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#87
NOVEMBER 2019

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A new smart system
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and better vaccine strategies
reduce antibiotic use

What can a 14 000-year-old puppy
tell us about the impact of
domestication and environmental
stress on DNA?

SPECIAL FEATURE
HOW TECH IS TAKING
ON TERRORISM

Editorial

Tech tackling terrorism, making factories a better place to work and a 14 000-year-old puppy revealing the impact of domestication

welcome to this month's Research*eu magazine

50% of overall public funding for security research in the EU comes from the Horizon 2020 programme. This month's special feature highlights the work being done by seven EU-funded projects, approaching the problem from diverse angles such as harnessing innovative technologies to identify threats, streamlining CCTV analysis and blocking the illicit use of crypto currencies.

We talk to Jordi Arias Martí, coordinator of the LETS-CROWD project, about their work on making crowded events across Europe more secure for citizens. They are setting out to find ways to deter, prevent, protect people from, pursue and effectively respond to criminal and/or terrorist actions. To do so they have created the LETS-CROWD Server, which offers agencies a suite of tools to make mass gatherings safer.

Security is clearly improved through EU-wide collaboration, as is scientific research. A shining example is the METSY project, which we catch up with one year on in our **Life After** feature. By unveiling the links between psychotic disorders and metabolic comorbidities, the project opened the door for new therapeutic options. The team is currently involved with the Innovative Medicines Initiative's (IMI) LITMUS project, which brings together 53 participants from across Europe, the US and Israel, including nine pharmaceutical companies.

Our health is also related to our work environment. According to data extracted this year by the EU's statistical office, the manufacturing sector employed 30.4 million people in the EU in 2016. Many of those will be working in factories. Our **Project of the Month**, Factory2Fit, is looking at ways to engage and motivate factory workers. One of a series of tools they have created is an app that collects and offers workers private, real-time feedback on their work wellbeing and achievements, and insights into how these are related.

If these projects, and the others covered in this edition of the magazine, intrigue you, check out our EU Agenda on the inside of the back cover for a brief overview of upcoming events at which other projects will be appearing, or browse the website for articles on results and news.

As always, dip in and out of our nine thematic sections showcasing the very best of EU-funded research in many diverse fields and until next month, if you have queries, questions, suggestions (but hopefully never a complaint), please feel free to drop us a line at editorial@cordis.europa.eu

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AcTakines: the next generation of immunotherapy

Immunotherapy is rapidly becoming the fourth pillar in combating cancer, next to surgery, chemo- and radio-therapy. With cytokines failing to show clinical efficacy, European researchers are turning to an innovative approach for addressing cytokine toxicity.

Cytokines are immune-regulatory proteins governing key physiological processes in the body. Cytokine dysfunction is associated with numerous pathologies including autoimmune disorders and cancer, and cytokines have therefore been exploited for treatment. However, their very spatially restricted activity pattern means that when administered systemically for therapeutic purposes, they cause severe side effects.

CELL-SPECIFIC TARGETING OF CYTOKINES

The EU-funded CYRE (Cytokine Receptor Signaling Revisited: Implementing novel concepts for cytokine-based therapies) project proposed to control the spatial distribution of administered cytokines. For this purpose, they developed activity-on-target cytokines (AcTakines), which only unveil their activity on target cells while remaining inactive en route through the body. “Our aim was to support the safe exploitation of the clinical potential of cytokines,” explains project coordinator Jan Tavernier.

AcTakines consist of a mutant cytokine, with strongly reduced binding affinity for its receptor complex, and a targeting moiety that binds a cell-specific surface marker. This facilitates specific targeting and avoids the systemic toxicity associated with the pleiotropic binding of cytokines.

Following proof of principle for structurally diverse cytokines such as type I and II interferons, tumour necrosis factor (TNF) and interleukin-1 (IL-1), CYRE researchers validated the AcTakine effects *in vivo* in different mouse models for melanoma, lymphoma and breast carcinoma. When targeting cancer cells or distinct cells of the immune system, efficacy of AcTakines paralleled

that of classic cytokines, leading to complete tumour growth arrest but without the undesired side effects. Improved treatment outcome was achieved in combination therapy with doxorubicin or when targeting the tumour vasculature. Apart from minimal toxicity, administration of AcTakines provided anti-tumour immunity.

