



#102

MAY 2021

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SPECIAL FEATURE
EU RESEARCHERS TACKLE
POLLUTION FOR A CLEANER,
GREENER EUROPE

Editorial

Innovative solutions for achieving a pollution-free Europe,
how a feisty SME adapted its cutting-edge diagnostic technology
to aid in the fight against COVID-19 and celebrating the launch
of Europe's largest ever astronomy network

Welcome to this month's Research*eu magazine

When your editor was a primary school child, he remembers several geography lessons that went into very scary and graphic detail on the terrible effects of acid rain and how human activities were responsible for such a hideous form of pollution. In hindsight, acid rain really does seem to have been the in-vogue form of pollution that caused (with very good reason) so much anxiety in the 1980s and 1990s and is your editor's first real recollection of being confronted with the notion of pollution... well, those geography lessons and the fabulously kitschy 1990s cartoon 'Captain Planet and the Planeteers' that taught children the importance of protecting the environment and fighting pollution (YouTube it if you don't know it, it's truly excellent).

Thankfully, acid rain is not a form of pollution that is a commonplace in Europe today but there are other pollutants that do cause real damage to both human health and ecosystems. Citizens tend to complain most about noise and odour pollution as common bugbears in their everyday lives, but poor air quality is definitely a major challenge that needs to be addressed – one 2018 report from the European Environment Agency (EEA) wrote that up to 400 000 premature deaths can be attributed to air pollution each year, a truly staggering number.

The EU is not sitting on its laurels though with regards to tackling pollutants. As part of the European Commission's wide-reaching European Green Deal initiative, it is due to shortly launch an ambitious

EU Zero Pollution Action Plan in spring 2021. This aims to create a toxic-free environment across the EU by monitoring, reporting, preventing and – where necessary – remedying pollution from air, water, soil and consumer products. Of course, such an ambition requires the back-up of innovative research and development into novel solutions, and would you believe it, in this month's special feature we highlight seven EU-funded projects that have been doing just that!

Moving on, **Project of the Month** celebrates the launch of a major new milestone, that being the creation of Europe's largest and most far-reaching astronomy network which will really provide a boost to European efforts and contributions to working out the mysteries of the vast cosmos above us. In **Life After**, we catch up with Israeli SME MeMed Diagnostics that was funded under the **AutoPilot-Dx** project and find out how they have actively adapted their novel diagnostic assay to contribute to the fight against COVID-19. And as always, our final page is reserved for **EU Agenda** which provides an overview of the (primarily online) events taking place that could be of interest to you, our dear readers. At the risk of sounding like a scratched record as we say this every month, do check regularly the status of any event that you're interested in!

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

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A point-of-care microdevice for accurate cancer diagnosis

Presently, most cancer-related biomarkers exhibit limited diagnostic capacity and low specificity. A European initiative has developed an innovative biosensor that can accurately measure biomarkers in body fluids at the point of care with great sensitivity.

There is solid evidence that many cancers contain a small population of cancer-initiating or cancer stem cells responsible for tumour onset, relapse and therapy resistance. These cells also seem to have the ability to migrate to distant sites and cause metastases. However, methodologies for detecting cancer stem cells and incorporating them into routine cancer diagnosis or for monitoring response to therapy are laborious.

A PORTABLE DEVICE FOR DETECTING CANCER-RELATED BIOMARKERS

The EU-funded BIOCDx (A miniature Bio-photonics Companion Diagnostics platform for reliable cancer diagnosis and treatment monitoring) project has developed an ultrasensitive point-of-care device for the measurement of cancer biomarkers in whole blood samples. "Our goal was to generate a robust tool for fast cancer diagnosis that will facilitate improved clinical decisions," explains project coordinator Ioanna Zergioti.

The device incorporates a microfluidics cartridge enabling the filtration of blood samples towards plasma and the selection and transfer of minute amounts of sample to the detection unit. Detection of circulating protein biomarkers is performed by a sandwich bioassay which uses nanoparticles to enhance the sensing optical signal.

Utilisation of ultrasensitive photonic elements offers a 100-fold improvement in sensitivity compared to current technologies. Moreover, miniaturisation of the sensor enables development of a portable device that can be used at the point of care.

The BIOCDx device is set up to detect the cancer stem cell-specific transcription factor TWIST1, which has a role in cancer metastasis. TWIST1 controls the expression of the blood

circulating protein periostin and procollagen C-proteinase enhancer protein (PCOLCE), both thought to be involved in tumour development and progression.

The different platforms are integrated into a portable device and have been tested using blood and plasma samples from patients with breast cancer or prostate cancer as well as healthy volunteers. An added bonus is that the BIOCDx device can be adapted to enable diagnosis of other diseases.

REINFORCING INDUSTRIAL TECHNOLOGY LEADERSHIP IN EUROPE

"BIOCDx was an industry-driven effort that brought together key players from the fields of sensors, microfluidics, smart medical devices and systems, as well as biopharmaceuticals," emphasises Zergioti. Participating SMEs have infused their know-how and experience into the key components and innovations of the BIOCDx technology.

The multidisciplinary collaboration in the BIOCDx project gave rise to a new generation of smart medical devices with functionalities comparable to existing highly specialised hospital equipment. These miniaturised smart

“ Our goal was to generate a robust tool for fast cancer diagnosis that will facilitate improved clinical decisions. ”



systems also offer significant improvements in terms of size, cost and affordability, reliability and robustness, low power consumption and user acceptability.

BIOCDx has also contributed to strengthening Europe's position and competitiveness in the manufacturing of miniaturised smart systems. The technological knowledge gained during the project has led to the PhosPrint spin-off company for the design and development of high-quality laser bioprinting systems. In addition, LioniX International partnered with other EU companies to develop diagnostic platforms for cancer detection in urine, while a commercial point-of-care instrument is under way at the same company for the diagnosis of coronavirus.

According to Zergioti: "We have demonstrated that the cooperation between universities, high-tech companies and industrial partners can lead to integrated systems with high market potential."

BIOCDX

- Coordinated by the Institute of Communication and Computer Systems in Greece
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/732309
- Project website: biocdx.eu

Gold nanoparticles deliver greater diagnostic sensitivity

Nature-mimicking nanoparticles could revolutionise medical diagnostics and open the door to the next generation of antiviral drugs.



“The key potential benefits we identified in using rSAMs were robustness, ease of manufacturing and short lead times combined with low cost,” says Sellergren. “For instance, virus antigen-based tests today currently rely on expensive and often difficult to produce antibodies. Overcoming these hurdles could speed up pandemic response actions and increase global testing availability.”

SENSITIVE DIAGNOSTIC TECHNIQUES

So the rSAMs-NANO project set about examining whether the application of rSAMs could improve on existing medical diagnostic and therapeutic techniques.

“This research was inspired by previously published work on nanoparticle-based pathogen inhibitors,” explains Sellergren. “For instance, glycan-decorated gold nanoparticles were shown to have promising inhibitory properties on bacteria and virus particles.”

These nanoparticles lacked the dynamic, biomimetic features of rSAMs. To test their hypothesis, the project team deposited rSAMs as adaptable shells on gold core nanoparticles, to see if greater diagnostic sensitivity could be achieved.

“We systematically investigated the influence of gold nanoparticle size, anchor layer properties and rSAM composition on the stability of the core-shell particles,” adds Sellergren.

“We were able to identify a unique combination that allowed us to achieve stability.”

The efficiency of these dynamic shell nanoparticles in detecting infection was trialled using capsid proteins and inactive virus particles. Nanoparticle sensors for example were validated against different influenza virus strains.

Self-assembled monolayers (SAMs) – layers of organic molecules that assemble spontaneously on surfaces – are an important element of modern nanotechnology. Potential applications include the fabrication of extremely thin insulator films and nanoscale electronic devices.

“Reversible self-assembled monolayers (rSAMs) are able to reversibly assemble on charged surfaces, to form molecularly defined layers,” notes rSAMs-NANO (Nanoparticles with switchable shells for virus sensing and inhibition) project coordinator Börje Sellergren, professor of Biomedical Technology at Malmö University, Sweden. “This behaviour gives them some potentially interesting biomimetic properties.”

In particular, Sellergren and Marie Skłodowska-Curie research fellow, Yulia Sergeeva, were interested in whether rSAMs could be applied to mimic the way cells interact with their surroundings or their encounters with pathogens. This could be very useful in the fields of tissue engineering and biosensing, and eventually in developing ways of inhibiting virus-host cell interactions.

In these experiments, the project discovered that the ligand-modified nanoparticles interacted strongly with their receptors. “Furthermore, ligand mobility significantly strengthened target binding. This in turn led to detection sensitivities that exceeded those seen with alternative receptors such as antibodies.

“Ultimately, we were able to show that we could produce stable, gold-core rSAM-shell nanoparticles,” says Sellergren. “These were then shown to interact strongly with their receptors.”

BIOSENSING BREAKTHROUGH

These findings could represent a significant breakthrough in biomimetic biosensing and diagnostic techniques. The materials pioneered in the project have been patented by the inventors and are being exploited by a small start-up company established following project completion. Licence agreements are currently being negotiated.

The techniques pioneered through the rSAMS-NANO project could conceptually also be used to inhibit virus entry by blocking the receptor at the early stages of

“With this Marie Skłodowska-Curie Actions programme project, we also sought to support a researcher with exceptional skill in this field.”

infection. This could be of interest to the pharmaceutical sector, with a view to eventually developing next-generation antiviral drugs.

“With this Marie Skłodowska-Curie Actions programme project, we also sought to support a researcher with exceptional skills in this field,” notes Sellergren. “These skills matched perfectly with what we required in order to progress towards our goals.”

RSAMS-NANO

- Coordinated by Malmö University in Sweden
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/794999
- Project website: bit.ly/3rQ9hg1

HEALTH

Taking the long view in suicide prevention

A unique project in Iceland followed 4 000 children to investigate how the social environment affects biological reactions, emotions and behaviour.

The EU-funded project LIFECOURSE (A multilevel analysis on the effects of stress on biology, emotions and behaviour throughout childhood) is a unique longitudinal study which draws together information on personal, social and biological features of young people’s lives. The goal is a greater understanding of how these factors interact to influence the development of emotional reactions such as depression and anxiety as well as behaviours such as substance use, self-harm, suicidal behaviour and delinquency among young people.

SUBSTANCE ABUSE

“I’ve been working in this field of understanding what explains outcomes in children and adolescents for over 20 years,” says LIFECOURSE project coordinator Inga Dóra, who set up the website in Icelandic (Icelandic Centre for Social Research and Analysis) (ICSRA) in 1999.

“While we know quite a lot about the effects of the environment on different outcomes, we were seeing



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5-10% of children lost in substance abuse every year, so that was one of the drivers for this project,” explains Dóra.

The ICSRA has published over 150 studies in the last two decades, focussing on what predicts mental health and behaviour among young people. The primary prevention model to decrease substance abuse among young people, now used in over 30 countries across five continents, is based on these studies.

Reykjavik University in Iceland provided an excellent setting for the project, as the country is enthusiastic about societal data collection, with the first census carried out in 1703. A large amount of data is collected on individuals from pre-birth to adulthood, but much of it appears in separate databases that are not cross-linked.

BIRTH THROUGH ADOLESCENCE

The LIFECOURSE project retrospectively followed the entire cohort of children born in 2004, over 4 000 individuals, charting their lives through the birth registry, school health assessments, unemployment and deprivation statistics, and reports from child protection services. The data was cross-referenced and additional measurements added by taking saliva samples and using questionnaires from over half the cohort at ages 12, 13 and 14.

“There are thousands of questions we can now answer with this data.”

As a result, the LIFECOURSE data represents the first multilevel cohort study that combines biological, behavioural and social data from before birth through adolescence for an entire population birth cohort of adolescents.

The project was supported by funding from the European Research Council. “With this funding the project was made possible,” adds Dóra. “Without that we would not have been able to do this.”

A WEALTH OF INFORMATION

Key questions that the LIFECOURSE project seeks to answer are how stress affects physiology, emotions and behaviour, how the community level and individual level of stress interact over time, and whether the impact of childhood stress is reversible. “We’re in the midst of crunching the data, and will answer these questions in numerous papers in years to come,” says Dóra.

“This is only a tiny bit of what we’ll be able to find out. There are thousands of questions we can now answer with this data. The idea was to create an infrastructure that would allow scientists with different focuses to come together, in order to answer questions on how to plan and support policies.”

Dóra adds that she and her team are now reaching out to scientists from around the world to work with the ICSRA on drawing findings from the LIFECOURSE data.

LIFECOURSE

- Hosted by Reykjavik University in Iceland
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/647860
- Project website: bit.ly/LIFECOURSE-project



LIFE AFTER...

Catching up with AutoPilot-Dx: Utilising novel biomarker-based assay technology in the fight against COVID-19

*In the April 2020 issue of Research*eu we featured the AutoPilot-Dx project that had developed a novel assay to accurately diagnose between bacterial and viral infection, thus helping efforts to avoid the unnecessary prescription of antibiotics. In the rollercoaster year since, the project team have, with the continued support of the EU, shifted their attention to COVID-19. Tanya Gottlieb, vice-president of Scientific Affairs at coordinating company MeMed Diagnostics, tells us more.*

Following the successful development of their novel assay, partners in AutoPilot-Dx (Fast tracking market adoption of a novel immune-based diagnostic for improving antibiotic stewardship: automation, piloting and health economics) had been in the process of developing a point-of-care platform called Key that would allow the test, according to the signature based on three host protein biomarkers called BV that react differently to bacterial and viral infection, to be performed when and where needed and provide a result within 15 minutes. "This has now been completed, a CE mark has been obtained and we expect to have an FDA approval sometime in 2021," Gottlieb says. "Today, the Key platform administering the BV test is in routine use at early access medical centres in Germany and Israel."

Joining the battle against COVID-19

Moving on to develop BV and Key further, MeMed Diagnostics won a second

EU-funded grant and began the DECODE project. "This project was originally focused on advancing our previous work under AutoPilot-Dx but as the pandemic progressed, we turned our focus to investigating potential applications of the BV biomarkers in COVID-19 patient management," explains Gottlieb. "To support these efforts, the Commission was happy to permit the rescoping of DECODE."

In 2020, the MeMed team under DECODE has supported the development of a new product for early detection of severity in COVID-19, based on data collected from medical centres in Germany, Israel and the United States.

"We have applied machine learning to derive a new signature comprising the three original BV biomarkers that indicates the likelihood of a patient infected with SARS-CoV-2 progressing to severe disease outcomes, including sepsis, respiratory failure and mortality," adds Gottlieb. "This novel signature is the basis for a product called 'MeMed COVID-19 Severity' and we're now collecting SARS-CoV-2 patient samples for the purpose of its clinical validation." MeMed anticipates being ready to apply for regulatory approval in Europe and the United States in Q2 2021.



Finally, the company is also working towards compatibility of its tests with whole blood as currently serum is required, which will expand the utility of MeMed BV and MeMed COVID-19 Severity to additional clinical settings.

"EU funding has been instrumental in supporting the maturation of our products and all of this is ultimately to ensure that we can have a positive impact on patients and improve EU healthcare overall," Gottlieb concludes.

AUTOPILOT-DX

- Coordinated by MeMed Diagnostics in Israel
- Funded under Horizon 2020-Societal Challenges and Horizon 2020-Industrial Leadership
- cordis.europa.eu/project/id/701088
- Project website: autopilotdx.org



Tanya Gottlieb
Vice-president of Scientific Affairs, MeMed Diagnostics
© MeMed, Tanya Gottlieb

“EU funding has been instrumental in supporting the maturation of our products and all of this is ultimately to ensure that we can have a positive impact on patients and improve EU healthcare overall.”

Making history: crafting a shared cultural identity in Europe

Who gets to define what makes a European? Researchers say this is a job for everyone, not just policymakers.

The European Heritage Label is a scheme launched in 2006 that recognises buildings, documents, monuments and events which are seen as milestones in the creation of modern Europe. It's one of a number of programmes that seek to foster a European identity through a shared cultural heritage, contrasted to ideas of national identity.

