversity on land. “I also hope that we might gain an increased appreciation for the richness of deep-time ecosystems, many of which may have been as complex and diverse as those that we see around today,” he concludes.

TERRA

- Hosted by the University of Birmingham in the United Kingdom
- Funded under H2020-ERC
- Project website: bit.ly/TERRA-project
- cordis.europa.eu/project/id/637483

FUNDAMENTAL RESEARCH

How bacteria bear a grudge against viruses

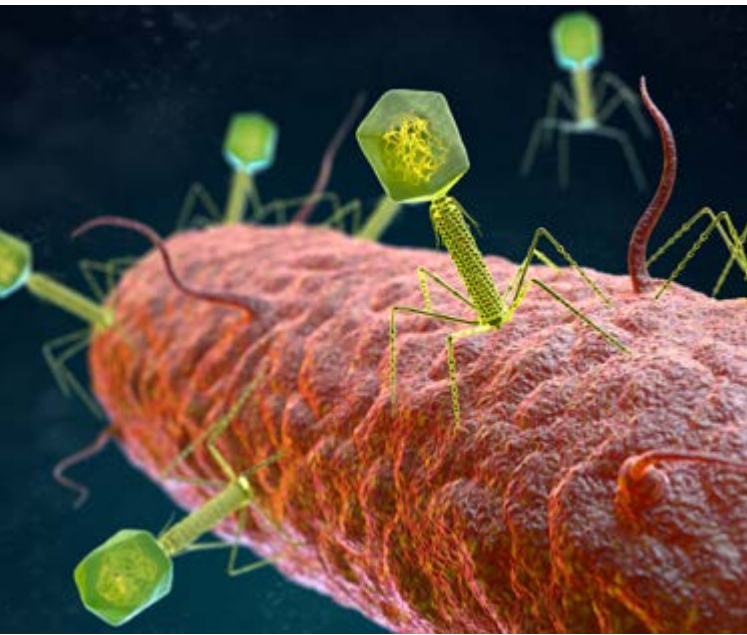
Better understanding immune systems as stages for the ongoing evolutionary battle between viruses and bacteria could lead to opportunities to use viruses as alternatives to antibiotics.

Microbes in natural ecosystems are under constant threat from viruses. To survive in this hostile environment, bacteria have evolved an adaptive immune system called CRISPR-Cas.

“A really interesting aspect of this immune system is the fact that microbes are able to memorise individual viruses,” explains project coordinator Stan Brouns, associate

professor of molecular biology at Delft University of Technology, the Netherlands. “This is achieved by hijacking and storing genetic viral information.”

Brouns made this recent discovery when he saw bacteria launching a primed immune response against heavily mutated viruses. “This implies that the CRISPR-Cas



© Tatiana Shepeleva, Shutterstock

system remembers threats over the long term,” he says. “This would provide a huge evolutionary benefit.”

LONG-TERM MEMORIES

Brouns wanted to take this discovery further. The REMEMBER (Adaptive immunity in prokaryotes: how Bacteria do not forgive and do not forget their enemies) project, supported by the European Research Council, enabled him to move to Delft University, where he was able to establish his own dedicated lab and assemble a talented team.

“I really wanted to determine the mechanism behind this process of primed memory formation against viruses,” he notes. “Viruses mutate, so how can bacteria keep memories up to date, and stay one step ahead?”

Using a combination of genetic and biochemical approaches, including state-of-the-art molecule imaging of living *Escherichia coli* cells, Brouns and his team were able to make some startling findings.

“The big question we asked was how bacteria are able to keep their memories up to date,” he adds. “What we found was that molecular ‘genetic scissors’, akin to those discovered by this year’s Nobel Prize for chemistry winners, are critical to defending against viruses.”

These molecular scissors are used by bacteria to cut pieces of viral DNA. The destruction of this DNA is coupled to the

“ We were able to show how there is a continuous update of CRISPR systems, and how this is achieved. ”

formation of new memories, and it is this coupling that keeps memory banks in the CRISPR system up to date.

“We also identified the role of a particular new protein, which makes sure that the molecular scissors work and that the memories acquired are functional,” explains Brouns. “And for the first time, we were able to see first-hand how CRISPR systems in cells really function.”

Using an advanced microscopy approach, Brouns was able to analyse how these molecular scissors scan DNA to find the current sequence they are targeting. “This is an immense task, as cells are full of DNA,” he says. “We found that these scissors worked remarkably fast, which also helps to explain why the CRISPR systems are so efficient.”

WORLD OF POSSIBILITIES

Brouns believes that the fundamental insights achieved in REMEMBER will help to reshape our understanding of the complex evolutionary relationship between bacteria and viruses.

“We were able to show how there is a continuous update of CRISPR systems, and how this is achieved,” he notes. Brouns says that scientists in the United States have shown how CRISPR memories can be used for biological data storage. Computer images for instance can be converted into DNA sequences and stored in CRISPR systems.

Brouns is currently building up a bacteriophage (the viruses of bacteria) biobank. “One possibility is that these could be alternatives to antibiotics,” he adds. “There is still a lot of research ahead before we can think of clinical use. The big question though, is whether these could one day be used as therapeutics, and if we can prevent bacteria from becoming resistant to viruses with their CRISPR systems.”

REMEMBER

- Hosted by Delft University of Technology in the Netherlands
- Funded under H2020-ERC
- cordis.europa.eu/project/id/639707
- Project website: brounslab.org



AGENDA

MARCH 2021

WORLDWIDE
International Women's Day

**8
MARCH**

**15 → 19
MARCH**

ONLINE
S4D4C Final Networking Meeting
→ bit.ly/3fc2w2r

ONLINE
UNISECO Final Conference
→ bit.ly/UNISECO

**18 → 19
MARCH**

**21
MARCH**

WORLDWIDE
International Day of Forests & World
Down Syndrome Day

ONLINE
EuroHPC Summit Week
→ bit.ly/EuroHPC-Summit

**22 → 26
MARCH**

**29 MAR
→ 1 APR**

ONLINE
World Bio Markets Congress
→ winwind-project.eu/conference

**MORE
EVENTS**

[cordis.europa.eu/
news](https://cordis.europa.eu/news)

**1-2
MARCH**

BRATISLAVA, SLOVAKIA

15th European Nuclear Energy Forum

The forum will be an occasion for broad discussion among all stakeholders on the opportunities and risks of nuclear energy. The topics will be chosen in a way to allow discussions linked to the energy challenges faced by the EU Member States. Founded in 2007, ENEF annual forums take place alternatively in Bratislava and Prague. These are open to everyone with an interest in nuclear energy.

→ bit.ly/15th-ENEF

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.

JOIN US TO CELEBRATE THE **100th** ISSUE OF RESEARCH*EU MAGAZINE!

Some of our eagle-eyed readers may have already realised that the magazine you're holding in your hands right now is issue 99 and so in March we'll naturally reach the 100th edition of Research*eu!

CORDIS thus cordially invites you to celebrate this important landmark with us after a decade of bringing you the most innovative EU-funded research results.

We'll be marking our big 100th within the magazine itself and, throughout the month of March, on our dedicated social media channels, where we'll be running polls, games and other such frivolities.

Many thanks for sticking with us for all this time – and here's to the next 100!



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