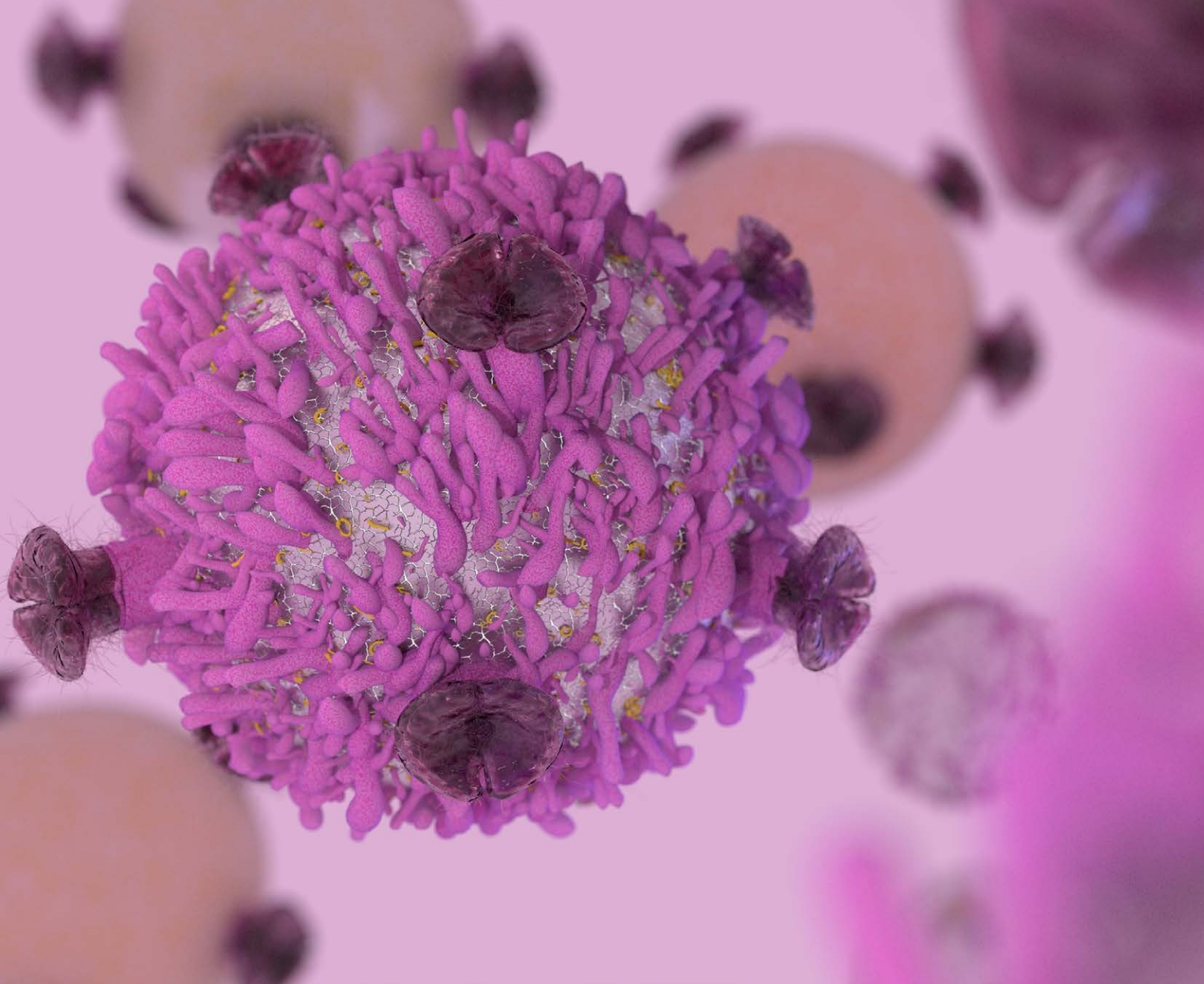
ACTAKINE MERITS

Looking back to 1980 when as a PhD student he was part of the team that cloned interferon genes, Tavernier reminisces about the huge expectation the scientific community had for these novel anticancer drugs. Unfortunately, major toxicity issues blunted their full clinical potential.

CYRE has demonstrated that the AcTakine concept can in principle be applied to every type of cytokine. By developing AcTakines for structurally different types of cytokines, scientists have demonstrated that the intrinsic toxicity of cytokines can now be controlled. The single cell-type targeting precision of AcTakines renders them safe for systemic administration while preserving their therapeutic potential.

AcTakines can be used to treat a very broad range of cancers, reducing the overall clinical development costs. Importantly, since they do not necessarily target the tumour cells themselves, resistance to therapy will be significantly lower compared to traditional anti-cancer drugs.

To take AcTakines from bench to bedside, Tavernier co-founded with Nikolai Kley a spin-off company called Orionis Biosciences. The company that now also operates across the Atlantic has built a very extensive IP portfolio covering many aspects of the AcTakine



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“*AcTakines will make their way to the clinic for a broad range of diseases beyond cancer, including many autoimmune disorders.*”

platform. Selected AcTakines with optimised pharmaceutical properties for human use are already in the production phase. According to Tavernier, further clinical development in collaboration with key pharma companies in the immunotherapy field will facilitate the phase I clinical trials, which are expected to commence by the end of 2020.

Looking to the future, Tavernier is feeling confident: “AcTakines will make their way to the clinic for a broad

range of diseases beyond cancer, including many autoimmune disorders.” With immunotherapy currently focusing on targeted antibodies, immune checkpoint inhibitors, and cell-based therapies, AcTakines will help revive the therapeutic potential of cytokines.

CYRE

- Hosted by VIB in Belgium.
- Funded under FP7-IDEAS-ERC.
- cordis.europa.eu/project/id/340941

New drug aims to increase the success of kidney transplants

The EU-funded Renaparin project is supporting the clinical trial needed to move a new drug for preventing Delayed Graft Function towards commercialisation.

Donor kidneys lack a natural blood flow when waiting to be transplanted into the recipient. Known clinically as Delayed Graft Function (DGF), the resulting kidney injuries and potentially impaired function of the organ can cause the receiving patient to go into dialysis within the first week of the transplant – among other issues.

Given the alarming shortage of organs available for transplantation, the prevention of DGF is a top priority for the transplant community.

This is why the Swedish pharmaceutical company Corline Biomedical is developing a drug aimed at improving the outcome of kidney transplantations. Called Renaparin®, the candidate drug is used to treat the donor organ outside the body and, by doing so, repair the damaged vascular bed before the transplantation.

With preclinical data showing that Renaparin® improves kidney functionality after transplantation, Corline is eager to advance the drug to the next level. The EU-funded

Renaparin (Improving kidney transplantation outcome with Renaparin® for patients with End-Stage Renal Disease by attenuating graft ischemia reperfusion injury) project supports the clinical trial needed to move the drug towards registration and eventual commercialisation.

“The intent is to demonstrate Renaparin’s® potential to improve the number of successful kidney transplantations,” says project coordinator Henrik Nittmar. “The resulting clinical safety data will constitute the basis for further clinical development and commercialisation of the product.”

BUMPS IN THE ROAD

Through Phase I/IIa clinical trials in humans, this project aims to demonstrate that the drug is safe for use in a clinical setting. Furthermore, the project intends to evaluate several clinically relevant endpoints that could be used to show that Renaparin® is effective at preventing DGF, along with gaining end-user experience that is critical to guiding Corline towards registering the drug for approval and subsequent marketing and sales efforts.

However, the launch of the clinical trial phase was significantly delayed due to inconsistent data on Renaparin®’s stability. In response, the project assembled a team of internal and external experts who worked with the Swedish Medical Products Association (MPA) to overcome any regulatory concerns. The team also worked closely with the Swedish transplant surgeon community to gain their trust in the drug.

“It took us 6 months of hard work before we were able to rule out any patient risks and re-submit the updated trial application to the Swedish MPA for renewed approval,” says Nittmar. “Compared to the industry standard, we were able to handle this issue remarkably fast – a point of great pride amongst the project team.”