The EUROHERIT (Legitimation of European cultural heritage and the dynamics of identity politics in the EU) project sought to examine these programmes critically, investigating the political and social drivers that shape the notion of a European identity.

"Through these initiatives the very idea of common or shared European cultural heritage is governed and created," says project coordinator Tuuli Lähdesmäki. "These are institutions that are not only seeking to promote the existing cultural heritage, but at same time setting out what it might mean."

COLONIAL HISTORY

"The narrative of this heritage," explains Lähdesmäki, "stems from the EU's values discourse, such as those expressed in the Treaty of Lisbon: equality, tolerance, human rights and



“There isn’t one narrative, or one history of Europe’s past; there are competing and contradictory narratives.”

more. It ties those to physical places and environments which manifest these values.”

“There are interesting elements in how the heritage discourse promotes the idea of the EU as a representative of these different values, in a way that might be a bit difficult to object to,” adds Lähdesmäki.

“In a way, if you were objecting to the heritage narrative, then you are against these core values – democracy, peace and so on. That kind of implicit tone is included in this heritage discourse.”

The project of cultivating a shared European identity also meant articulating what was not European – the creation of an ‘other’, according to Lähdesmäki.

“The sites given this award are not dealing with the history of minorities, for example, or of colonialism and imperialism, which is also part of the common history of Europe.”

“In the future, there will be heritage sites which recognise these elements of European history as part of the EU’s narrative on European cultural heritage.”

Lähdesmäki, an associate professor at the University of Jyväskylä in Finland, says the EUROHERIT project emphasises that no singular body can lay claim to defining Europe’s cultural identity and shared history.

“This is an ongoing process in which new perspectives and reinterpretations of the past are constantly emerging. There is no apolitical discussion of cultural heritage, it’s everyone’s task to participate,” explains Lähdesmäki.

“Of course, the EU is enabling various projects in which heritage is dealt with, so the EU has an important role in

that. But all conservation projects need to consider what they are conserving, and what they are saving for future generations.”

COMPETING NARRATIVES

The project was supported by the European Research Council. “This funding really enables the use of methods that take a longer time, like broad ethnographic research, and without this it would have been impossible to implement,” notes Lähdesmäki.

As a result of the project, Lähdesmäki and her team created three policy briefs. One, targeted at Finnish cultural policymakers, encouraged participation in the European Heritage Label scheme – a recommendation that was taken up.

The other two, addressed to EU officials, laid out suggestions for ways to improve the process of selecting European Heritage Label sites.

“There isn’t one narrative, or one history of Europe’s past; there are competing and contradictory narratives,” concludes Lähdesmäki.

“Discussion of Europe’s past is an ongoing process, we need to examine what events from the past we want to remember and share as cultural heritage, and also take into account flexibility, variety and self-reflection, in how we define our cultural heritage, how we tell the story of Europe and its history.”

EUROHERIT

- Hosted by the University of Jyväskylä in Finland
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/636177
- Project website: bit.ly/EUROHERIT

Remembering complex histories of violence

Rather than being singular acts, complicity with oppressive regimes and resistance against them are a fluid continuum that blurs the line between victim and perpetrator.



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How do societies remember past violence, and in particular, widespread complicity with that violence? That is the central question of the EU-funded project GREYZONE (Illuminating the ‘Grey Zone’: Addressing Complex Complicity in Human Rights Violations), which examined the limitations of transitional justice institutions’ processes of accountability for past violations of human rights.

“We were looking at authoritarian regimes, apartheid and military dictatorships,” explains project coordinator Mihaela Mihai. “We were particularly interested in finding out how both widespread complicity and forms of resistance that don’t conform with a heroic model tend to be erased from public memory.”

The project, supported by the European Research Council, focused on three goals. First, to conceptualise complicity with state violence by offering a structurally and

temporally attuned account of responsibility. Secondly, to conceptualise resistance in a way that challenges the dominant ‘hero-elect’ model. And finally, to assess artworks’ capacity to open up uncomfortable public conversations about complicity and resistance in a way that challenges the erasures of complicity.

LEGAL IMAGINARY

Transitional justice is limited in its ability to conceptualise complicity with state violence, says Mihai, because it is evolved from a legal imaginary. “Many scholars and advocates of transitional justice come from the legal profession, where the understanding of political responsibility is modelled on legal responsibility,” she notes.

Legal responsibility tends to focus on a clearly identifiable act committed by an individual at a certain moment in time. “Within enduring repressive regimes, you can start as a victim and end up as an accomplice. Law is therefore a very blunt instrument for addressing the structural, temporal and spectral nature of violence,” continues Mihai.

GREYZONE examined four different case studies: authoritarianism and military occupation in Vichy France, colonial apartheid in South Africa, communist authoritarianism in Romania and military dictatorship in Argentina.

In each case, Mihai and her colleagues at the University of Edinburgh found that individuals differed in their reaction to, and participation in, systemic violence.

The group also sought forms of what Mihai calls ‘impure resistance’ by individuals who sometimes resisted, sometimes cowered, out of fear, personal ambition or desire to protect loved ones.

This picture stands in contrast to: “The normative model of the hero-elect, conceptualised as sovereign,

“We were particularly interested in finding out how both widespread complicity and forms of resistance that don't conform with a heroic model tend to be erased from public memory.”

unencumbered, courageous, usually a man, featuring exceptional virtues and resilience, whose commitment is unwavering,” says Mihai.

IMPURE RESISTANCE

Finally, the team also pored over film and literary works that revealed the many faces of both complicity and resistance, in their complexity.

“Art can often more powerfully disclose, problematise and politicise memory, in a way that, for example, trials and commissions of inquiry cannot,” explains Mihai. “Artworks inspire the public – intellectually, emotionally, sensorially – to embrace a more complex view of both complicity and resistance.”

By highlighting acts of solidarity and resistance that are not recognised as such, Mihai and her colleagues aim to give them visibility. They hope this will expand people's imagination of what they can do in response to various forms of repression.

“Because it is the exception, the heroic model is alienating,” adds Mihai. “If what it takes is a hero, many of us will feel discouraged, when in fact impure resistances will have an important impact under repressive political conditions.”

The results of the study have been published in a variety of international outlets, and Mihai's own contribution is the subject of her forthcoming book, ‘Caring for Memory: The Arts of Complicity and Impure Resistances’.

GREYZONE

- Hosted by the University of Edinburgh in the United Kingdom
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/637709
- Project website: bit.ly/greyzone-project

SOCIETY

Innovative approach elucidating the medieval history of the Horn of Africa

An EU-funded project explores the territory and the material remains of the Sultanate of Adal from an archaeological angle.

The cultural landscape of the Sultanate of Adal, a state that controlled much of what is now Somaliland and southern Ethiopia during the 15th to 16th centuries, played a vital role in some of the most significant events in the modern history of the Red Sea. The state's history, while known through some written sources, has never been thoroughly investigated from an archaeological viewpoint.

A LANDSCAPE ARCHAEOLOGY PERSPECTIVE

The project MEDLAND_HORN.AFRICA (Medieval landscapes in the Horn of Africa. State, territory and materiality of the Adal Sultanate (15th-16th centuries AD)), with a focus on western Somaliland, set out to explore the relationships between the different communities that

“... we increase our understanding of how communities with radically different lifestyles, material cultures and landscapes could build shared identities and work together.”

lived in the region and how they built a shared landscape integrated into international economic systems. Marie Skłodowska-Curie fellow Jorge de Torres Rodríguez explains: “The project challenged preconceived ideas such as the dichotomies between urban dwellers and nomads and the assumed irreversibility of urbanisation processes. The idea was to understand how and why communities with very different lifestyles could interact, share interests and undertake common activities, and how they related to the state structures that controlled the territory.”

The project launched an ambitious plan for the acquisition and processing of environmental, archaeological and historical data on the Sultanate of Adal. A key result from this was a geographic information system database that gathers archaeological and geographical information available on western Somaliland. A series of publications presenting the archaeological results of the project and an interpretative framework, which, for the first time, addresses the relationships between nomads and settlements in Somaliland from a cohesive point of view, was also produced. “From this interpretation, we increase our understanding of how communities with radically different lifestyles, material cultures and landscapes could build shared identities and work together,” notes de Torres Rodríguez.

Project work has helped build a more accurate, historicised discourse on Somalia, a region whose deeper past is poorly known, and has paved the way for the Somaliland public to find out more about their archaeological heritage. Widespread interest in Somaliland archaeology, driven by the project, is also helping to raise awareness of the need to protect it.

MORE QUESTIONS THAN ANSWERS

While achieving profound results, the project’s work also led to many unanswered questions. De Torres Rodríguez explains: “We have gathered a significant amount of information about the archaeology of the medieval period in Somaliland, and we have laid the foundations for an interpretative framework for the communities that inhabited the territory, but as research progressed, we realised that the relationships between these groups were just one facet of a far more complex reality.” Therefore, the project’s research has acted as a ‘trigger’ for a new way of understanding the medieval archaeology of Somaliland, and beyond the specific deliverables.

A CONTINUED FOCUS ON SOMALILAND

De Torres Rodríguez will further his archaeological research in Somaliland in a new EU-funded project, StateHorn. “It aims to understand the reasons that made the medieval states of the Horn of Africa very stable in comparison to the current problems of governance the region faces nowadays.”

StateHorn will grow from the actions of this project and incorporate the data and experience generated during it. “Many of the deliverables will be adapted and expanded for the new project, to guarantee that the information generated by MEDLAND_HORN.AFRICA will continue to be published and disseminated in academic and social forums,” he concludes.

MEDLAND_HORN.AFRICA

- Coordinated by the Spanish National Research Council in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/795442
- Project website: bit.ly/medland-africa





TRANSPORT AND MOBILITY

What makes time spent travelling worthwhile?

Transport planners often focus on minimising travel time, but an EU-funded project has shown that 'time well spent' can be just as important for users choosing a particular mode of transport.

Does the daily commute feel like wasted time? A time of stress where you feel you could be doing something more useful and productive?

A major EU-funded survey of 3300 people in eight EU countries, each recording between 7000 and 10000 trips, has found that better travel experiences or being able to carry out certain activities while travelling are at least as important to travellers as time and/or money spent on the trip.

"This could lead to a new definition of worthwhile travel time, which could be important for designing more sustainable mobility systems that people actually want to use," says MoTiV (Mobility and Time Value) project coordinator Ghadir Pourhashem, senior researcher in intelligent transport systems, University of Žilina, Slovakia.

The project gathered data on positive and negative perceptions of travel time in Belgium, Finland, France,

Italy, Norway, Portugal, Slovakia and Spain using a 'crowdsourcing' type Woorti smartphone app devised by the MoTiV project team.

The app automatically detects trips and modes of transport as well as changes between modes. Users entered further details on their travel experience via the app.

Information was collected across different transport modes – private cars, long-distance and short-distance public transport, buses, cycling and walking – balanced by gender, age group and geographical coverage.

TRAVELLERS DON'T NECESSARILY WANT TO LIMIT TRAVEL TIME

"The biggest surprise was that people want enjoyable travel time," Pourhashem adds. "If they enjoy it, they don't necessarily want to minimise their travel time."



“Our results make the case that, from a traveller’s perspective, the experience of travel matters and should have a central role in transport planning.”

“If a traveller feels their trips are worthwhile because it can boost fitness – as is the case with walking or cycling – or enjoyment of scenery, or productivity because they can read or use mobile phones while travelling, then they may not mind travelling for longer,” Pourhashem explains.

The project focuses on the traveller’s experience and uses a multimode approach, whereas transport planners normally gather information on a specific mode of transport.

For short-distance public transport, reliability of travel time and a smooth ride were key. Doing paid work while en route is less important. Car drivers are less likely to think their travelling time is worthwhile.

NEW APPROACH TO MOBILITY PLANNING

“The project provides valuable data and evidence for investing in higher-quality transport as an alternative to investing in speedier transport,” Pourhashem says, noting: “Overall our results make the case that, from a traveller’s perspective, the experience of travel matters and should have a central role in transport planning.”

For example: “Most of our transport planning is geared to men’s mobility needs. Now it is time for city planners and transport authorities to consider other aspects, such as the generational and gender dimension,” Pourhashem says.

He points out that women may need to use prams on public transport systems. And if obstacles can be removed, or other negative experiences such as crowding, poor seating quality and reliability improved, it would lead to higher use of public transport by certain groups.

The MoTiV project will help to improve the appraisal of transport projects with a new user-focused ‘worthwhileness index’ based on the level of productivity, fitness and enjoyment. “The next research challenge is to quantify ‘worthwhileness’ in monetary terms so that estimates can be embedded more easily in conventional appraisals,” adds Pourhashem.

Future mobility systems should aim for zero ‘wasted’ time in travel, rather than small reductions in travel time on inherently wasteful transport modes, he concluded.

MOTIV

- Coordinated by the University of Žilina in Slovakia
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/770145
- Project website: motivproject.eu
- ▶ bit.ly/motiv-video

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Helping business set up alternative transport systems

Residents in remote areas with few buses, disabled professionals in need of a ride to attend last-minute appointments and women travelling in dangerous neighbourhoods are all citizens at risk of 'transport poverty'. The HiReach research initiative supported start-ups to tackle the problem.

The unemployed and the low paid can struggle to pay for bus fares or buy and maintain a car to travel to daily activities. These are just two examples of European citizens at risk of 'transport poverty', as identified by the EU's HiReach (High reach innovative mobility solutions to cope with transport poverty) research project.

Others include people living in villages where few buses run, elderly residents who can't negotiate cheaper, online ticketing services or women who feel unsafe on public transport.

Some 25 start-ups tested flexible transport solutions for different social groups poorly served by traditional transport options like scheduled buses and trains and taxi services. Nine of them said that, by the end of the EUR 2 million programme, they had moved to the stage where they were ready to launch on the market.

"HiReach demonstrated that the role of informal groups and local associations is often crucial in order to solve transport poverty issues," says Simone Bosetti, transport engineer at Italian transport consultancy TRT Trasporti e Territorio.

"In deprived territories, public transport operations are financially risky and often not profitable or cost-covering."

TRT coordinated the eight-partner consortium, including a partnership with Impact Hub Vienna, which helps grow start-ups designed to benefit society.

The researchers first analysed the mobility needs of different social groups in six regions in Germany, Greece, Italy, Luxembourg, Portugal and Romania.

They interviewed ethnic minorities, migrants, disabled and elderly citizens, young people, women and low earners about their daily routines and travel choices and

wishes. The team identified the limitations in current transportation services and wrote the open-access book 'Re-thinking Mobility Poverty: Understanding Users' Geographies, Backgrounds and Aptitudes'. This explores mobility inequalities and redefines the concept of 'transport poverty'.

SOCIAL VISION

The project partners came up with a series of recommendations to develop inclusive, affordable and reliable mobility solutions. Groups from across Europe brainstormed ideas with start-up specialists at a week-long bootcamp in Vienna and went on to develop business plans and to test them in real-life conditions.

The businesses developed are social enterprises such as Spanish start-up Hoopcarpool, which connects drivers and passengers through carpooling, so people can share rides.



© DGLimages, Shutterstock

“*The HiReach Startup Lab has had direct impacts on local communities and the vulnerable groups involved.*”

It includes features such as a wheelchair space and an ‘only women’ option.

“We wanted to have a social impact”, explains entrepreneur Andrea García speaking on the project’s video.

Also based in Spain, Nemi enables the flexible provision of buses in low-population areas while Childfy connects families with children for carpooling, with the aim of creating a better work-life balance.

Many of the start-ups use new technologies to offer customers more flexible on-demand journeys. With the slogan ‘See the world through your ears’, Austrian start-up

Dreamwaves uses augmented reality for its routing app to help visually impaired and blind people to travel more independently. British start-up CityMaaS is a journey planner for reduced mobility people that makes use of artificial intelligence technology.

The innovators developed their technologies faster thanks to the market research and the intensive feedback received from start-up experts during HiReach. “The HiReach Startup Lab has had direct impacts on local communities and the vulnerable groups involved,” adds Bosetti.

HIREACH

- Coordinated by TRT Trasporti e Territorio in Italy
 - Funded under Horizon 2020-TRANSPORT
 - cordis.europa.eu/project/id/769819
 - Project website: hireach-project.eu
- ▶ bit.ly/HiReach-video

TRANSPORT AND MOBILITY

Online repository highlights security and safety advances in aviation

The EU wants safer and more secure aircraft, with Horizon 2020 spearheading relevant innovation. Thanks to OPTICS2, stakeholders now have an overview of remaining gaps and recent achievements.

The European Commission has a vision for the future of European aviation called Flightpath 2050. One of its key goals is to ensure the security and safety of all types of aircraft, with less than one accident per 10 million commercial flights. Numerous related Horizon 2020 projects have been funded to get us there. But there is one problem: the absence of a real overview of everything that’s being done in research. Simply put, we don’t have enough means to ensure that the EU is on track to meet its targets.

OPTICS2 (Observation Platform for Technological and Institutional Consolidation of research in Safety and Security) addresses that problem with a comprehensive assessment of relevant security and safety projects in the

air transport field. “We deliver a yearly state-of-the-art report on European aviation safety and security research. Each report identifies research gaps and bottlenecks for innovation, while providing the European Commission with recommendations on how to best address them,” states Micol Biscotto, coordinator of OPTICS2 and project manager at Deep Blue.

The project consortium actually keeps all stakeholders in the loop. EU agencies and national authorities receive the project’s views on progress towards Flightpath 2050 goals, blocking issues and advice on future Strategic Research and Innovation Agenda (SRIA) revisions. The Advisory Council for Aviation Research and Innovation in

Europe (ACARE) and industry are informed of the state of the art in aviation safety and security research, as well as past and ongoing research on specific topics and solutions ready/not ready for adoption. Finally, the research community learns about trending topics and gets a chance to influence the EU Work Programme. It all forms a virtuous feedback loop encouraging innovation.

BENCHMARKING INNOVATION

Besides its reports, the project team feeds the OPTICS2 Open Repository: an online database presenting the state of the art in research in an engaging, comprehensive and interactive manner. The platform is, according to Biscotto's own words, open source, sustainable, interactive, engaging, simple and intuitive. All stakeholders involved in aviation safety and security research will find something of interest as they navigate it.

"Everyone stands to benefit," Biscotto explains. "EU agencies for example, have a better idea of the level of maturity and ease of adoption of the funded projects, as well as the areas and topics that are not sufficiently covered yet. Meanwhile, the research community and industry will find added value in our benchmarking, which complements well other databases such as CORDIS, the Horizon 2020 Dashboard and TRIMIS."

Much has already changed since the project began in 2017. "Certain areas which were under-researched are now being addressed. There is a substantial number of

“ We deliver a yearly state-of-the-art report on European aviation safety and security research. Each report identifies research gaps and bottlenecks for innovation, while providing the European Commission with recommendations on how to best address them. ”

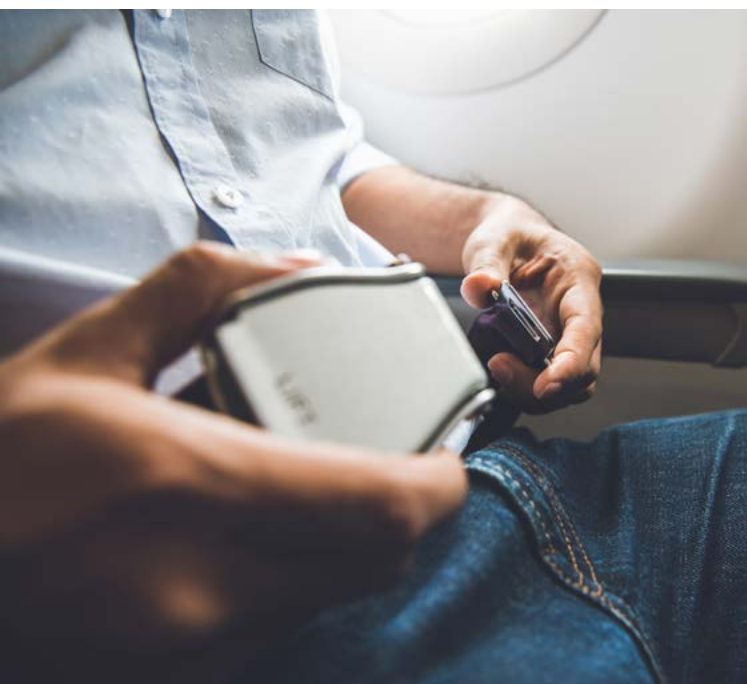
new projects on drones, but also advances in governing safe performance, resilience by design and attempts to integrate human factors already at the design stage in a multimodal setting (aviation and maritime)," says Biscotto. "On security aspects, there have been research advances in building and exploiting security intelligence, for example in forensic methods and resolving incidents related to terrorist attacks. We observed early development of the security radar concept, as well as an attempt to develop a security baseline across all transport modes."

Despite all these positive advances, several research priorities remain and which OPTICS2 doesn't fail to point out. These include matters related to the human role in future aviation, aircraft survivability, certification methods, biological threats and a sector-wide security culture.

The project team is currently working on its 4th-year assessment, which will put special emphasis on investment in research and research contribution to competitiveness, standards and regulations. Biscotto and her peers are also eyeing a future international benchmarking.

OPTICS2

- Coordinated by Deep Blue in Italy
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/770138
- Project website: optics-project.eu





CLIMATE CHANGE AND ENVIRONMENT

World-leading climate models and tools simulate and predict regional climate with unprecedented fidelity in Europe

Imagine being able to look at decadal projections of climate and weather with an even higher resolution – from a 100 km grid view to 25 km. This greatly improves our understanding of the drivers of variability and change in European climate and how to better manage climate risks.

Climate is fundamental to our lives – from our food, water and health to our transport and economy. A better understanding of global climate processes and how they impact our weather and climate, in the past and for the future, is critical given the reality of climate change.

The EU-funded project PRIMAVERA (PRocess-based climate sIMulation: AdvAnces in high resolution modelling and European climate Risk Assessment) has developed some world-leading global climate models that, together with advanced analysis, tell us more about the processes that have driven changes in weather and climate in recent decades and how they might play out in the future.

HIGHER RESOLUTION OPTIMISES RISK MANAGEMENT

“Our seven modelling groups developed new global models with higher resolution (think pixel size of a camera, our new models have pixels 25 km wide whereas the standard models have pixels more than 100 km) that could show us more detail, so that we could better represent weather and climate over Europe and globally,” explains Malcolm Roberts, PRIMAVERA project coordinator. By better modelling both the large scale, such as the midlatitude jet stream, and smaller scales, such as tropical cyclones and extreme storms, it is possible to better quantify future climate risk for people and infrastructure.

In addition to modelling, the team developed new tools to analyse the huge data volumes they produced. This enabled them to look at specific weather/climate features (e.g. blocking, when high pressure stays in one place and can cause summer heatwaves or winter cold snaps) and

whether these might change in the future. These new tools help optimise public and private sector decision-making and increase the capability to manage climate risks.

PRIMAVERA's visualisation tool Data Viewer offers an excellent illustration of what can be achieved when the model resolution is increased.

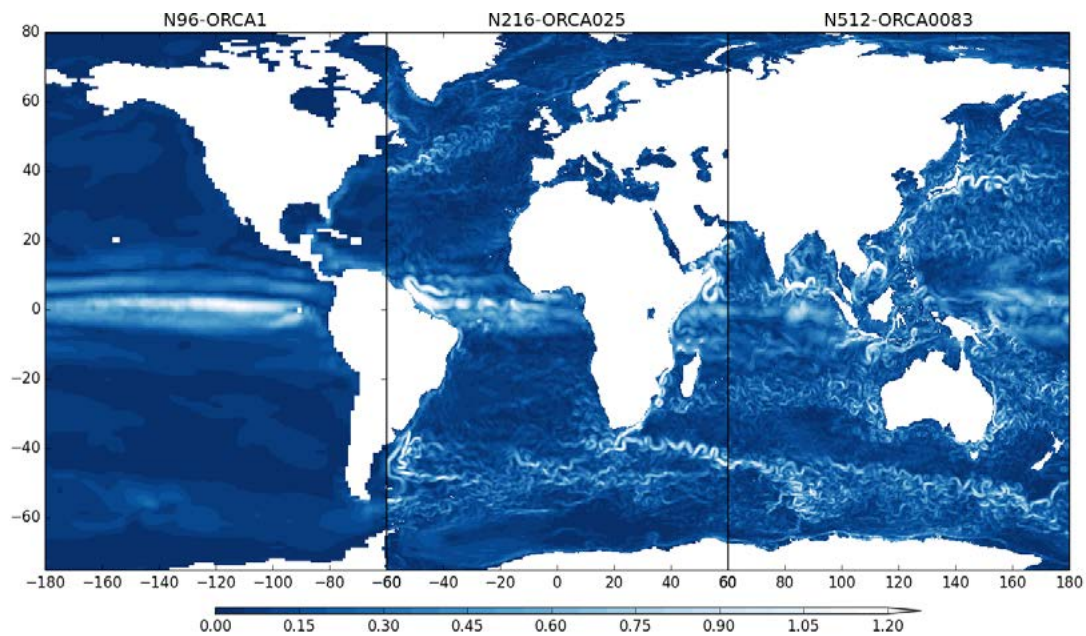
NEW CLIMATE SIMULATIONS ENHANCE INFORMATION

The Intergovernmental Panel on Climate Change's 7-yearly assessment reports deliver climate information from more than 40 international climate modelling groups. However, because of the complexity and expense of running these models on large supercomputers, the spatial detail (resolution) is less than ideal, which can mean they do not properly represent some important weather and climate phenomena.

PRIMAVERA addressed this by developing new climate simulation experiments that would be achievable with its significantly more expensive models that provide insight into what the standard models might be missing. “We've managed to raise the bar on the quality of climate information by doing this and produced useful advice both in terms of policy and for some industry sectors such as renewable energy, insurance and energy grids,” says Roberts.

HOW THE REINSURANCE INDUSTRY IS BENEFITING

The simulations provide new insights into improving the climate models to produce more reliable projections of future change. The project's data sets (about 1.5 PB of data,



equivalent to about 250 000 HD movies) are being used by the whole climate science community for research. The project team produced a catalogue of wind storm events from the models that will be used by the reinsurance industry to assess the risks due to storm damage.

PRIMAVERA

- Coordinated by the Met Office in the United Kingdom
- Funded under Horizon 2020-ENVIRONMENT
- cordis.europa.eu/project/id/641727
- Project website: primavera-h2020.eu
- bit.ly/PRIMAVERA-video

CLIMATE CHANGE AND ENVIRONMENT

Insects, climate change and plant defences – unravelling the connection

Climate change is causing profound impacts on Arctic ecosystems. An EU-funded project investigated the links between higher temperatures, insects and the chemical gases emitted by plants.

The Arctic is warming at twice the speed of the global average. Climate change is altering the region in ways that are unprecedented in recent times, and scientists are trying to figure out what it will all mean.

One perceived change is on the level of volatile organic compounds (VOCs). These are chemicals released by plants to protect themselves from stressors, such as high temperatures and attacks from herbivorous insects. In the Arctic, VOCs have important implications for aerosol formation.

This is key for climate models, as aerosols actually scatter radiation and can counteract climate warming. Previous studies have shown warming to increase Arctic VOCs.

“But note that the cooling impact is estimated to be much less than the warming impact from greenhouse gas emissions,” says Tao Li, assistant professor of Terrestrial

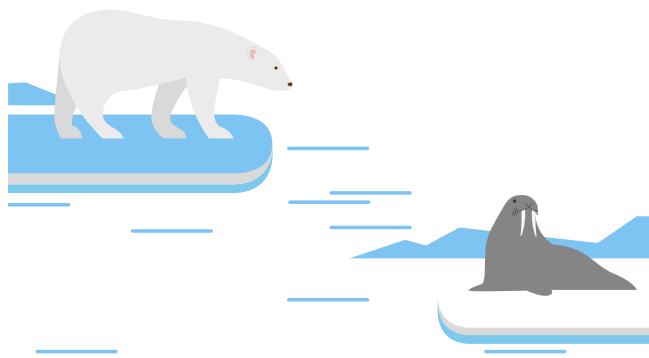
Ecology at the University of Copenhagen, Denmark and Marie Skłodowska-Curie postdoc fellow.

Yet the root causes of the changes are still unknown. To this end, the HIVOL (Herbivore-induced emissions of biogenic volatiles from arctic plants under climate warming) project investigated links between Arctic VOCs, warming temperatures and insect herbivory.

The team worked on several, long-term climate change experiments, which have been running from a few months to several decades. In these experiments, small areas of tundra are heated by open-topped greenhouses attempting to mimic future climate.

“By comparing measurements from the heated areas and the adjacent environments, we can assess climate-induced changes,” explains Riikka Rinnan, professor in the

The Arctic is warming at twice the speed of the global average.



Department of Biology and head of the Rinnan Lab at the University of Copenhagen.

Specifically, the goals were to measure how warming is changing insect attacks on woody plants in the Arctic, how this changes VOC emissions, and how the impacts of insect herbivory should be included in emission models to extrapolate this information to a larger scale.

“Our research shows that warming not only directly increases VOC emissions, but also has important indirect impacts, by increasing insect feeding pressure, for example,” adds Li, lead researcher on the HIVOL project.

UNCOVERING THE LINKS

The impacts of insect feeding varied depending on the plant and insect species in question. Interestingly, the levels of feeding by leaf-chewing insects had stronger effects on VOC emissions than climatic warming itself.

“Surprisingly, warming further enhances the impacts of chewing insects on VOC emissions, and such effects appear to be consistent irrespective of warming duration,” notes Li.



In the boreal mountain birch forest, the team found that the emission rates increased linearly with the extent of leaf damage caused by caterpillar feeding. Also, some specific compounds were only released when moth caterpillars were feeding on the leaves.

These new results could be translated into further research avenues, and for use in monitoring ecosystem changes and informing pest management strategies.

“VOCs could be potentially used as biomarkers for non-invasive detection and monitoring of caterpillar populations in the mountain birch forest,” explains Li.

WHAT'S NEXT?

The Rinnan Lab will continue with further experiments assessing responses in mountain birch forests with different herbivore outbreak histories.

“We will also expand to a larger scale and measure VOC emissions from a whole mountain birch forest, while monitoring insect densities. Our activities in upscaling the responses and modelling will continue benefiting from the results of HIVOL,” Rinnan adds.

HIVOL

- Coordinated by the University of Copenhagen in Denmark
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/751684
- Project website: bit.ly/3cBH0bx

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SPECIAL FEATURE

EU RESEARCHERS TACKLE POLLUTION FOR A CLEANER, GREENER EUROPE

Editorial

“Pollution should never be the price
of prosperity” — Al Gore, environmental campaigner
and former US Vice-President

Pollution affects us all, from the air we breathe, to the water we drink, to the food we eat. Sometimes it may not be very noticeable that we're breathing in polluted air, for example, but pollution is actually the largest environmental cause of multiple mental and physical diseases, as well as premature deaths, particularly amongst children, people with certain medical conditions and elderly citizens. In Europe, noise pollution is the type of pollution most commonly complained about by citizens, but odour pollution is also a regular bugbear for many. However, it is poor air quality that is arguably the most pressing environmental challenge in many European countries – according to one 2018 report from the European Environment Agency (EEA), poor air quality is responsible for over 400 000 premature deaths in the EU each year.

From a social perspective, pollution in all of its various guises does not affect everyone equally. People who live in poorer, more deprived areas tend to be more exposed to pollutants, as these areas are often located close to contaminated sites or near traffic-heavy road arteries. Research has found that those who own their home are less likely to be exposed to pollution than those who either rent in the private sector or reside in social housing. People living in socially deprived areas are also more likely to suffer from chronic health conditions, such as obesity, and these conditions increase vulnerability to environmental pollutants. Early evidence also points to higher death rates from COVID-19 for communities that experience a combination of poverty and high levels of air pollution (though of course, more research is needed to fully clarify these interactions).