PROMISING INITIAL RESULTS

Back on track, researchers continue to work towards the end goal of demonstrating Renaparin®'s safety for use in treating DGF. With the clinical trial running, the drug has already been used to treat patients in the intended way, and feedback from transplantation surgeons has been positive. By the end of the project in February 2020, researchers are confident that Renaparin® will have completed Phase I/IIa clinical trials and be well-positioned for further development in Phase IIb/III trials.

"Corline's long-term strategic focus lies in establishing Renaparin® as a new cell replacement technology in kidney transplantations. This project plays a key role in helping us achieve that goal," says Nittmar.

“Corline's long-term strategic focus lies in establishing Renaparin® as a new cell replacement technology in kidney transplantations. This project plays a key role in helping us achieve that goal.”

RENAPARIN

- Coordinated by Corline Biomedical AB in Sweden.
- Funded under H2020-HEALTH.
- cordis.europa.eu/project/id/756195
- Project website: corline.se

HEALTH

Improved acne care with new digital assessment tool

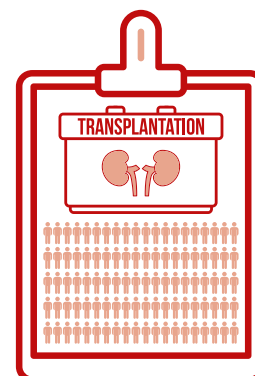
If the European healthcare system is to become more efficient, patients need to be better able to self-manage some conditions, and digital solutions can be key. ScanZ created a tool which improves quality of life for acne sufferers and treatment by medical professionals.

Despite being the eighth most common diagnosis globally, acne assessment scales use subjective terms such as 'some' or 'many' to quantify the presence of lesions. With more than 25 different scales, these are inexact.

Furthermore, the wider context (age, gender, accompanying conditions such as hormonal disorders, nutrition, genetic factors and psychosocial elements) is generally not taken into account.

Clinicians have to exercise their best judgment based on their own experience and previous cases, making it difficult to monitor treatment plans consistently over time and over different points of care.

With EU support, and in conjunction with partner hospitals, the ScanZ (Digital acne assessment tool enabling acne diagnosis in cost and time efficient way) project was



8 000 to 10 000 people
in the **US** and the **EU**
die each year while on the
kidney transplant waiting list

“*ScanZ represents an important contribution for the enhancement of acne care.*”

able to improve a pre-existing cheap and effective tool. As well as enabling a standardised acne assessment, the tool also enhances tracking along the care pathway. This results in patients getting the right treatment, at the right time and place, as well as becoming active participants in their condition's management.

PRODUCT AND PLATFORM

ScanZ consists of a tablet-based software application and handheld scanner. The scanner uses a specialised light technique, known as multispectral imaging, to read skin characteristics. In addition to counting lesions, the underlying algorithms quantify severity using features such as gland activity, oiliness and pigmentation, providing an objective assessment. The combined information is then made available to healthcare practitioners.

The system has been developed to offer optimum management across the whole care pathway. For example, it can be used by pharmacists to select the most appropriate over-the-counter medication, as well as by secondary care providers to record history and disease progression using the standardised assessment. In practice, this means that nurses can perform follow-ups instead of dermatologists.

To date, the system has been demonstrated at the Harrogate and District NHS (National Health Service) Foundation Trust in the UK. The study protocol has been approved by the NHS Ethics committee and preliminary staff training has been undertaken in preparation for the clinical study.

“ScanZ represents an important contribution for the enhancement of acne care. Indeed, it was recognised in an NHS report as a solution for some challenges related to treatment, including the overuse of antibiotics and the problem of antimicrobial resistance,” says project coordinator Sava Marinkovic.

SELF-CARE

ScanZ enables patients to get the right acne treatment at the earliest time, avoiding some of the long-lasting



negative impacts, such as physical scarring or psychological distress. Monitoring their own skin through an app extension of the core platform, enables patients to self-manage their health – a goal of the EU's health-care strategy.

Allied to this is the project's contribution to the EU's goal of integrated healthcare by introducing the technology at multiple care points, from pharmacy to primary care, and hospitals to clinics. This reduces treatment visits and avoids repetition of ineffective treatment.

The first ScanZ product, a tablet-based analysis tool, is currently undergoing final preparations before submission as a Class IIa medical device. Additional imaging algorithms and the scanner will be available sometime after 2020, on completion of the clinical studies.

Marinkovic says: “The initial focus is to ensure the product meets the needs of patients. Afterwards, we will incorporate more of the data/algorithmic aspects and hardware. Given that acne is a class of general inflammatory diseases, we plan to later focus on other related diseases such as rosacea, psoriasis and eczema.”

SCANZ

- Coordinated by Myskin DOO Beograd (Stari Grad) in Serbia.
- Funded under H2020-LEIT-ICT, H2020-HEALTH and H2020-SME.
- cordis.europa.eu/project/id/733543
- Project website: scanz.net



LIFE AFTER...

Catching up with METSY: How the link between psychosis and obesity has paved the way towards new treatment options

This month we catch up with METSY, featured in our October 2018 special section that focused on mental health. METSY unveiled the links between psychotic disorders and metabolic co-morbidities and thus opened the door for new therapeutic options tackling psychosis whilst preventing metabolic complications.

The key outcome for METSY (Neuroimaging platform for characterisation of metabolic co-morbidities in psychotic disorders) was that weight gain is indeed associated with first episode psychosis (FEP) and that the potential medical impact lies in identifying patients with high risk of rapid weight gain, and guiding their treatment to prevent metabolic comorbidities. Advancing these findings was an absolute priority. "And luckily, this is happening," comments Project coordinator Matej Oresic. "There are now multiple studies ongoing derived directly from the METSY results, also with researchers who had not been originally involved with METSY itself."



With METSY, we were among the first to highlight the importance in studying metabolic co-morbidities in psychoses.

Matej Oresic

Project coordinator of METSY

© Matej Oresic

PUSHING THE METSYS DECISION SUPPORT TOOL TOWARDS CLINICAL INTRODUCTION

We found out that METSY had developed a decision support tool to help provide better and more targeted treatment to at-risk patients. "To achieve this, further pilots are needed to test the tool in-clinic," admits Oresic. "However, the METSY participant involved in the tool development has done that in one disease area already, for Alzheimer's disease, and a spin-off company has been established."

Oresic hopes that further steps will be taken to achieve something similar with the decision support system for psychosis, however it's still a work in progress.