The EU already has stringent environmental regulations that aim to tackle all major pollutants in order to benefit human health and preserve biodiversity and healthy ecosystems, the latter of which is a major EU ambition under its far-reaching European Green Deal. Specifically, the new EU Zero Pollution Action Plan, an important element of the Green Deal, is due to be formally adopted during spring 2021. This Action Plan aims to create a toxic-free environment across the EU by monitoring, reporting, preventing and – where necessary – remedying pollution from air, water, soil and consumer products. The 2021 edition of the EU Green Week that takes place every year at the end of May and beginning of June is also dedicated to the zero-pollution ambition.

In this month's special feature, we meet seven EU-funded projects under the Horizon 2020 programme that have been at the forefront of efforts to tackle the scourge of environmental pollutants, including air, odour, marine and tap water contaminants. From innovative apps that help to put citizens in the driving seat to enact positive change to cutting-edge sensors and other devices that can monitor and actively reduce pollution, these projects show that there are many imaginative and technological solutions to a pressing challenge that truly impacts all of us... whether we're really aware of it or not.

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

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ICARUS lights up the path to green cities with new tools to monitor and improve air quality

The path to green cities is full of obstacles. Thanks to air pollution monitoring technologies and improvement recommendations from the ICARUS project, nine European cities are now much closer to overcoming them.

People living in cities have grown used to the notion of air quality. Weather forecasts now systematically mention it and are able to do so thanks to networks of ground-based air quality monitoring devices. But whilst these networks do the job, they are not yet dense enough and their set-up and maintenance are not cheap.

Researchers have tried to move towards geo-statistical methods based on the interpolation of in situ observations to reduce cost and enhance spatial resolution. But uncertainties are a major drawback. They also investigated the use of atmospheric pollution transport models, but these require accurate estimates of initial and boundary conditions as well as high-quality and up-to-date emissions inventories. This information is not always available, while the models themselves demand high computer power and struggle to make predictions for complex terrains," says Denis Sarigiannis, professor of Chemical Engineering at the Aristotle University of Thessaloniki and coordinator of the project ICARUS (Integrated Climate forcing and Air pollution Reduction in Urban Systems).

ICARUS has taken a completely different route. The team optimised existing models and computational techniques to reduce uncertainty through a data fusion approach, developed wearable sensors allowing citizens to assess their exposure, and estimated health impact based on the uptake of pollutants instead of concentration in ambient air. Their key motivation was to inform citizens and advise them on more environment-conscious behaviour, while also capturing societal interactions to assess the impact of policy.

A TALE OF NINE CITIES

The project's technologies were tested in nine cities representative of the various urban settings found across Europe: Basel, Brno, Ljubljana, Roskilde, Stuttgart, Thessaloniki, Athens, Milan and Madrid. "We selected these cities carefully to cover the whole spectrum of green urban management. They are of different sizes, with very different social, cultural, climatic and environmental conditions, and they had all already adopted a number of technical and non-technical measures to reduce air pollution and carbon footprint," Sarigiannis explains.

SPECIAL FEATURE



The project team assessed a total of 45 policies in cooperation with local authorities. They used a fully integrated impact assessment paradigm to estimate the changes in emissions, concentrations, exposure and health impacts brought by those policies. They also carried out cost-benefit and cost-effectiveness analysis for each of them. “We sent the results to local authorities so that they could have a better reading of how these policies really performed,” adds Sarigiannis.

CITIZEN EMPOWERMENT

Over 600 citizens participated in exposure campaigns. They were asked to wear a physical activity wristband recording steps, distance, type of activity, heartbeat and sleeping patterns, as well as another one capable of absorbing a wide range of organic chemicals. They also wore a custom-built portable sensor that captured their exposure to PM, temperature, humidity and their location, and even received a static sensor measuring indoor air quality in their homes. “Participants answered a questionnaire and received a feedback report with data and charts. They expressed high interest in ICARUS activities and outcomes,” Sarigiannis notes.

For the others, the ICARUS consortium developed a mobile app called RQuality which promotes wellness and

environmental awareness. Any citizen in the test cities can freely use the app to track air quality data in real time and be informed of individual exposure to airborne chemicals. The app tracks consumption patterns and lifestyle choices to estimate their carbon footprint, and even reports incidents affecting air quality in their area.

Local authorities aren’t left empty-handed either. The project’s decision support system (DSS) will help them improve air quality and assess climate change governance, as Sarigiannis explains. “DSS users can perform a fully integrated assessment of both predefined policies and new policy scenarios. They can estimate impacts in terms of changes in air pollution and population exposure, and conduct a full cost-benefit analysis.” With this and ICARUS’s three proposed pathways for the realisation of green cities within the next 50 years, all they have to do now is take decisive action.

ICARUS

- Coordinated by the Aristotle University of Thessaloniki in Greece
- Funded under Horizon 2020-ENVIRONMENT
- cordis.europa.eu/project/id/690105
- Project website: bit.ly/icarus2020-archive

A citizen-driven approach to tackle odour pollution

A brand-new app to help citizens monitor and identify the sources of odour pollution is being offered by the D-NOSES project. The project’s work is a welcome step forward in a field where some have argued that inaction has prevailed for too long.

Pollution not only has a highly negative impact on the environment, it disturbs our senses too, notably the sense of smell. The statistics speak for themselves: odour pollution is the second highest cause of environmental

concern among citizens after noise – accounting for more than 30 % of relevant complaints on average.

Regulations have so far failed to solve this problem, and it is not an issue that industry is focusing on either. In

this context, it seems only appropriate to provide citizens with the means to take things into their own hands. The D-NOSES (Distributed Network for Odour Sensing, Empowerment and Sustainability) project has been doing just that, gathering stakeholders around the table and providing them with an app to monitor odour pollution and be able to act on the evidence provided.

Rosa Arias, chemical engineer at the University of Barcelona, CEO at Science for Change and coordinator of D-NOSES, discusses the project's work and its expected impact on the issue of odour pollution.

Odour pollution is often ignored in environmental regulations. How do you explain this?

Rosa Arias: There are three key factors at play. Odour abatement techniques are usually expensive, emitting industries will typically oppose regulatory initiatives, and odours are difficult to measure. Indeed, ambient odours are mixtures made of hundreds of volatile compounds that spark a reaction in our sense of smell. The way we perceive them is so unique and complex that so-called 'electronic noses' or traditional chemical analysis cannot mimic it.

Do we have any information on odours' actual impact on citizens' health?

Odours are just a matter of good or bad smells! All types of odours, regardless of their character and hedonic tone (good or bad smell), may cause discomfort. We may like the smell of biscuits or coffee, but that same smell, if it is very intense and frequent, can be unbearable.

Although odours do not normally present serious health problems, they can act as a warning signal for more serious environmental or health issues potentially harmful to human health. Our sense of smell is very precise and we can smell harmful substances in very low concentrations to prevent any harm. For example, hydrogen sulfide (H_2S), the typical smell of 'rotten eggs' produced by stagnated waters or the sewage system, can be perceived in concentrations as low as 10 ppb (parts per billion). This is very convenient, as higher concentrations are lethal!

Broadly speaking, we can smell ambient odours at concentrations that are not harmful for our health, but even at such low levels they can generate general discomfort, headaches, lack of sleep, lack of concentration, accentuation of respiratory problems, stress, insomnia, nausea and anxiety.



D-NOSES proposes a paradigm shift in the way odour pollution is being tackled. What does your approach consist of and what makes it innovative?

D-NOSES addresses this problem by involving public administrations, industry, research institutions and citizens in participatory sessions, following the quadruple helix model of innovation. Together, they can co-design improvements that reduce the impact of odour pollution on affected communities.

Our ultimate goal is to introduce the issue to policy agendas, so we created a multilevel governance model. At the local level, we work together with environmental authorities and municipalities in 10 pilots across Europe, Chile and Uganda. At national level, we inform specific regulations on odour pollution in several countries such as Chile and Portugal, while promoting the creation of a standardisation group in Spain. This will be the first standard with the 'citizen science' concept in its title, which will set a precedent for the entire community and may be eventually adopted at European level. Finally at the European level, we inform about the revision of the European Industrial Emissions Directive (EID) to introduce 'odour' as one of the sources of pollution.

How do you overcome the existing barriers to detection?

We know that each substance has different odour thresholds. The combination of dozens or hundreds of substances in ambient air produce an odour perception that is more than the sum of each individual threshold, since chemical interactions occur and the combined odour is unique. We also have to account for the fact that the sensitivity to odours can be very different from person to person, and that further difficulties can arise due to external agents such as weather conditions making it difficult to identify the emission source.

To tackle these issues, I came up with the idea of creating a citizen science app to monitor odour pollution and empower citizens to create collaborative odour maps in real time based on their perceptions. The OdourCollect app takes advantage of already known research techniques



Rosa Arias,
coordinator of D-NOSES
© Rosa Arias



The OdourCollect app takes advantage of already known research techniques and adds an extra layer of citizen collaboration on top of them.



and adds an extra layer of citizen collaboration on top of them. This will help ensure that directly affected communities are not left defenceless. Users can monitor odour impact in real time, understand which type of odours they are perceiving, and correlate the observations with potential origins to identify potential improvements.

How successful has the app been so far?

We have more than 1100 registered scientists and over 9100 odour observations collected worldwide. In Barcelona we have developed a pilot in the Forum area where we have more than 600 odour observations with more than 50 neighbours involved. The results in terms of frequencies and types of odour perceived correspond to traditional odour studies, thus showing the validity of the proposed methodology.

We are currently correlating the obtained data with industrial operations, to find the situations that cause a higher impact and act upon them. The generated data is invaluable for environmental authorities to monitor odour impact and for the emitting industries to produce odour management. Anyone can contribute to the project, as in the end the best sensor for measuring an odour is the human nose itself.

How do you plan to help improve regulations?

We have been analysing the regulatory frameworks in D-NOSES countries and will produce strategic governance

roadmaps for each country. Hopefully, these will push environmental authorities and policymakers to adopt scientifically sound methodologies.

The project will soon be completed. Do you have any follow-up plans?

OdourCollect and the International Odour Observatory, together with the policy documents to be generated, will be the main legacy of the project. We are currently developing the D-NOSES Exploitation Plan to guarantee the exploitation of the project results after its end. We will also seek further opportunities in the brand-new Horizon Europe to continue the good work done in D-NOSES.

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

Citizen science practices generate new scientific knowledge, empower citizens and encourage critical thinking. This process contributes to the democratisation of science and, in the case of OdourCollect and D-NOSES, can foster social awareness of odour pollution, generate a sense of co-responsibility and contribute to mitigating effects. Hopefully, our long-term impact will be the introduction of odour pollution to policy agendas at European, national, regional and local levels to protect European citizens from this type of pollution and improve their quality of life.

D-NOSES

- Coordinated by the Ibercivis Foundation in Spain
- Funded under Horizon 2020-Science with and for society
- cordis.europa.eu/project/id/789315
- Project website: dnoses.eu
- ▶ bit.ly/d-noses-video

A sensor network to reduce the risk of tap water contamination

Getting sick from drinking tap water could soon become much less likely thanks to work under the CoPs project. By combining advanced sensors, data loggers and a cloud system, the project team can now provide continuous monitoring of key water resources.

The Food and Agriculture Organization (FAO) says that 38% of water bodies in the EU are under significant pressure from agricultural pollution. Of course, most European regions have a system in place to prevent

contamination from reaching tap water: Farmers are asked to keep a record of their pesticide consumption, and sampling at critical locations is undertaken on a regular basis. But what if any contamination event were

In **2021**, people are still getting sick from **drinking tap water**, and this costs society some **EUR 220 million every year**



not require chemical reagents so does not generate any chemical waste.

TOWARDS A LAUNCH IN 2022?

With the system now operational, project partners have been focusing on optimisation. They are notably working to increase the sensor's lifespan so that future customers can use the system with minimum maintenance. "We are working on the third-generation prototype and we are aiming for field testing in summer 2021. Once this is done, we'll need 6 months to gather user feedback and get ready for the first launch," Krangnes says.

The CoPs solution was extensively tested in the lab to validate results and get the best possible performance. "It's a very important process. For example, part of the CoPs solution is submerged and contains very sensitive electronics and sensing parts. A simple moisture leak could result in system damage. To prevent such a scenario, we need to test the system under higher pressure than what it is designed for in order to ensure that the design will withstand extreme conditions and that the customer will not face issues," Krangnes concludes. Now that it's done, the team intends to deploy beta version prototypes for large-scale testing in relevant environments.

to occur between these samplings? The hard truth is, in 2021, people are still getting sick from drinking tap water, and this costs society some EUR 220 million every year.

"From our point of view, the solution is to provide a tool that can sample continuously thanks to a dense mesh network of sensors," notes Lars Krangnes, CTO at Cautus Geo and coordinator of the CoPs (Continuous hazardous water Pollutants sensing in the environment) project. "With such a network, we can quantify the contamination, identify which contaminants are present, locate the source of contamination, determine where it's heading and investigate whether it's a persistent problem. It's the ultimate way to reduce chemical contamination and prevent outbreaks."

CoPs' three project partners successfully developed such a solution by combining their respective expertise in groundbreaking electrochemical sensors, miniaturised electronics and geo-monitoring hardware and software. The resulting system tracks the unique fingerprint of chemicals contained in pesticides and fertilisers: It records these signals under controlled conditions before studying variations in the environment.

"The sensors are the heart of the system. They have been uniquely designed to target each chemical of interest and can identify them within seconds to minutes. The system also includes a new type of data logger that controls and powers the sensors while sending the data to a cloud-based system for further processing and presentation of the results. We've used the latest IoT technology to create an all-round, user-friendly and intelligent solution," Krangnes explains. The system is also environmentally friendly. Unlike other products on the market, it does

COPS

- Coordinated by Cautus Geo in Norway
- Funded under Horizon 2020-Societal Challenges and Horizon 2020-LEIT
- cordis.europa.eu/project/id/820501
- Project website: cops-h2020.com
- ▶ bit.ly/COPS-video

A set of new eyes to detect oil spills in harbours and coastal areas

Harbours often lack the appropriate tools and technologies to properly monitor marine pollution. The IMPRESSIVE project has developed a brand-new solution specifically for their needs, combining Copernicus satellite data with hydrodynamic modelling and remotely controlled monitoring vehicles.

When will the days of illegal tanker discharges and accidental oil spills damaging seas and oceans finally be behind us? Judging by recent events – we could mention the Mauritius oil spill in early 2020 or, as recently as February 2021, the one faced by Israel when it found 90% of its 190 km long Mediterranean coastline covered in tar – there is little reason to be optimistic. But maybe the use of new technologies such as Earth Observation (EO) satellites and remotely operated monitoring vehicles could soon turn the tide.

Traditionally, authorities wanting to monitor oil spills have had to resort to on-site monitoring using aircraft and ship surveillance. But these methods are far from ideal. Beyond the few events covered in mainstream media, experts estimate the amount of oil spilled annually worldwide to be over 4.5 million tons. According to Ioannis Dontas, senior consultant at Aratos.Net Ltd, a subsidiary of the Aratos Group, failure to detect these events in due time is usually due to delays between discharge and detection, poor weather conditions preventing overflights and limited resources.

But technology has evolved considerably over the past few years. Synthetic-aperture radar (SAR) images have been used to monitor open ocean waters, wastewaters and oil spills. Even better, they can now be combined with optical images from EO satellites such as the Copernicus Sentinels. Remotely operated vehicles are another emerging technology that can be used in multiple marine

environments, supporting risk mapping and alert systems. But to date, these solutions have never been combined to meet the needs of harbours and coastal areas.

“There is an obvious need for an integrated solution,” says Dontas, who’s also the coordinator of the project IMPRESSIVE (Integrated Marine Pollution Risk assessment and Emergency management Support Service In ports and coastal environments). “One that would provide port authorities, competent administrations and the maritime industry with constant monitoring and control around ports.”

A FULLY AUTOMATED SOLUTION

IMPRESSIVE’s main innovation is the use of data from EO satellites and remotely operated vehicles to monitor harbours. “Our autonomous surface vehicles (ASVs) and unmanned aerial vehicles (UAVs) provide a sharper and cheaper alternative approach to the traditional use of boats to monitor water quality and sources of pollution. In addition to these, we have developed a platform that gathers and fuses data acquired from multiple EO satellite platforms, air and sea-level sensors, as well as a full set of downscaled hydrodynamic models based on CMEMS products,” Dontas explains.

With this unique combination, the project team can produce near real-time data on an area of interest, and also do so in a fully automated process. The IMPRESSIVE platform provides maps, statistics, GeoAnalytics and alerts on the monitored area. Users can browse, display and further analyse these products as well as request additional ones.

Three pilots are foreseen to demonstrate the technology. At the Rafina Port in Greece, the project team used relevant satellite data to evaluate IMPRESSIVE’s hydrodynamic models and the first operational version of the platform. At the Taranto port in Italy, they are combining this EO data with the use of the project’s UAV for air-based monitoring. The third and final pilot will be set in Puerto de la Luz in the Canary Islands. It will combine all sources of data and technical means developed under the project.





The amount of oil spilled annually worldwide is estimated at over 4.5 million tons

The second and third pilots have been delayed due to the COVID-19 pandemic, but the team was able to conduct preliminary tests of oil spill and wastewater detection and alert modules. “These were shown to work very well, with a total of 281 Sentinel-1 SAR acquisitions since June 2020,” Dontas adds.

“To the best of our knowledge, there is no European harbour or port with this set of tools.”

Once IMPRESSIVE completes its objectives, it will undoubtedly be of high commercial appeal to harbours usually resorting to manned boats and sampling stations operating from fixed positions. “To the best of our knowledge, there is no European harbour or port with this set of tools. Although our solution will be developed and tested in European settings, the system will be exportable to harbours and coastal areas all over the world. We aspire to a global market, and its potential is enormous,” Dontas concludes.

IMPRESSIVE

- Coordinated by Aratos.Net Ltd in Greece
- Funded under Horizon 2020-LEIT-SPACE
- cordis.europa.eu/project/id/821922
- Project website: impressive-project.eu

Exploring toxic expertise, the petrochemical industry and environmental justice

Toxic substances are everywhere. But what social responsibility do polluters have, and what are they doing about environmental justice? To find out, new research examined the topic of toxic expertise within the realm of global petrochemical companies.

Toxic expertise is a double-edged sword. On the one hand, you have scientific expertise on the effects of toxic pollution. On the other hand, there’s the expertise about the nature of toxicity that is used to justify lax corporate social responsibility and a lack of meaningful regulations.

Sitting between these two poles are the ongoing, often heated, debates about the social, economic, environmental and health impacts of toxic pollution.

“Toxic substances are ever-present in modern day life and, due to their effects on health and the environment, are matters of public concern,” says Alice Mah, a professor of Sociology at the University of Warwick.

With the support of the EU-funded ToxicExpertise (Environmental Justice and the Global Petrochemical Industry) project, Mah led an effort to gain new insights into the complex ways expertise works within – and in relation to – the global petrochemical industry. “We focused our work on the

petrochemical industry as it is a significant and controversial source of toxic pollution,” explains Mah. “Furthermore, the industry is characterised by unequal regulations and risks across different countries and populations.”

SHEDDING LIGHT ON THE DYNAMICS OF CORPORATE POWER

The ToxicExpertise project, which received support from the European Research Council, set out to conduct the first systematic social scientific study of the global petrochemical industry as it relates to corporate social responsibility and environmental justice. To do this, researchers started by examining toxic expertise within the leading global petrochemical companies and environmental NGOs operating in Europe, China and the United States.

“These investigations shed light on the shifting dynamics and networks of corporate power in the global petrochemical industry,” notes Mah. “They also gave us a better understanding



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of how corporations use technical expertise across different fields and to serve a variety of purposes.”

Next, the research team conducted in-depth case studies in China and the United States – two of the world’s top petrochemical producers. “These case studies highlight that despite the environmental and health impacts of pollution, local attitudes often remain ambivalent towards both pollution and the polluters,” says Mah. “We also found that the case studies revealed stark and long-standing social inequalities in toxic exposures and risks.”

Based on this work, researchers developed an interactive Global Petrochemical Map, an online, interactive public resource. “Working collaboratively with international researchers and community organisations, we mapped 75 cases around the globe of major petrochemical sites, local communities, community and labour mobilisations, and details of emissions, environmental and safety records, photos and media reports,” Mah explains.

“Despite decades of environmental justice activism, enduring, systemic environmental injustice remains, particularly for minority, low-income and working-class communities around the world.”

The project also launched ‘Toxic News’, an e-magazine, and is currently finalising ‘Petrochemical Planet’, a book that will provide a comprehensive overview of the project’s work.

PUSHING THE BOUNDARIES OF SOCIAL SCIENTIFIC RESEARCH

The ToxicExpertise project has succeeded in pushing the boundaries of social scientific research into the wide-ranging impact the petrochemical industry has on society.

“Despite decades of environmental justice activism, enduring, systemic environmental injustice remains, particularly for minority, low-income and working-class communities around the world,” concludes Mah. “This project puts the spotlight on these social inequalities, the role of powerful corporations, and what needs to be done to ensure a more just – and sustainable – industrial transformation.”

TOXICEXPERTISE

- Hosted by the University of Warwick in the United Kingdom
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/639583
- Project website: bit.ly/3cEAm0w

New insights on protecting our skin from air pollution

Air pollution isn’t just bad for our hearts and lungs – it’s also harmful to our skin. To learn more, three young researchers from across Europe investigated the harmful impact different types of air pollution has on our skin and what we can do to better protect it.

According to the European Environment Agency (EEA), over 85% of Europe’s urban population is subjected to air pollution levels that the World Health Organization considers to be harmful to one’s health. While the effect of air pollution on our respiratory and cardiovascular systems is well documented, new evidence shows that it also has an adverse impact on the body’s largest organ – the skin.

With a surface area of nearly 2 square metres, our skin is designed to protect us against potentially harmful environmental factors. However, this ability is not unlimited. “When exposure to environmental stressors, such as air pollution, exceeds the skin’s normal defensive ability, problems begin to arise,” says Marc Eeman, a research scientist at Dow Silicones Belgium.

Over 85% of Europe's urban population is subjected to air pollution levels harmful to one's health



With the support of the EU-funded project CITYCARE (Impact of air pollutants on cutaneous responses in both healthy and compromised skin barrier, and innovative solutions to protect skin against urban pollution), Eeman is leading a group of three PhD students working to understand how air pollution affects the skin and what can be done to better protect it.

“As an Innovative Training Network, funded with the support of the Marie Skłodowska-Curie Actions, the CITYCARE project provides training and support to three early-stage researchers from across Europe,” adds Eeman. “Leveraging the expertise of two renowned research universities and one leading industrial player, we have significantly advanced our scientific knowledge about the wide-ranging impact air pollution has on the skin.”

EVALUATING HOW DIFFERENT TYPES OF POLLUTION IMPACT THE SKIN

To start, the three PhD students spent 6 months at Dow's laboratory in Seneffe, Belgium. Here, they built a state-of-the-art, reconstructed 3D skin model, which served as the project's key tool for evaluating the effects of various environmental stressors on cutaneous tissue.

“By learning to make our own skin model, we were able to customise it to meet the unique needs of our own research,” explains Roxane Prioux, a PhD student from the University of Ferrara. “For example, by amplifying or silencing the expression of genes of interest, or via the up or downregulation of certain proteins, one can better investigate the effects of air pollution, understand the mechanical pathways, and how it all relates to skin diseases.”

Returning to their home institutions in Belgium, Italy and Switzerland, the students then used the 3D model as the basis of their own research projects. For instance, one student developed a 3D *in vitro* human reconstructed epidermis to simulate the effect diesel exhaust has on the skin.

“It is important to understand how these particles affect our skin and which underlying mechanisms are involved,” notes Irini Magdelina Dijkhoff, a PhD student from the Adolphe Merkle Institute at the University of Fribourg. “This research is the foundation for identifying how we can protect our skin against air pollution.”

The students also investigated how ozone and cigarette smoke impact the skin. “The first step towards developing innovative solutions to better protect our skin is to understand how different air pollutants affect the cutaneous responses and biomechanical properties,” says Benedetta Petracca, a PhD student from Dow Silicones Belgium. “Our research has done exactly that.”

ATTRACTING SIGNIFICANT INTEREST

The consortium organised an awareness-raising seminar and three scientific workshops, all of which were well received. Although the project is still a work in progress, it is already attracting significant interest – including from several major cosmetic companies and skincare scientists.

“It has been such a gratifying experience to contribute to the development of these young researchers,” concludes Eeman. “I look forward to seeing what comes next.”

CITYCARE

- Coordinated by Dow Silicones Belgium in Belgium
- Funded under Horizon 2020-MSCA-ITN
- cordis.europa.eu/project/id/765602
- Project website: citycare-itn.eu
- ▶ bit.ly/CityCare-project



New filter-less, water-based cleaning system reduces air pollution by up to 99%

A new air pollution abatement system, targeting a vast range of pollutants and contaminants present in the air we breathe, has been devised by the APA project. Multiple pilots across Europe have already confirmed the superiority of this technology to filter-based alternatives.

Air pollution is a growing problem in Europe and globally. It impacts outdoor environments of course, but also our workplaces where the likes of carbon monoxide, radon, nitrogen dioxide, volatile organic compounds (VOCs) and second-hand smoke negatively impact our daily life and our health. According to the World Health Organization (WHO), some 40 million people from the 115 largest cities in Europe are exposed to air exceeding defined thresholds for at least one pollutant.

Of course, filter-based air cleaning devices do exist. But the EU-funded consortium APA (Filter-less air pollution abatement system able to clean a wide range of pollutants at ground level for a healthier workplace and more sustainable environment) has found room for improvement in an innovative filter-less technology capable of significantly abating dangerous particles (from PM10 to PM0.01), gases (NOx, CO, SOx, VoC, etc.), viruses and bacteria.

Giuseppe Spanto is the coordinator of APA. He accepted our invitation to present the new system to Research*eu magazine and explain to us its advantages compared to existing alternatives.



Giuseppe Spanto, coordinator of APA
© Giuseppe Spanto

“ We have been able to consistently demonstrate the capability of APA technology to successfully reduce the widest range of ambient air pollutants while leaving measurements to independent third parties and institutional bodies. ”

What is APA and what makes it better than filter-based systems?

Giuseppe Spanto: APA uses only water and mechanical processes. It has been recognised as a Best Available Technology and is very different from what competitors offer because it does not require filters, abates simultaneously particles and chemical pollutants, works at ground level and can be configured in a cluster if needed. It has low running costs and a total cost of ownership (TCO) several times lower than any existing alternative. But there is more: it can trap and destroy nanoparticles as small as 0.01 µm (several times smaller than virus size) and can even be used to detect possible virus presence – thanks to the water used to clean the ambient air. The technology is particularly advantageous during this pandemic period.

How does the system work exactly?

APA is a functioning system based on a three-stage chamber carrying out only mechanical and physical processes, with a patented wet deposition and abatement (multi-quenching) special system called ‘deposition stack’. This enables us to increase overall pollution abatement efficacy by over 95 % and even exceed 99 % of efficacy on the main air pollutants. Depending on customer choices, we can also embed a remote monitoring system that acquires and processes the pollution and environmental data. This system can operate, control and switch on/off the APA without any physical human intervention.

Could you provide one or two examples of concrete use cases?

Our technology is designed to operate independently. It doesn’t consume much energy and only a very small quantity of water. This means we can easily deploy and run it in many countries.

We have a large range of interesting and prominent pilots already set up. Two of them are very important, namely the ‘Pollution Free School’ in Rome and the deployment

of two APA systems in a rail station in Tel Aviv. In Rome, we deployed an outdoor cluster of three APA devices in a school play area. We achieved a 50% reduction in particles and NOx concentrations (even black carbon) in only 2 weeks! In Tel Aviv, we also reduced PM and NOx pollution levels by 50% and 35% respectively, in just 4 weeks.

Can you tell us more about your other tests in operational settings?

We have deployed over 135 real-world installations so far and tested the technology in very different settings: indoor and outdoor, at industrial sites, business locations and in urban spaces. In all cases, we have been able to consistently demonstrate the capability of APA technology to successfully reduce the widest range of ambient air pollutants while leaving measurements to independent third parties and institutional bodies.

What's truly remarkable is how quickly the positive effects are achieved (usually in a few weeks of activities) and the extent of air cleaning. We have witnessed a 99% reduction at source in a biomass cogeneration site, as well as an over 60% reduction inside an airport and in semi-enclosed outdoor urban settings. We have also achieved a 40% reduction in both particles and gaseous pollution concentrations in outdoor places thanks to our 'pollution absorbers cluster' patented approach in a period of only about a month. No other competitors have succeeded in reaching such figures across such a wide range of pollutants.

What has been the feedback from potential customers so far?

We have always received very positive feedback from customers. No negative impacts of the technology were identified, and it has proved flexible and adaptable enough to answer all their needs. Our growing turnover, the skills acquired and the interest from stakeholders demonstrate this success.

This phase 2 project focused on commercialisation and patenting. What did you achieve in this regard? What's your strategy?

Phase 2 of the SME Instrument project has been very successful, since even during the COVID-19 pandemic we had the end users and test sites to confirm the effects and validate our activities. Thanks to the project's multilevel approach, we now have many more patents granted in major economies and industrial countries worldwide. This will allow us to scale up faster in the future.



© APA

Our commercialisation strategy is ready. It will focus on engineering activities and IP transfer models, as well as establishing strong and long-term partnerships with large corporations in different sectors.

What are your follow-up plans now that the project is completed?

Follow-up plans include an important project we recently won as lead SME, named NeZAPoB (Nearly Zero Air Pollution Building). It focuses on new energy efficiency solutions based on the air cleaning power of APA.

Besides this project, we are focusing on a second round of investment as well as important parts of the business. These include: enhancing and strengthening the organisation structure and its international mindset at the management and operations level; supporting commercial activities and working capital; extending certification frameworks globally, focusing on the IP transfer models and 'core technology' management; and expanding APA solutions for other reachable markets (air treatment units, interior design and smart office, medical sector etc.).

APA

- Coordinated by Innovation in Science & Technologies in Italy
- Funded under Horizon 2020-ENVIRONMENT and Horizon 2020-SME
- cordis.europa.eu/project/id/672051
- Project website: istechpot.com



Assessing carabid beetles as a biocontrol for slugs and other pests

Conservation biological control, which taps natural predation to control agricultural pests, is environmentally friendly – unlike toxic pesticides. CaraSlug investigated the use of carabid beetles for slug control.

Globally, slugs threaten crops including potatoes, wheat, brassicas, strawberries, canola and soybean. These pests cause considerable economic damage, especially in countries with mild and wet climates.

Current control measures are expensive and either toxic to non-target organisms and the wider environment, unfeasible for large areas or only successful against certain species. Also, as slugs are often within soil which protects them from control agents, single applications are usually ineffective.

The Marie Skłodowska-Curie Actions supported project, CaraSlug (Carabids as biocontrol agents for slugs in Oregon and Ireland – a novel and interdisciplinary approach to determine key malacophagous species and beneficial management options), investigated carabid beetles, one of the natural predators of slugs, as a potential biological control.

“While carabid beetle predation rates on slugs were disappointingly low, the results were more promising for other pests, such as caterpillars and crane fly larvae,” says Inga Reich, Marie Skłodowska-Curie fellow at the National University of Ireland Galway, the project host.

A paper has already been published in ‘Insects’, with three more under development, which include looking at carabid predation on alternative prey, such as springtails or earthworms.

PUTTING BEETLES THROUGH THEIR PACES

As well as being natural enemies of slugs, carabid beetles were selected for CaraSlug because they are often abundant in agroecosystems, and different species are active at different times of the year. This is beneficial as slugs can be problematic all year round.



CaraSlug looked at carabid beetle assemblages in Oregon, United States, in 10 differently managed grass seed fields – till vs no-till and vegetated vs non-vegetated field margins. This allowed the team to determine which management options worked best for carabid species feeding on slugs, and caterpillars and crane-fly larvae, which were also investigated.