FURTHER COLLABORATION THROUGH THE IMI

Another important METSY finding was a lipid signature



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that suggests that psychotic patients who are most at risk of developing metabolic complications have increased markers of liver fat already prior to such complications. "Related to these findings, we are currently involved with the Innovative Medicines Initiative's (IMI) LITMUS project," explains Oresic. "This project is developing novel molecular diagnostic tools to diagnose and monitor non-alcoholic fatty liver disease (NAFLD). Although it's in its early stages we still aim to evaluate the diagnostic tools in the psychiatric population."

Reflecting on the impact of EU funding, Oresic comments: "With METSY, we were among

the first to highlight the importance in studying metabolic co-morbidities in psychoses, which is receiving increased interest in psychiatry."

Looking ahead, Oresic hopes that the METSY findings and tools will allow him and his team to pursue further research aiming to understand the metabolic component in psychosis.

METSYS

→ Coordinated by the University of Turku in Finland.

→ Funded under FP7-HEALTH.

→ cordis.europa.eu/project/id/602478

Online registry connects materials of counterculture and non-conformism in Eastern Europe

There are numerous historical documents and objects that substantiate cultural movements and forms against communism in Europe. However, the collections in which the documents and objects are created are scattered and largely unfamiliar to the wider public. An EU-funded project has a solution.

The COURAGE (Cultural Opposition: Understanding the Cultural Heritage of Dissent in the Former Socialist Countries) project worked to compile information on as many of the collections and artefacts of the cultural resistance movements and initiatives as possible in an online registry and database – one that is user-friendly and searchable. Sándor Horváth, the primary project coordinator, explains: “We wanted to provide materials which would further research on extremely diverse forms of cultural opposition in Eastern Europe.” Cultural opposition has had a very exciting history in the region, but it has rarely been recognised as part of a pan-European culture.

A CLOSER LOOK AT KEY ACHIEVEMENTS

COURAGE created a living database in 16 languages – the COURAGE Registry – that describes and connects collections of materials that constituted forms of counterculture and non-conformism under state socialist authoritarian systems in Eastern Europe. The registry has furthered the discovery of collections that have been scattered and hidden because official cultural politics under state socialism prohibited the systematic archiving of dissident culture. “We also created a handbook, which addresses the culture of dissent and made a pioneering attempt to integrate results into educational settings via our learning platform,” adds Horváth.



Péter Apor, project coordinator, notes another achievement: "Having persuaded several hundred archives and museums, including private collectors, that it is beneficial for them to join the registry. They collaborated with us to prepare the descriptions, and there are quite a few who made COURAGE a personal cause." The registry allows archives and museums to map materials similar to their holdings in Europe and launch joint projects across national and cultural borders.

Tamás Scheibner, registry manager, dissemination manager and developer of higher education materials, further notes: "Usually, research results are only slowly incorporated into educational practices and institutions. The COURAGE Learning Platform helps teachers integrate up-to-date knowledge into their courses." Full narrative course-aids for secondary schools have been prepared, while the interactive curricula for higher education leaves space for individual professors to curate materials from the rich COURAGE database. "What is entirely new is the modular syllabus system invented at the Hungarian Academy of Sciences. It allows professors to modify the default syllabus modules and create and share their own modules with one another," outlines Scheibner.

COURAGE INTO THE FUTURE

"Leading European policy-makers have asked us to expand the registry into a platform that covers not only Eastern European but also Western European non-conformism," reports Horváth. This would be beneficial for

“ We wanted to provide materials which would further research on extremely diverse forms of cultural opposition in Eastern Europe. ”

the European community, and the project hopes to source funding to realise this plan. "We actively seek collaborative partners from Russia and the United States so that we can help European archives and museums establish partnerships beyond the EU," adds Horváth.

The database also has a lot of potential for investors, particularly in the SME sector. "Art galleries, for example, might greatly benefit from developing a marketplace for Eastern European neo-avantgarde art that would also serve museums interested in raising funds for new acquisitions and improving conditions for preserving and exhibiting their materials," notes Horváth. Such relationships would help sustain high-quality research in the humanities, and as Horváth says: "Investors are welcome to approach us." A Euronews video is available for further information.

COURAGE

- Coordinated by the Research Centre for the Humanities, Hungarian Academy of Sciences in Hungary.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/id/692919
- Project website: cultural-opposition.eu
- ▶ youtu.be/B9TL28csyVY

SOCIETY

Filling in the research gaps on the borders and boundaries of contemporary Syria

When borders change, as seen with Lebanon and Palestine, research is carried out to study and document them. However, this has not been the case with the Syrian borders. An EU-funded project set out to change this.

Literature, mainly monodisciplinary, is limited when it comes to the study of borders, a field that suffers globally

from theoretical weakness and the use of outdated research methods and techniques. Syria's borders are no

exception to this. As Matthieu Cimino, project coordinator of SYRIANBORDERS (The Fall of a Colonial Legacy: A Modern History of Syrian Borders (1920-2015)), explains: “I found that there has been absolutely no research on the history of the Syrian borders – it is non-existent.”

This is concerning especially post-2011 in a country that went through the Syrian revolution, the civil war and the war that followed – a country where borders and boundaries are key issues. Cimino adds: “In the Syrian context, it is important to understand how different non-state actors perceive the boundaries of Syria, how relevant they are now, and how they have been configured over time.” Cimino stresses that research into this area is vital: “Borders and boundaries are the envelope of the state – charged with important symbolic values.”

SYRIANBORDERS worked towards two main objectives. The first was to contribute to the history of contemporary Syria by analysing the country through the prism of its borders, and secondly to produce a monograph that would include post-2011 dynamics. Ultimately, this should provide researchers, political actors, civil servants and the public with an understanding of post-2011 reconfigurations of the Middle East as well as the potential implications for Europe.

LESSONS LEARNT

“The first thing we realised is how the borders – post-colonial 1920 Syria – were profoundly internalised by

“ *In the Syrian context, it is important to understand how different non-state actors perceive the boundaries of Syria, how relevant they are now, and how they have been configured over time.* ”

Syrian actors,” explains Cimino. Symbolically and in the minds of Syrians such as the opposition and the Syrian state, the notion of Syria’s borders, as we understand them to be right now, was internalised. “But in parallel, with the emergence of non-state actors such as the Kurds, the idea of Syria’s borders was the exact opposite,” Cimino adds.