Sampling took place biweekly for 15 months. Beetles were captured with pitfall traps, two rows per field, one close to the edge and one 70 m in. Each row had five sample points, each with four pitfall traps and one refuge trap to determine pest prevalence. Beetles were killed after sampling using dry ice and then identified in the laboratory.

DNA was extracted from the guts of beetles and screened for slugs and other pests using qPCR. The extracted DNA was also submitted for next-generation sequencing (NGS), carried out to gain information about the beetle's overall diet. Pest predation was detected but at rates lower than expected.

Feeding trials were conducted with the most common species of carabid beetle *Nebria brevicollis*, which accounted for most slug predation as tested by the qPCR.

Beetles were starved for 7 days before being presented with juvenile slugs and slug eggs, then left for 4 days. None of the slugs or their eggs were consumed, indicating that the positive qPCR results were more likely due to scavenging than predation.

"We found that *N. brevicollis* fed on other pests, caterpillars and crane-fly larvae, during their autumn emergence. As

“While carabid beetle predation rates on slugs were disappointingly low, the results were more promising for other pests, such as caterpillars and crane-fly larvae.”

this coincides with the timing of grass seed sowing, it could help delay population growth in these pests until the crop is less susceptible to damage,” explains Reich.

A SUSTAINABLE AGRI-FOOD INDUSTRY

Pesticides are damaging to the environment and human health. CaraSlug is aiming to further the EU's ambition of building a sustainable agri-food industry and to develop an alternative pest control approach.

The team will further assess the impact of *N. brevicollis* on the native invertebrate fauna in Oregon grass seed fields. The outcome of work conducted in Ireland to determine the influence of farming intensity on slugs and carabids will be completed. This work, focussing on larvae, was delayed by the coronavirus pandemic.

CARASLUG

- Coordinated by the National University of Ireland Galway in Ireland
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/750296
- Project website: bit.ly/CaraSlug_project

FOOD AND NATURAL RESOURCES

Integrated fisheries management delivers ecosystem benefits

A better understanding of the wider social and environmental consequences of industrial fishing will lead to more effective ecosystem-based approaches to the management of our marine resources.

Industrial-scale fishing has had a significant impact on marine ecosystems. Despite decades of management plans and regulations, many fish stocks are still overexploited, and marine environments continue to be degraded.

"Fishing management approaches often do not consider the wider ecosystem consequences of fishing," explains Marie Skłodowska-Curie fellow Silvia de Juan, researcher at the Institute of Marine Science (ICM-CSIC) in Spain, who worked on the project FishMan (Unwanted catches

of trawl fisheries: ecosystem effects and advances to an integrated management approach in the Mediterranean).

“To move towards a more sustainable world, we need to better understand how fisheries alter ecosystems, and how this failure to reach long-term sustainability goals might impact society.”

Such ecosystem-based approaches include respecting quotas and avoiding catches of undersized individuals and vulnerable species. The EU's reformed Common Fisheries Policy, which includes measures such as a discard ban for several commercial species, known as the Landing Obligation, and improved fishing gear, has played a critical role in moving European fisheries towards more sustainable practices.

UNDERSTANDING FISHING PRACTICES

The FishMan project, undertaken with the support of the Marie Skłodowska-Curie Actions programme, sought to better understand the implementation of these regulations as well as the continued ecological impact of fishing. This was achieved in part through an analysis of current trawl fishing practices in the north-west Mediterranean.

“We wanted to take into account all the components of fishing, from the biophysical properties of fishing grounds to the perceptions of fishermen,” adds de Juan. “The goal was to study the consequences of fishing activities from different perspectives.”

Through this work, de Juan was able to shed new light on the consequences of trawl fisheries in Mediterranean ecosystems. A key focus was on the loss of some of

“Taking into account the perception of fishermen is essential if we are to effectively advance towards an ecosystem-based approach.”

the most vulnerable marine species, as well as the socio-economic impact of measures on local fisheries.

“Small decisions such as fishing in certain habitats or discarding fractions of the catch can have significant effects through the system,” notes de Juan. “Ecological conditions are fed back to fishermen through their ability to catch fish. These cascading effects need to be considered in the formulation of fisheries management plans.”

ASSESSING ECOSYSTEM IMPACTS

A lasting legacy of the FishMan project will be its holistic approach to assessing the ecosystem impacts of fisheries, encompassing key ecological, social and economic indicators.

This will lead to more accurate predictions of the effects of fishery restrictions in the future. The approach pioneered by FishMan could also help to identify alternative fishing practices capable of reducing ecosystem disturbance, while having minimal socio-economic impacts on fishermen.

“Our framework was successfully tested by a north-west Mediterranean trawling fleet,” says de Juan. “We demonstrated that our framework is a promising tool for monitoring the effective implementation of ecosystem approaches to fisheries management.”

Some of the project data still needs to be processed, and de Juan expects this information will further flesh out FishMan's wider societal perspective of sustainable fishing. “Incorporating the human dimension will ensure that our research results are applicable in real-world scenarios,” she explains.

“Taking into account the perception of fishermen is essential if we are to effectively advance towards an ecosystem-based approach.”

FISHMAN

- Coordinated by the Spanish National Research Council in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/743545
- Project website: bit.ly/FishMan-project





INDUSTRIAL TECHNOLOGIES

Translucent, touch-sensitive wood is revolutionising construction

Wood is rarely associated with high-tech electronics, transportation and structural building components. All this is changing with a fusion of nature and nanotechnology that transforms native wood into a translucent, touch-sensitive surface as strong as metal.

The buildings and construction sector accounted for 39% of energy and process-related CO₂ emissions in 2018. The global production of cement alone is the third largest source of CO₂ emissions due to human activity after fossil fuels and changes in land use. Bio-based materials offer an exciting opportunity to have a significant positive impact on our environment. Timothée Boitouzet, CEO and founder of the French SME Woodoo and coordinator of the EU-funded project Woodoo (Augmented Wood – transforming wood into construction material strong as concrete and translucent as amber), has made this his life's focus.

Combining architectural studies in Japan with investigations of the chemistry, physics and molecular biology of wood at Harvard and MIT, Boitouzet founded Woodoo in 2017. The company's products leverage cellulosic nanotechnology to bring us pioneering high-strength, weatherproof and fire-resistant wood materials that are as translucent as amber. Woodoo's team fortified its market position with two new products, the scale-up of manufacturing and operations, filing of patents and establishment of collaborations with world-class automobile design manufacturers.

A BIO-BASED 'TRANSFUSION'

Wood is typically about 25% lignin, a natural polymer that acts as a binder between wood cell walls creating a natural composite. Second in abundance only to cellulose, it serves important functions in living plants but is vulnerable to ultraviolet rays, decay and insects in cut wood. "Woodoo selectively extracts lignin and replaces it with specialty polymers. The new materials feature unprecedented mechanical strength, durability, fire resistance and optical properties," explains Boitouzet. "By replacing emissive primary building elements, Woodoo's biomaterials will be 17 times less energy-intensive than glass, 130 times less than steel and 475 times less than aluminium."

EARTH'S LUNGS BREATHE LIFE INTO ELEGANT BIO-BASED CREATIONS

Whereas traditional construction materials contribute substantially to atmospheric emissions, forests are the largest storehouse of carbon after our oceans. They absorb and store about 30% of carbon emissions from fossil fuels and industry. Cultivating forests is good for our planet. Woodoo uses local wood materials including low-grade wood species (beech, birch, pine and aspen), all sourced from sustainably managed EU forests within 300 km of the manufacturing plant.

Woodoo's cost-effective alternatives to premium woods have a strength that parallels concrete, glass and steel. High-tech functionality for translucent wood displays and panelling will transform the display and use of information in conference rooms, commercial retail centres, airports and train stations around the world. Elegant, touch-sensitive, translucent, smart wood surfaces for automobiles and electronics will enhance the user experience while decreasing the carbon footprint.



The global production of **cement** alone is the **3rd** largest source of **CO₂ emissions** due to human activity



A QUANTUM LEAP IN MATERIALS DESIGN – AT LIGHTNING SPEED

Boitouzet concludes: “Usually, it takes nearly a decade to scale up material technologies and find a market niche. We have done so in less than 3 years, in large part due to the Woodoo project. Woodoo is revolutionising the way wood is used and perceived. Rather than a primitive material that is the antithesis of innovation and futuristic design, wood is transformed through technology into high-tech materials that simultaneously address the most pressing issues of our time.” The company has garnered over 35

coveted tech and innovation awards. Its growing portfolio of cost-effective, high-tech bio-based products will soon be touching our lives with touch-sensitive wood.

WOODOO

- Coordinated by Woodoo in France
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/829651
- Project website: woodoo.com
- ▶ bit.ly/Woodoo-video

INDUSTRIAL TECHNOLOGIES

Exotic new materials inspired by plants

The natural world offers solutions to many problems and challenges faced by humanity. Researchers are creating new materials and surfaces based on the designs of nature.

To create the next generation of synthetic materials, researchers are turning to nature for inspiration. Plants are intricately designed and efficient structures, with a variety of components performing critical roles in the organism’s success.

The outermost layer known as the cuticle, for example, is a smart polymer composite material which controls the regulation of water permeability or protection, forms

structural colours, and provides either smooth, frictionless surfaces or sticky ones.

These impressive traits can be translated into new materials for human benefit, thanks to the innovation of researchers funded under the Marie Skłodowska-Curie Actions programme.

“My favourite results are the environmentally friendly glitter based on cellulose nanocrystals, and studies of how plant surface topology influences insect adhesion.”



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The PlaMatSu (Plant-inspired materials and surfaces) project has been investigating these properties to come up with innovative new materials, and had two main goals. One was to address current challenges of creating new materials, through analysing the structure and functions of plant cuticles. The other side of the project involved educating the next generation of scientists, to train newcomers to turn bio-inspired science into innovation.

“PlaMatSu sought to develop new functional materials and surfaces that are inspired by the structure, function and working principles of the plant cuticle,” says PlaMatSu’s coordinator Nico Bruns, professor of Macromolecular Chemistry at the University of Strathclyde in Glasgow.

WHAT WE CAN LEARN FROM PLANTS

PlaMatSu gained new fundamental understanding of the developmental factors and genetic underpinnings of the structure of a plant cuticle. They found it to be a multifunctional, hierarchically structured material.

Scientists in the project team included biologists, chemists and physicists, and studied things like the structural colour properties of the cuticle

“My favourite results are the environmentally friendly glitter based on cellulose nanocrystals, and studies of how plant surface topology influences insect adhesion,” notes Bruns. The role leaf surfaces play to repel insects is something which was reported in an article in ‘Scientific American’.

The researchers used everything that they had learned from analysing plant structures to then create novel synthetic materials that hold similar properties.

A NEW GENERATION OF BIOMIMICRY EXPERTS

The second strand of the project involved training new researchers. PlaMatSu trained a total of nine early-stage

researchers (ESRs) to a PhD level in the field of bio-inspired materials and surfaces.

As Bruns explains, this was the perfect opportunity to supervise ambitious researchers by internationally renowned experts on bio-inspired materials. The ESRs have now completed their research, and are now finalising their PhDs. Soon they will be fully trained and ready to embark on promising careers in academia and industry.

“The EU money enabled an international PhD school at the forefront of bio-inspired materials research,” adds Bruns.

COMMUNICATING THE RESEARCH

The PlaMatSu project carried out a wide range of efforts to communicate the research they were undertaking. This included publishing studies in prominent journals such as ‘Advanced Materials’, one of the leading scientific journals for materials research.

The ESRs also organised an exhibition, entitled ‘Our Future is Nature Inspired’, which was held at the Cambridge University Botanic Garden from September to November 2020. Some researchers were interviewed on the BBC Look East TV programme, discussing their research.

Collaborations between the various research groups are continuing, and the teams based in the United Kingdom are working to establish a United Kingdom-based research centre for bio-inspired material systems. They are currently working towards a major funding application.

PLAMATSU

- Coordinated by the University of Strathclyde in the United Kingdom
- Funded under Horizon 2020-MSCA-ITN
- cordis.europa.eu/project/id/722842
- Project website: plamatsu.eu
- bit.ly/PlaMatSu-video



The pivotal role of blockchain technology in securing robot swarms

An EU-funded project sheds light on how the union of blockchain with distributed robotic systems can pave the way for safe, reliable and trustworthy swarm robotic systems.

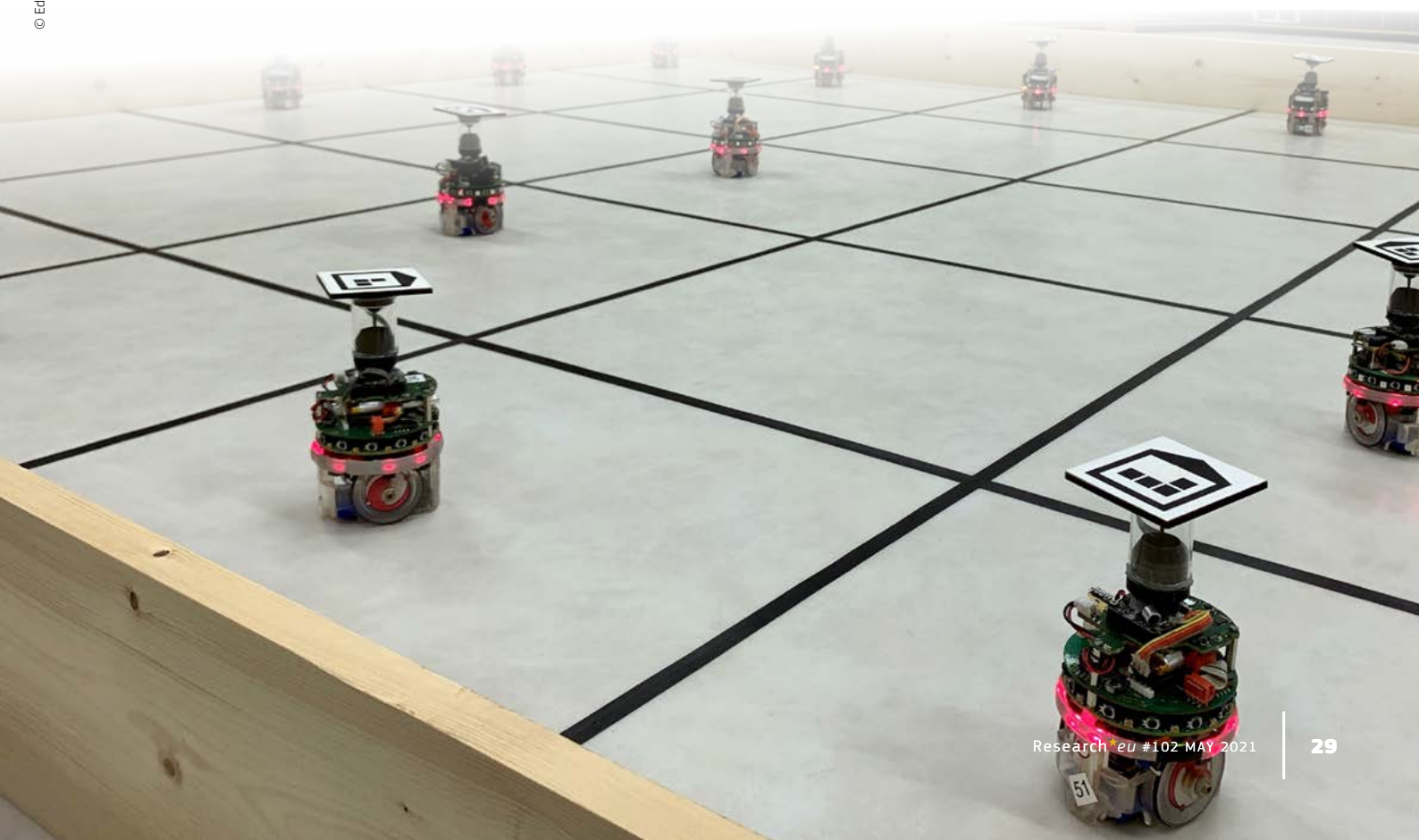
Inspired by nature, swarm robotics – the use of multiple robots that accomplish a task by forming structures and behaviours similar to the ones observed in natural systems – is expected to transform many industrial applications such as logistics and last mile delivery. However, the very characteristics that make these robots ideal for certain applications like robot autonomy and decentralised control present obstacles when it comes to transferring the technology from academic institutions to real-world problems. One such challenge is the concern over a lack of security standards in the field.