For example, over the past few months, Cimino has been working on the geography and history textbooks that have been created, disseminated and taught by both the Kurds and the Islamic State. Cimino notes: “It was very interesting to see their differing perceptions of what the territory of Syria is supposed to be.”

NEXT STEPS

“First thing, we are now publishing the books that will follow the international conference that we organised in November 2017, ‘Exploring Syria’s Borders and Boundaries’,” reports Cimino. “On 7 April, I signed a contract with Palgrave Macmillan, a large publisher in the US.” They are currently waiting for articles for the book titled ‘Syria: Borders, boundaries, and the state’, which is due to be published in November 2019.

Secondly, regarding the academic aspects, Cimino confirms: “I will focus on understanding nationalistic ideology and non-state actors by looking at their textbooks and seeing how they teach history and geography.” On a final note, Cimino emphasises how the Marie Skłodowska-Curie programme helped him: “It has given me the opportunity to do field work and open myself to write work and has definitely helped change my academic career.”

SYRIANBORDERS

- Coordinated by the University of Oxford in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/701923





Identifying legal and administrative barriers and solutions for hydrogen technology

Despite the progress of fuel cells and hydrogen technology, legal and administrative processes (for planning, safety, installation and operation) struggle to keep up, resulting in costly delays which jeopardise investment. HyLAW's evidence-based approach offers sector traction.

The EU-funded coordination and support action project HyLAW (Identification of legal rules and administrative processes applicable to Fuel Cell and Hydrogen technologies' deployment, identification of legal barriers and advocacy towards their removal) was the first of its kind to comprehensively review the root causes behind legal and administrative barriers holding back the deployment of fuel cell and hydrogen (FCH) technologies, in 18 national legal systems, as well as the EU's own.

HyLAW generated reports to shape future legislative solutions, and its public website provides 3 000 unique visitors per month with information on the legal and administrative process (LAP) obligations applicable for hydrogen technologies. As well as raising the profile of the technology amongst policy-makers, HyLAW also helped consolidate the largest European network of national hydrogen associations and experts (i.e. the project partners) under the umbrella of Hydrogen Europe.

FROM AUDIT TO ACTION

HyLAW established the scope of their work in consultation with companies who had successfully overcome legal and administrative challenges, despite a lack of publicly available guidance. Data about which LAPs constituted a deployment barrier, and their time and/or resources impact, was collected from each participating country.

"This workflow allowed us to prioritise barriers, focusing on the most severe, for targeted follow-up actions," says project coordinator Nicolas Brahy. "One example is in the maritime field where certification of hydrogen vessels is difficult. By understanding precisely what causes this barrier, we could collect the necessary data to aid legislative development."

All the data was made publicly available through a dedicated online database, in formats appropriate for targeted users, mainly operators seeking to bring hydrogen technologies to market and needing to comply with existing rules. But the database was also intended to inspire policy-makers by showcasing better practices from other EU Member States.



"The underlying Excel file contained more than 55 000 fields. Seeing this become an easy to navigate website, following many hours of brainstorming and piloting, is something we are proud of," explains Brahy.

Coordinated by Hydrogen Europe, the European association for FCH technologies, which brings together over 120 industrial members and 17 national associations (such as non-profit organisations), HyLAW further strengthened European cooperation in the sector.

"It's the first time ever that the entire European FCH sector has united with a clear and common ambition," says Brahy. "Within HyLAW, this network was essential to collecting accurate data at a national and sometimes even regional level."

SUPPORTING DECARBONISATION

The push for hydrogen technologies is in line with the EU's decarbonisation agenda. In support of this, Hydrogen Europe's Charter requires all its members to recognise hydrogen as an enabler for a net zero emission society.

The HyLAW project was fully in line with these ambitions. For example, the 'Hydrogen in the gas grids' category deals with the LAP implications of injecting (decarbonised) hydrogen

“ *It's the first time ever that the entire European Fuel Cell and Hydrogen sector has united with a clear and common ambition.* ”

into the gas grids. For every 1 % of European natural gas demand replaced by renewable hydrogen, CO₂ emissions could reduce by 8 million tonnes each year.

Despite the project's end, the team still maintains the website, keeping the database up-to-date, and leads follow-up activities and initiatives such as a maritime working group, as part of their ongoing commitment to the sector.

Beyond this, the team will collect relevant data surrounding policies and regulations affecting hydrogen deployment, but not covered by HyLAW for the Fuel Cells and Hydrogen Observatory (FCHO), culminating in a public database in 2020.

HYLAW

- Coordinated by Hydrogen Europe in Belgium.
- Funded under H2020-ENERGY.
- cordis.europa.eu/project/id/735977

ENERGY

Advanced electrochemical diagnostics promise to extend the healthy life of fuel cells

Fuel cells produce electricity without combustion, yielding only heat and water as by-products. Onboard technology to increase performance and decrease costs should enhance uptake in a myriad of applications.

The Industrial Revolution was largely powered by steam engines and coal combustion. Today, steam turbine generators relying on combustion of fossil fuels produce over 65 % of the world's electrical energy.

Polymer electrolyte membrane fuel cells (PEMFCs) are among the top contenders for cleaner renewable energy. Applications include heat and electricity generation for homes and buildings (so-called micro-combined heat and power or μ -CHP) and for backup power.

An advanced diagnostic and monitoring tool developed by the EU-funded project HEALTH-CODE (Real operation pem fuel cells HEALTH-state monitoring and diagnosis based on dc-dc COnverter embeddeD Eis) promises to significantly enhance performance and decrease costs of PEMFCs in these and other applications.

SIMPLE REACTIONS, COMPLEX DIAGNOSTICS

PEMFCs produce electricity directly from hydrogen and oxygen gases. Hydrogen gas at the anode is split into positive hydrogen ions (protons) and electrons. A catalyst-coated PEM separating the anode and cathode allows only the protons to diffuse. Electrons are forced through an external circuit to the cathode, generating electricity. At the cathode, the electrons and hydrogen ions combine with oxygen from the air, producing water that flows out of the cell.

A number of things can affect both the functioning and lifetime of PEMFCs, including impurities in the hydrogen fuel source or inadequate supply of fuel or oxygen. The presence of sulfur-based compounds in PEMFCs, due to impurities in the gas stream after reforming for example, can poison the catalyst layer. Water balance is critical, as too much causes 'flooding' and too little can dry out the membrane.

The HEALTH-CODE monitoring and diagnostic tool controls all these conditions and detects issues before they irreversibly affect the functioning and lifetime of PEMFCs.

ADVANCED SPECTROSCOPY PROVIDES THE SOLUTION

According to project coordinator Cesare Pianese: "Previous monitoring approaches relied on numerous conventional sensors of temperature, pressure, mass flow rate and voltage among others. These require massive data analyses as well as modelling techniques to compensate for the lack of direct information on the electrochemical processes occurring inside the cells."

The HEALTH-CODE solution is a step-change for monitoring and diagnoses of PEMFC performance. The tool exploits electrochemical impedance spectroscopy (EIS), a well-known technique already used in numerous applications. Its wide utility rests in the plethora of information it delivers, covering electrode parameters and multiple electrochemical reactions that take place at different rates.

Validation in a real operating environment confirmed the tool's ability to detect a fault mode before irreversible damage occurs, more reliably than previous approaches, and with integration adding less than 3% to production costs. The resulting reduced operating and maintenance costs will be a key incentive for the uptake of PEMFCs.

EMPLOYING PEOPLE AND INFRASTRUCTURE TO CREATE DISASTER-RESILIENT SOCIETIES

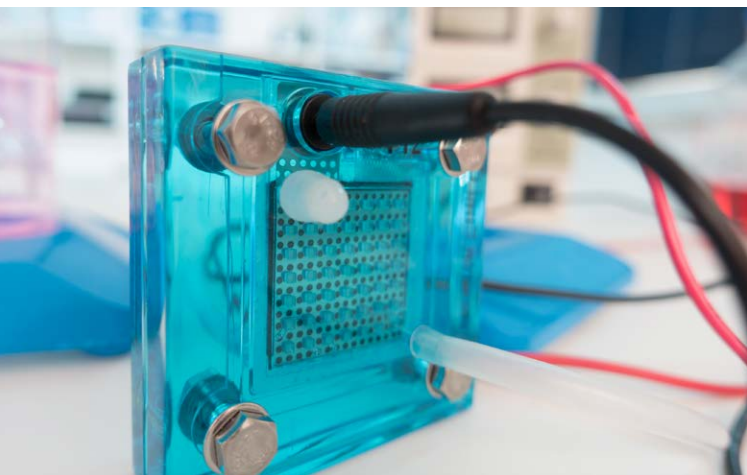
Earthquakes, forest fires, tsunamis, tornadoes and other natural phenomena cause untold misery to millions of people every year. And it's not just natural phenomena – manmade actions, such as cybercrime and terrorism, could also cause untold damage to society.

In our latest **Results Pack**, we look at how EU-funded research has utilised people and infrastructure to create better and more efficient **disaster-resilient societies**.

Effective disaster resilience is dependent on effective management. In all of the above disaster scenarios, first responders are key and must be protected. Citizens are also vulnerable and many new technologies are being developed to increase risk awareness and resilience amongst the general populace.

To find out more, browse, download or order
a physical copy of the Results Pack here:
cordis.europa.eu/article/id/410190





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According to Pianese: “Exploitation will lead to improved maintenance, integration within new energy paradigms such as smart buildings/grids and enhanced implementation of virtual power plant management.” In addition, the technology could soon benefit applications beyond PEMFC-based μ -CHP and backup power. Among others, mobile systems (cars, buses, trains) could be the first fuel cell-based technologies to benefit from EIS-based monitoring and diagnosis.

“Exploitation will lead to improved maintenance, integration within new energy paradigms such as smart buildings/grids and enhanced implementation of virtual power plant management.”

Innovation should continue well beyond project completion, thanks to two successful joint workshops generating heightened interest. Furthermore, there are plans for development of a ‘growth ecosystem’ nurturing cross-fertilisation among players at the regional, national and international level.

HEALTH-CODE

- Coordinated by the University of Salerno in Italy.
- Funded under H2020-ENERGY.
- cordis.europa.eu/project/id/671486
- Project website: pemfc.health-code.eu

ENERGY

New synthetic biology approaches enhance solar energy collection by bacteria

Meshing bacteria with technology can not only turbocharge photosynthesis, but also provide new ways to obtain inexpensive, unlimited clean energy from sunlight. SYNTHPHOTO's new synthetic approaches and experimental findings are providing a step towards this reality.

Plants, algae and bacteria capture light energy from the Sun and transform it into chemical energy through photosynthesis. These phototrophs harvest sunlight thanks to millions of photosynthetic pigments – like chlorophyll and bacteriochlorophyll – contained in each photosynthetic cell. To be able to absorb light energy and pass it on to the energy-requiring reactions of photosynthesis, these pigments need to be attached to the backbones of specialised proteins.

The EU-funded SYNTHPHOTO (Powering cells with light: the synthetic biology of photosynthesis) project provided further insight into this poorly understood binding mechanism. “We want to figure out how pigment-protein complexes are made and how they start a process that eventually results in the production of adenosine triphosphate – a complex organic chemical that powers the thousands of chemical reactions that enable the cells to grow and divide. These light-harvesting complexes not

only provide energy for life, they also hold the secret of designing devices that could one day provide truly clean, unlimited energy from sunlight,” notes Neil Hunter, coordinator of SYNTHPHOTO.

INVESTIGATING CHLOROPHYLL BIOSYNTHESIS

Researchers in the Hunter laboratory have cloned and sequenced many of the genes for the chlorophyll biosynthetic pathway from *Rhodobacter sphaeroides* – a purple photosynthetic bacterium – and from the cyanobacterium *Synechocystis*. They successfully produced many of them in an active form in *Escherichia coli*. With focus on the enzymology of this pathway, the team uncovered the enzyme reactions that underpin the first and third steps of chlorophyll biosynthesis as well as the actual identity of the enzyme that bestows the green colour to the plants – so dominant on Earth it is visible even from outer space.