Blockchain, an emerging technology originating in the digital currency field, is proving to be an effective way to achieve tamper-resistant, secure data sharing systems. The combination of blockchain with distributed robotic systems therefore opens the door for more secure,

autonomous, flexible systems. The EU-funded BROS (Blockchain: a new framework for swarm RObotic Systems) project, with the support of the Marie Skłodowska-Curie Actions (MSCA) programme, set out to investigate this synergy. “Specifically, we worked towards understanding how we make swarms of robots secure and make decisions without a centralised authority and how solutions can be implemented in real-robot swarms,” explains Marie Skłodowska-Curie fellow Eduardo Castelló Ferrer.

PROFOUND RESULTS FROM MIXING TWO TECHNOLOGIES

“We designed, analysed and programmed several models and methods that combined blockchain-based technology and robotics in general and swarm robotics in particular,” notes Ferrer. Even though it was the first time



“In a nutshell, we realised that key future aspects for swarm systems such as security, privacy and safe data sharing can be significantly improved by adding blockchain-based technology into their operations.”

that this combination was explored, the project managed to prove, from a theoretical point of view, the feasibility of combining both techniques to solve current problems in the field, such as security and distributed decision-making.

The developed models and methods were then later validated through a series of experiments implemented in real-robot systems. “These experiments, for instance, show for the first time that a Merkle tree – a fundamental technology in the blockchain space – is a feasible method for encapsulating cooperative and collaborative robotic missions without disclosing high-level information about the mission itself,” adds Ferrer. In other words, robots can verify whether an individual job is part of a collective mission or not without knowing the outcome of the mission. “In technical terms, data verification can be separated from the data itself.” The project also offered a system whereby robots in a swarm, to cooperate in mission completion, have to ‘prove’ their integrity to their peers by exchanging cryptographic proofs.

“In a nutshell, we realised that key future aspects for swarm systems such as security, privacy and safe data sharing can be significantly improved by adding blockchain-based technology into their operations,” says Ferrer.

OPENING DOORS

“After the completion of BROS, we were able to publish high-quality work in several foundational papers which can be found on my website as well as organise the first public academic events in the field of blockchain-based technology for robotics,” concludes Ferrer. This is in addition to the three academic events organised during the project: one workshop and two symposiums to maximise the exposure and dissemination of the project’s work. These symposiums resulted in an emerging academic community of researchers, scientists and artists, amongst others, who developed an interest in the field of blockchain robotics.

BROS

- Coordinated by ULB in Belgium
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/751615
- Project website: bit.ly/BROS-overview

DIGITAL ECONOMY

Novel technologies enable human-robot interactions in warehouses

Efficient human-robot interaction is widely seen as the future of warehouse logistics. The EU-funded SafeLog project has delivered three technologies that should facilitate it, thereby reducing downtime related to unforeseen events in those warehouses where strict separation of humans and robots is the watchword.

Walk around a typical warehouse where products for e-commerce platforms are stored, and you’ll see two types of ‘workers’: robots and humans. Each have their own set of tasks and most often work in strictly distinct

environments. If a human accidentally enters a robot’s operating area, an entire section or even the whole warehouse will stop working, for safety reasons. This is of

“With our algorithm, we can basically organise, replan and orchestrate around 1 000 robots with humans.”

course far from convenient, and it can result in delays and higher operating costs.

In this context, various research teams have been working on new solutions allowing human-robot interactions. The SafeLog (Safe human-robot interaction in logistic applications for highly flexible warehouses) consortium, led by the Karlsruhe Institute of Technology (KIT) is one of them.

“Our objective is to enable humans to safely enter the area where the robots are working without the need to stop the whole warehouse,” says Björn Hein, coordinator of the SafeLog project. “We first developed a safety concept and a new technology to detect whether a robot comes close to a human. As soon as it does, the individual robot will slow down or even stop. The advantage here is that such a system is much cheaper than the very expensive strategy of equipping all robots with safety laser scanners.”

The second innovation is a concept and planning algorithm which can manage and orchestrate a heterogeneous team consisting of humans and robots sharing the same warehouse area. “Robots typically stay on their programmed paths, while humans can deviate and choose to take another route. We needed the rest of the warehouse – or

at least all robots nearby – to react accordingly. With our algorithm, we can basically organise, replan and orchestrate around 1 000 robots with humans,” Hein explains.

The third project outcome is meant to help human workers deal with instructions to fetch and collect certain goods in the warehouse. To guide them to the right location, SafeLog uses augmented reality (AR): The person in the warehouse wears an AR device showing the optimal path to the destination along with other relevant information. Using the same system, service technicians can even get information about the robot they are looking at, error messages, etc.

TOWARDS A LICENSING MODEL?

Whilst the SafeLog technologies have yet to be tested at a real customer site, several integration workshops and testing in a near-real environment have shown promising results. “The safety technology is positively heading towards certification. This would allow new and interactive warehouse concepts combining humans and robots,” Hein adds. “The planning and orchestration components could finally handle more humans and robots than originally planned, and it seems feasible to set up large warehouse systems. Besides, it seems our AR technology will soon be mature enough to assist human workers in everyday warehouse settings.”

With the project now completed, the consortium is focusing on the commercialisation of their safety technology and concept. Several companies have already shown interest in licensing the safety concept, and Hein doesn't exclude



such licence models for the future. Research will carry on, too: The safety technology is being tailored to ensure safe interaction of humans and mobile robots, while adaptation to the needs of other application fields is also on the table.

Further down the road, Hein envisions a potential SafeLog 2.0 dedicated specifically to the efficiency of human-robot interactions. "It seems like AI-based techniques and cognitive architectures focusing on understanding humans in the context of interactions with robots have a huge potential," he concludes.

SAFELOG

- Coordinated by the Karlsruhe Institute of Technology in Germany
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/688117
- Project website: safelog-project.eu
- ▶ bit.ly/SafeLog-video

DIGITAL ECONOMY

Putting the 'spott'-light on interactive content marketing

Today's consumers are more demanding and have shorter attention spans. As a result, advertisers are looking for innovative new 'pull' marketing solutions. One such solution is a new interactive content software programme that allows marketers to create engaging internet advertisements.

The Golden Rule of advertising is to be where your customer is. In the past, this typically meant 'pushing' your message to consumers. "Consumers were often reduced to being nothing more than a set of eyeballs, with marketers fighting for the attention of these eyeballs," says Jonas De Cooman, founder and CEO of Spott, a company specialising in interactive content software.

But things have changed a lot since the days of push marketing. "On the one hand, new technologies have given consumers more power to control what they see, while, on the other hand, our attention spans have decreased," explains De Cooman. "This shift in consumer behaviour has been mirrored by a shift away from 'push' marketing in favour of 'pull' marketing."

In this new era, marketers are using content to engage with their audiences. According to De Cooman, for these content experiences to work, a customer must be able to seamlessly go from inspiration to action – which is exactly where the SPOTT (Pioneering ICT-platform setting the new standard on advertising and how consumers shop) project comes into play.

"SPOTT is an interactive content software programme that allows marketers to add an interactive layer to their content," notes De Cooman. "This interactive content increases engagement, improves conversions and strengthens search engine rankings."



“Just because the internet is becoming increasingly visual doesn't mean it has to be any less interactive.”

Now, with the support of EU funding, SPOTT is one step closer to achieving its goal of becoming the reference for interactive content.

FROM CONCEPT TO SOFTWARE AS A SERVICE SOLUTION

SPOTT has evolved from a concept into a true software as a service solution. “In other words, our product is now mature enough for prospective customers to give SPOTT a try and, based on their experience and results, decide to adopt it,” adds De Cooman.

This approach seems to be working, as the solution is currently being used in 125 countries and by such major global brands as Mango, Elle, Adidas, Zalando, Nespresso, Ikea, Estee Lauder and Marie Claire, to name only a few.

It has also helped produce nearly 70 000 minutes of interactive video and over 4 million interactive pictures. It has earned a slew of awards and recognitions, including a listing in the Global Disrupt 100 and a 4.8 (out of 5) rating on Capterra and Trustpilot.

The company was named a Rising Star in Deloitte's Fast 50, Belgian Scale-Up of the year 2019, and Young Belgian Marketing Company in 2020.

MAKING THE INTERNET AN INTERACTIVE EXPERIENCE

By making content interactive, SPOTT has succeeded in adding extra value to content and commercials, namely, the ability for an audience to interact with them. “This interaction allows advertisers, retailers and publishers to gradually pivot from the traditional advertising solutions that no longer work towards such proven solutions as interactive ads, product placement and branded content.”

Despite its success, the company has no intention of slowing down anytime soon. To continue its growth trajectory, it is currently building an affiliate programme and adding to its reference cases.

“Just because the internet is becoming increasingly visual doesn't mean it has to be any less interactive,” concludes De Cooman. “Our aim is to help marketers build an internet where not only can users interact with text, but images and videos are also interactive experiences.”

SPOTT

- Coordinated by Spott in Belgium
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/823356
- Project website: spott.ai



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CORDIScovery podcast episode on
the new synergies of shopping?

→ bit.ly/CORDIScovery_e-shopping





Low-cost, flexible and secure Galileo-enabled software receiver in support of Space missions

EU-funded engineers are extending the flexibility and cost benefits of Space Global Navigation Satellite System receivers running on software, providing spacecraft with seamless navigation capabilities from low to high Earth orbits – and potentially beyond.

In Space, GNSS receivers enable satellite navigation, precise timing, precise orbit determination and attitude determination. The EU-funded ENSPACE (Enhanced Navigation in Space) project has made quantum leaps in the development of a software GNSS solution that supports Galileo and is especially aimed at the small satellite market sector, one of the fastest growing in the 'New Space' age.

Software-based GNSS receivers enable a new concept for Space. This is an activity that project coordinator Qascom initiated with NASA in 2016. The experiment was based on the use of NASA's software-defined radio platform called SCaN, attached to the exterior of the International Space Station (ISS).

At first, the SCaN Testbed provided an orbiting laboratory on the ISS for the development of software-defined radio technology for improved navigation and communication

experimentations. "In ENSPACE, we evolved this concept and invested in a new software GNSS solution that has been installed in commercial off-the-shelf hardware and is also compatible with other system-on-chip components," notes Samuele Fantinato, head of the Advanced Navigation Unit at Qascom.

"Our goal is to provide a reference product for navigation, positioning and timing for Space missions that require a low-cost, secure and flexible software solution," adds Fantinato. Compared to integrated circuits, the software version offers great design flexibility, fast adaptability to the needs of Space and the ability to customise the GNSS applications according to the mission requirements.

“Our goal is to provide a reference product for navigation, positioning and timing for Space missions that require a low-cost, secure and flexible software solution.”

THE KEY CONCERNS IN SPACE

In Space, GNSS receivers need to operate in quite different environments from those of ground-based receivers. “Precisely determining satellite position in Space is quite easy for those flying in low Earth orbits. At higher altitudes, such as in geostationary orbits or in interplanetary missions, signal variability becomes prominent. Adding new constellations could increase accuracy in these orbits,” explains Fantinato. Project members have proposed novel techniques for enhanced navigation, positioning and security in Space.

Charged particles and gamma rays are another concern for GNSS receivers. The ENSPACE software GNSS solution integrates techniques and logic redundancy that offer a more robust positioning accuracy in case of radiation events.

“ENSPLACE experimentation has also shown the benefits of snapshot positioning on the ground – a technique for determining the GNSS receiver position using a very brief interval of the received satellite signal. In this case, the technology could be based on a satellite navigation

payload with minimum hardware and software that collect the sampled signals transmitted to the ground,” notes Alessandro Pozzobon, director at Qascom.

Researchers are currently planning evolutions in techniques to mitigate GNSS receiver vulnerability to jamming and spoofing. “Providing some level of authentication to tackle GNSS spoofing ensures accurate positioning and robust navigation that go beyond state-of-the-art GNSS services,” says Fantinato.

The Galileo-enabled receiver is integrated into the CubeSat mission BOBCAT-1 that was recently deployed from the ISS. After validating its performance in Space, researchers will work to further evolve the solution and transform it into a full GNSS receiver product. Furthermore, they will investigate the possibility of adapting the receiver to launchers or satellites orbiting around the Moon.

ENSPLACE

- Coordinated by Qascom in Italy
- Funded under Horizon 2020-FOOD and Horizon 2020-LEIT-SPACE
- cordis.europa.eu/project/id/776405
- Project website: enspace-gnss.eu

SPACE

Modelling Galilean moon atmospheres finds evidence that Galileo detected a water plume on Europa

By modelling interactions between Jupiter’s plasma flow and the atmosphere of its moons – Io and Europa – AuroraMHD advanced interpretation of previous data. This included hints that Galileo had registered a Europa water plume.

The two Galilean moons – Io and Europa – are both embedded in Jupiter’s vast magnetosphere. This is a swirling magnetised plasma of electrically conductive ionised gas. The gas interacts with the moons’ atmospheres generating aurorae, as observed by the Hubble Space Telescope.

Changes to the brightness and morphology of these aurorae correlate with the moons’ changing plasma environment. For example, bright spots near Io’s equator oscillate in relation to Jupiter’s changing magnetospheric



field. Europa's aurora is faint in the equatorial region, with bright patches in the northern and southern polar regions.

Io's plasma interaction electromagnetically couples Io and Jupiter through an invisible electric current of charged particles leaving auroral 'footprints' in Jupiter's southern and northern hemispheres. The brightness of these vary according to Io's local interaction with the magnetospheric plasma.

The project AuroraMHD (Constraints on Io's and Europa's atmospheres and interiors from modeling of the satellites' aurora), supported by the Marie Skłodowska-Curie Actions, developed a computer model to study the interaction between the moons and the moving magnetised plasma. "Comparing our results to actual plasma measurements increased our knowledge about the interiors and atmospheres of these moons. We also possibly identified a Europa water plume detected by Galileo," says research fellow Aljona Blöcker from the KTH Royal Institute of Technology in Stockholm.

MODELLING PLASMA INTERACTIONS

AuroraMHD modelled different physical phenomena from moon and plasma interactions, such as collisions between particles in the moons' atmospheres and plasma particles from Jupiter's magnetosphere. As these phenomena fluctuate over time, the simulations were generated from different configurations.

The results were compared with measurements from NASA's Galileo spacecraft, through a collaboration with ESTEC-ESA.

Data about the electromagnetic fields in Europa's plasma environment, from each simulation, were input to further simulations of the flux of energetic protons.

Water molecules can modify the electromagnetic environment of the atmosphere and so affect the trajectories of energetic particles. As Europa is hypothesised

“With no direct observations of water plumes, hints like this are extremely important.”

to have a water ocean under its crust, proton movements were simulated within different configurations of Europa's atmosphere, with a water vapour plume present.

The results were then compared to energetic particle measurements made by NASA's Galileo spacecraft. "We were excited to see that including a plume in our simulation leads to a similar proton depletion as measured during one fly-by of Galileo," adds Blöcker. "With no direct observations of water plumes, hints like this are extremely important. Energetic proton depletions had not been analysed in relation to different atmospheric features of Europa before."

The team also modelled plasma interaction with Io to investigate how variations in Io's plasma environment and atmosphere could affect the energy flux radiating away from Io, which influences its aurora footprint.

"We related changes in atmospheric and plasma densities, alongside magnetic field alterations, to the variations in the brightness of Io's footprint observed by NASA's Juno spacecraft," explains Blöcker.

HELPING FUTURE MISSIONS

Io is the most volcanically active body in our solar system with lava flows and eruptions present all over its surface. The moon has a thin atmosphere of sulfur dioxide and might harbour a magma ocean.

Europa has a weak oxygen atmosphere and, covered in ice, has the smoothest surface in our solar system. As it harbours a salty water ocean under its icy crust, it is believed to have the key ingredients to sustain life.

AuroraMHD's results help the planning of future spacecraft observations, such as ESA's JUPITER ICy moons Explorer (JUICE) and NASA's Europa Clipper mission.

AURORAMHD

- Coordinated by the KTH Royal Institute of Technology in Sweden
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/800586
- Project website: bit.ly/3vfrXaZ



PROJECT OF THE MONTH

Celebrating the launch of Europe's largest astronomy network

Europe has had two Horizon 2020-funded major collaborative networks for ground-based astronomy, the OPTICON and RadioNet projects. As RadioNet ended in December 2020 and OPTICON will officially close in June 2021, a major new project began in March 2021 and has formally brought the two networks together. This month, we stretch our editorial rules to the limit and shamelessly highlight all three projects as our Project(s) of the Month to commemorate this important milestone.

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“It is very exciting to have this opportunity to further develop European integration in astronomy and develop new scientific opportunities for astronomy research across Europe and globally.”

Anton Zensus, ORP scientific coordinator,
on behalf of the entire ORP management team

The new project, appropriately called OPTICON-RadioNet Pilot (ORP), will form Europe's largest ground-based astronomy collaborative network. ORP is intended to remove barriers between scientific communities and harmonise observational methods and tools for ground-based optical and radio astronomy instruments. Researchers will have access to a wide range of facilities, building on the successes and experiences of OPTICON (Optical Infrared Coordination Network for Astronomy) and RadioNet (Advanced Radio Astronomy in Europe) before it. ORP will also help to train an entirely new generation of astronomers.

In particular, ORP will foster the development of the booming field of multimessenger astronomy, which makes use of a wide range of wavelengths as well as gravitational waves, cosmic rays and neutrinos.

ORP has received around EUR 15 million in funding through Horizon 2020, will last for 4 years, contains 37 partners

from around the globe and will be formally coordinated from the CNRS National Institute for Earth Sciences and Astronomy in France. For more information, please see the project website: orp-h2020.eu

OPTICON

- Coordinated by the University of Cambridge in the United Kingdom
- Funded under Horizon 2020-INFRA
- cordis.europa.eu/project/id/730890
- Project website: astro-opticon.org

RADIONET

- Coordinated by the Max Planck Society in Germany
- Funded under Horizon 2020-INFRA
- cordis.europa.eu/project/id/730562
- Project website: radionet-org.eu/radionet/

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!



FUNDAMENTAL RESEARCH

Shedding light on dark matter

New theoretical models and search strategies aim to help solve the dark matter puzzle.

Despite making up nearly 80 % of the universe's matter, dark matter remains largely a mystery. "Although there is overwhelming evidence that dark matter exists at all cosmological scales, no experiment has yet been able to identify this elusive substance," says Kai Schmidt-Hoberg, a physicist at DESY. "As such, when it comes to understanding what dark matter consists of and how it acts, we remain largely in the dark."

Schmidt-Hoberg is leading the EU-funded NewAve (New avenues towards solving the dark matter puzzle) project. To solve the puzzle, researchers are building theoretical models of dark matter and studying new collider signatures. They are also developing new techniques for comparing and interpreting direct detection experiments and identifying astrophysical probes that constrain, or give evidence to, dark matter self-interactions.

EXPANDING THE EXPERIMENTAL LOOKING GLASS

The European Research Council project used a multidisciplinary approach, bringing together experts from theoretical and experimental particle physics, astrophysics and cosmology. "The scope of this project was very broad, taking into account many different possible incarnations of dark matter within a number of different fields," he explains.

Researchers worked in close contact with various experimental scientists and technology. For example, NewAve researchers used high-energy machines like the Large Hadron Collider, low-energy colliders like Belle II, and such beam dump experiments as NA62.

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According to Schmidt-Hoberg, these collaborations led to novel search strategies, which are very important to making full use of these experimental facilities and supporting their search for dark matter. For example, researchers identified new signatures that can be observed using existing experiments. They also studied what new design experiments would need to have to cover the most interesting dark matter scenarios.

“Although there is still no clear experimental signal for the elusive dark matter particle, the NewAve project added more options to our experimental looking glass,” remarks Schmidt-Hoberg. “As a result, we now have a better chance of discovery in future searches.”

THE SEARCH CONTINUES

The project resulted in a significant number of scientific publications. “I expect a number of these to have a lasting impact on the overall dark matter community,” he concludes. “The improved theoretical understanding of

“When it comes to understanding what dark matter consists of and how it acts, we remain largely in the dark.”

dark matter that this project helped provide opens up new avenues to our ongoing search for dark matter.”

Schmidt-Hoberg also benefited personally from the project. Based on its success, he has secured a position as a permanent staff member at the DESY Theory Group – a role that will see him continue his work on dark matter.

NEWAVE

- Hosted by the German Electron Synchrotron (DESY) in Germany
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/638528
- Project website: bit.ly/NewAve_project

FUNDAMENTAL RESEARCH

Advancing theories of how pathogens spread from animals to humans

Scientists around the world are racing to understand spillover effects, when diseases spread between animal communities and humans. The research could help protect us better from future diseases.

As the COVID-19 pandemic has shown, infectious diseases have the power to disrupt our very way of life.

One of the main underlying mechanisms scientists are trying to understand is the spillover effect: when and how pathogens spread across the species barrier from animals to humans.

This happens a lot in nature, but the rate has been increasing dramatically in recent decades. Much of the increase comes as humans encroach and disturb animal habitats around the world, such as with the expansion of agricultural areas into heavily forested and remote regions.

The latest dramatic example of this is the jump of SARS-CoV-2 from an animal reservoir to humans, resulting in the devastating COVID-19 pandemic. Other examples include HIV and Ebola.

“It is clear that there is a continuing risk of new emerging infectious diseases in the near future. In order to prepare for such species-jumping pathogens, it is crucial to understand the biological mechanisms driving spillover,” explains Benny Borremans, a disease ecologist at project partner the University of California in Los Angeles.

“It is clear that there is a continuing risk of new emerging infectious diseases in the near future. In order to prepare for such species-jumping pathogens, it is crucial to understand the biological mechanisms driving spillover.”

That was the mission of the EU-funded project SpIL (Spillover of *Leptospira* in island populations of the Channel Island fox). SpIL studied an exceptional data set of the spread of *Leptospira*, a bacterial pathogen that causes leptospirosis, between populations of California sea lions and Channel Island foxes.

“The project synthesised concepts and case studies from the literature to develop a new theory on the spillover of pathogens between ecosystems,” says Borremans, lead researcher on the SpIL project and Marie Skłodowska-Curie fellow.

SCIENTIFIC ADVANCES

The first major outcome addresses a widespread problem when it comes to studying the spread of disease in a population: that it is difficult to know when exactly an individual has been infected, especially in animal populations.

A promising new approach measures the decay in biomarkers of infection, such as antibodies or the presence of genetic material of the pathogen. This lets researchers back-calculate when infection occurred.

“These analyses have traditionally only been done using experimental infection data, and a major advance of our work has been to enable the use of field data only,” explains Niel Hens, professor of Biostatistics at Hasselt University in Belgium and SpIL project coordinator.

A new statistical analysis created by the team let them integrate different biomarkers, improving the back-calculation of infection time. “This method is a major advance in the field,” adds Hens.

The work has been of immediate benefit for understanding the immune response against SARS-CoV-2, the pathogen which causes the COVID-19 disease. A rapid-response study led by Borremans was published in the journal ‘eLife’.

A second major outcome was the development of a new theory on spillover. The idea that the meeting of different ecosystems leads to spillover has been around for a while, but theoretical advances on the idea have been lacking.

“Through the synthesis of literature, we advanced new concepts on the spillover of pathogens near ecosystem boundaries,” says Jamie Lloyd-Smith, professor of Ecology and coordinator of the project work at the University of California.

The findings could be of instant use in preventing spillover effects.

“We find that although there are many reasons to indeed expect higher spillover rates at ecosystem boundaries, there are also mechanisms that decrease spillover rates,” Lloyd-Smith notes.

FUTURE RESEARCH

To avoid future pandemics, and truly understand spillover, scientists will need to establish a global survey network to continuously monitor samples in wildlife and humans.

“At the core of many of these efforts are quantitative modelling methods such as the ones developed in SpIL,” says Borremans.

SPIL

- Coordinated by Hasselt University in Belgium
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/707840
- Project website: bit.ly/2PGJ8ln



Teaching neural networks to go with the flow

From aircraft wings to Hollywood movies, a better understanding of how fluids move can find many applications.

Understanding how fluids move in three-dimensional space is central to a range of industries from medicine to engineering, and even creating convincing special effects in film. The EU-funded realFlow (Virtualization of Real Flows for Animation and Simulation) project sought to improve the connection between fluid models and the real world, using a machine learning approach.

Typically, fluid models are constructed to mimic real-world physics, giving researchers the ability to run simulations that are quicker and cheaper to carry out than physical experiments. realFlow was attempting the inverse. The project set out to create a system that could capture the underlying physics of real-world examples.

“For example, we’d like to have a cloud of smoke rising somewhere, and be able to predict what the underlying air movements are doing,” explains project coordinator Nils Thuerey, who is based at the Technical University of Munich. The goal was to be able to do this only from two-dimensional images.

To achieve this, Thuerey and his colleagues decided early on to pursue a machine learning approach. Neural networks were fed data on fluid movements such as smoke density and flow velocity, and allowed to come up with their own descriptions of the physics involved.

“We’d like to have a cloud of smoke rising somewhere, and be able to predict what the underlying air movements are doing.”

WINGS, WEATHER AND BLOOD

“The original proposal was to work with data, observational and simulated, to figure out what happens,” says Thuerey.

“Naturally we harnessed development in AI over recent years. We developed machine learning based on data sets, to be able to solve these different problems.” Thuerey adds his team is among the first to connect these physical problems with machine learning algorithms.

Being able to understand the underlying physical processes affecting a fluid, from footage of its movement, has a range of applications, such as analysing airflow over aircraft wings, or the forces generating weather systems.

Another application is in medicine, notes Thuerey. “You have the case of a marker injected into veins, where you can see the motion of a known quantity in an unknown field,” he explains.

“If doctors get immediate feedback about pressure distributions in a patient’s vein, they could adjust what they do in real time.”

SMOKE SIGNALS

Thuerey’s team also sought to improve the speed and quality with which smoke effects could be simulated by using a library of pre-generated data.

By taking the starting positions and velocity of smoke particles, a neural network builds a simplified model of the expected flow. It then searches the database for high-quality footage corresponding to those conditions.

The work was supported by the European Research Council. Thuerey says: “The grant was extremely effective, enabling us to work without spending a lot of time on

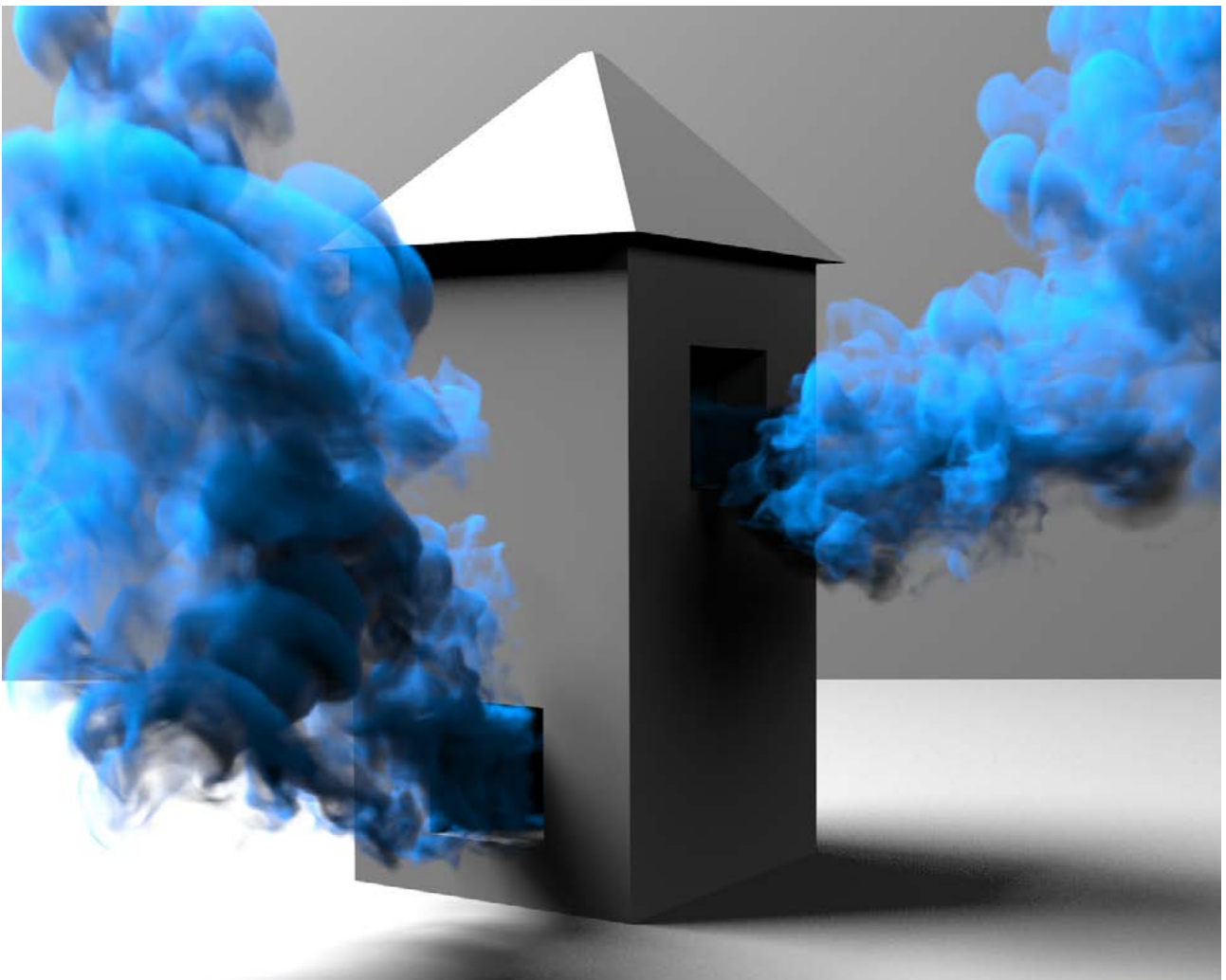
grant writing and worrying about immediate deliverables shortly after.”

He adds that the ERC grant also helped with his professional development, making a strong argument for his tenure at the Technical University of Munich.

The team has since secured a consolidation grant to further pursue their research. “This field, a combination of deep learning and physical simulation, has grown a lot,” concludes Thuerey. “Now we’re ready to take the next big step forward and go into practical applications. There are many exciting challenges to resolve.”

REALFLOW

- Hosted by the Technical University of Munich in Germany
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/637014
- Project website: bit.ly/realFlow-project
- ▶ bit.ly/2MjRe2e





AGENDA

JUNE 2021

ONLINE, PARTNER EVENTS AROUND EUROPE

EU Green Week

→ eugreenweek.eu

**31 MAY
→
13 JUN**

**2→3
JUN**

ONLINE

InvestHorizon Pitching eForum Health

→ bit.ly/eForumHealth

WORLDWIDE
World Environment Day

**5
JUN**

**8
JUN**

WORLDWIDE
World Oceans Day

PORTO, PORTUGAL
2021 Joint EuCNC & 6G Summit

→ bit.ly/EuCNC_6G_Summit

**8→11
JUN**

**20→25
JUN**

VENICE, ITALY

BIORIMA Nanosafety School

→ bit.ly/NanosafetyTraining

**2-4
JUN**

PONTA DELGADA, THE AZORES, PORTUGAL

All-Atlantic 2021

Held as part of the Portuguese Presidency to the Council of the EU, this conference will be an opportunity to discuss the progress of the current All-Atlantic marine research and innovation cooperation. It will strengthen the vision of “Connecting-Cooperating-Acting for the Atlantic Ocean”, launch an All-Atlantic Pledging Platform as a new approach to the existing cooperation and to deliver solutions to accelerate the twin green and digital transitions, building a greener, fairer, more resilient society.

→ allatlantic2021.eu

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.

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