Importantly, this is the first time that researchers successfully reconstituted the chlorophyll biosynthesis pathway in a non-photosynthetic organism. “We have successfully assembled genetic modules in *Escherichia coli* that produce the full chlorophyll pathway. Our results delineate a minimum set of enzymes required to make chlorophyll and establish a platform for engineering photosynthesis in heterotrophic model organisms,” notes Hunter.

UNCOVERING THE STRUCTURE OF LIGHT-HARVESTING COMPLEXES

Thanks to the use of atomic force microscopy, crystallography techniques and electron microscopy data, researchers constructed for the first time atomic-level

“Such artificial light-harvesting arrays will advance understanding of natural energy-converting systems, and could guide the design and production of proof-of-principle devices that can efficiently capture, convert and store solar energy.”

models of the whole photosynthetic membrane assemblies of *Rhodobacter sphaeroides*. The models successfully predicted the doubling time of the bacterium – a remarkable result.

Another important achievement has been the determination of a photosynthetic protein structure that harvests and traps infrared light and converts it into an electrical charge. The pioneering research was performed on a photosynthetic complex from the bacterium *Blastochloris viridis*, which can harvest and use light at wavelengths over 1 000 nm, the red limit for photosynthesis on Earth.

HYBRID STRUCTURES FOR ENHANCED LIGHT-HARVESTING

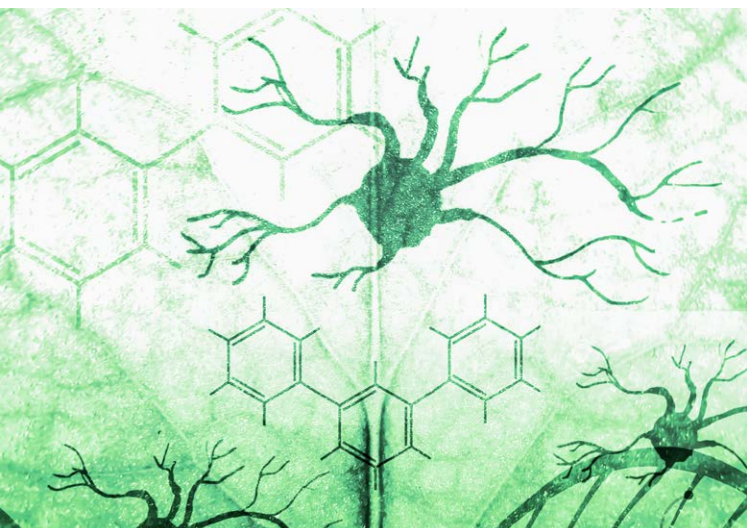
Using synthetic biology methods, researchers created the first hybrid photosynthetic complex in bacteria, which increases the efficiency of harnessing sunlight compared to natural photosynthesis.

The team also reported new surface chemistries and nanopatterning methods to facilitate the construction of innovative architectures for coupled energy transfer and trapping. In particular, they fabricated nanometre-scale patterns of photosynthetic complexes on self-assembled monolayers deposited on gold and silicon by using several lithographic methods.

“Such artificial light-harvesting arrays will advance understanding of natural energy-converting systems, and could guide the design and production of proof-of-principle devices that can efficiently capture, convert and store solar energy,” concludes Hunter. In the future there could be numerous applications in the energy industry.

SYNTHPHOTO

- Hosted by the University of Sheffield in the United Kingdom.
- Funded under FP7-IDEAS-ERC.
- cordis.europa.eu/project/id/338895





CLIMATE CHANGE AND ENVIRONMENT

A new smart system helps sniff out bad smells

A real-time sampling and monitoring system developed on EU project ODORPREP tackles the nuisance of bad smells – a common cause of complaint in towns in Europe.

Landfill sites, water treatment plants, paper mills and food factories are just some of the causes of odours, a growing problem in urban settlements in Europe and almost as distressing as noise. Odour emissions need not be such a nuisance, however, thanks to an on-demand system for monitoring and sampling the air, developed by EU project ODORPREP (Real time, automatic and remote-activated sampling system for industrial odour emissions compliant with the European Standard EN 13725).

The system is the first to incorporate feedback from local people with fast laboratory testing, meeting the latest EU standards on what constitutes a bad smell in the air. Italian company LabService Analytica developed and tested the system in its home country and is now selling its system to local authorities and environmental consultancies.

“There was nothing on the market before that was capable of integrating all the relevant empirical methods into a single solution,” said Ivano Battaglia, chief executive of LabService Analytica, which coordinated the project, partnering with the University of Bari. “The scientific community wanted an objective approach to determine the concentration levels of odorous emissions.”

Often if residents living near a factory complain of bad smells, they do so by contacting their local council or the environmental authority, and by the time an inspector makes a site visit, the smell is gone. The ODORPREP developers created a phone application to allow residents to report a bad smell the instant they detect it. Automatically, the nearest ODORPREP unit based in the resident's neighbourhood takes a sample of the air and stores it in a



“*There was nothing on the market before that was capable of integrating all the relevant empirical methods into a single solution.*”

bag ready for a technician to collect it. The system alerts the laboratory to collect the bag and contacts the factory, which takes its own sample to crosscheck the data.

On the basis of verifiable data checked at the laboratory and the factory, action can be taken to solve the problem causing the bad smell.

THE WHIFF OF A PROBLEM

ODORPREP also developed an ‘electronic nose’ – ancillary sensors that can predict concentrations of chemicals in the air that will be offensive to the human nose. These electronic noses are ‘trained’ on specific sites, using results from the samples taken by the ODORPREP system, to report levels of air concentration back to a central control centre. That means continual monitoring of air can be carried out and problems quickly spotted without a complaint being made.

The developers carried out tests in Taranto, southern Italy. The first in 2014 helped residents show environmental

authorities they needed to intervene at an industrial area causing pollution. The University of Bari published a paper on the ODORPREP solution, confirming its sampling method was as good as public air quality monitoring stations but faster and more affordable.

The following year, ODORPREP introduced its system in partnership with Italcave at the company’s Non-Hazardous Disposable Waste Factory. The partners showed the system could be adapted to any type of site. It monitored the air quality to ensure odours produced by the factory’s biogas production could be contained.

“The EU funding gave us the time and the resources to develop the IoT infrastructure and its related software that as an SME alone we wouldn’t have had,” said Battaglia.

ODORPREP

- Coordinated by LabService Analytica in Italy.
- Funded under H2020-ENVIRONMENT and H2020-SME.
- cordis.europa.eu/project/id/756865
- Project website: odorpren.it/en
- bit.ly/31NBcAx

CLIMATE CHANGE AND ENVIRONMENT

Why the rise and fall of Caspian Sea molluscs matters

Scientists studying molluscs and other small creatures from the great lakes around the Caucasus have not only created a new understanding of a little-known biota and the threats it faces in a key region where Eastern Europe meets Central Asia. They have also pioneered an integrated approach to modelling which could help us better understand the risks of human activity causing entire ecosystems to collapse.

Various factors make the Black Sea and Caspian Sea an excellent place to study the Pontocaspian – unique species that evolved in the strange salinities of the lakes. “The Caspian Basin is an isolated basin which allows you to

look at evolutionary pathways and natural stresses,” says Frank Wesselingh, senior researcher in marine biology at Leiden’s Naturalis Biodiversity Center in the Netherlands and project coordinator of PRIDE (Drivers of Pontocaspian



Level of the Caspian Sea is expected to drop 18 metres in the next 80 years



biodiversity RISE and DEMISE). “You have a great geological archive and a self-contained natural laboratory all in one,” Wesselingh adds.

RESPONSE TO STRESS

This outstanding geological record provides an account of how the region’s climate and environment changed over 3 million years and how biota responded. The scientists have used it to gauge how the Pontocaspian biota are coping with today’s harsh conditions.

They came up with some dramatic predictions. “We got a really good grip on what drives lake-level variation and what impact this has on the entire system. There is a good probability that the level of the Caspian Sea will drop 18 metres in the next 80 years,” Wesselingh says. Should this occur, vast extensions currently covered by the waters of the Caspian Sea will become dry steppe, as has already happened with the Aral Sea to the east. “That will have a lot of effect on biodiversity but will also have a devastating impact on coastal infrastructures in those areas,” Wesselingh adds.

BIOTA UPS AND DOWNS

The PRIDE team were able to map when and where the biota changed during the Quaternary period, giving a chronicle of the ups and downs of the Pontocaspian biota through time. Combining palaeontology, molecular biology and geology allowed them to pinpoint the origin and timing of several species, establishing pathways leading back to some surprising parts of the globe. “We did this for two mud snails, *Eccobria*, which have a common ancestor in an Arctic-North Atlantic species,” says Wesselingh.

The work allowed the PRIDE team to create a taxonomic information platform on the Pontocaspian biota and an information system on climate data, anthropogenic pressures and biodiversity in the Caspian Sea–Black Sea region.

It also allowed them to make a first estimation of the devastating effects that human activity – invasive species, habitat destruction, pollution – is having on the Pontocaspian biota. “Half to three quarters of species are either threatened, highly threatened or even extinct and this has happened in the last 50 years,” says Wesselingh.

At a time when reports such as the recent UN report on biodiversity are charting unprecedented rates of extinction, the PRIDE study homes in on how robust one biota is under stress.

“You always hear that nature can deal with anything and it is true that nature can deal with a lot of things but not forever. If you go beyond a certain boundary, a system can collapse into a new state where there is no turning back. So our question is what does it take to get a system like the Pontocaspian biota over the tipping point?” asks Wesselingh.

This research was undertaken with the support of the Marie Skłodowska-Curie programme.

PRIDE

- Coordinated by the Naturalis Biodiversity Center in the Netherlands.
- Funded under H2020-MSCA-ITN.
- cordis.europa.eu/project/id/642973
- Project website: pontocaspian.eu



Say good-bye to plastic bottles with mineral water made at home

More than 480 billion plastic drinking bottles were sold in 2016 and only half of those were collected for recycling, with detrimental effects for the planet and even human health. An EU-funded project could change that dramatically, providing clean and pure mineral water from your tap supply.

Plastics have changed our lives dramatically, enhancing personal convenience in many ways. However, they are increasingly finding their way back into the ecosystem – and our bodies.

Most people in Europe have access to clean tap water. The EU-funded RE-WATER (REvitalising tap WATER for reduced consumption of plastic water bottles) project is exploiting this with a novel countertop system. Sort of like a coffee pod machine, Retap Pure will produce an eco-friendly mineral water alternative with the taste consumers expect from bottled water.

SEEING THE FOREST AND NOT ONLY THE TREES

An on-the-go lifestyle and a desire for the purported health benefits of bottled mineral waters have contributed to a doubling of global bottled water consumption within a decade. According to project coordinator Lars Brøndum Petersen, from 212 billion litres in 2007, consumption rose to 391 billion in 2017. It is set to top half a trillion by 2021, translating into 20000 bottles sold every second.

“The market for Retap Pure is defined by the global market of household and professional water purification solutions, which in 2019 is valued at EUR 18.7 billion.”

Consumers may be happy, but recycling cannot keep up. The resulting plastic waste threatens oceans, coastlines, aquatic organisms and human health. It is estimated that between 5 and 13 trillion tonnes of plastic find their way into the world's oceans each year. In addition, approximately 7 litres of water are needed to produce a litre of bottled water. Further, the 212 billion litres of bottled water sold in 2007 required 54 million barrels of oil to produce them, approximately 2000 times more than that required to provide the equivalent volume of tap water. Add to this the carbon footprint associated with transporting the bottled water by plane, ship, train and truck to its point of sale, and the environmental impact of bottled water is huge.

A SIMPLE SOLUTION WITH POTENTIAL FOR TREMENDOUS IMPACT

EU-funding of the RE-WATER project provided the opportunity to assess the technical feasibility of the Retap Pure Machine, a simple countertop appliance that takes potable tap water, removes any chlorine added for disinfection, and enhances mineral content. It sports a carbon filter, reverse osmosis and enhanced minerals technology utilising Retap Pure Capsules for infusion of a variety of consumer-preferred mineral compounds.

HEADED TO MARKET

RE-WATER has enabled finalisation of the product and testing in an operational environment. The tests demonstrated compliance with EU standards and resulted in CE certification. The team has created awareness among target industry groups and established collaboration with key stakeholders.

Its well-defined market strategy should ensure a successful product launch with high impact.

According to Brøndum Petersen: “The market for Retap Pure is defined by the global market of household and professional water purification solutions, which in 2019 is valued at EUR 18.7 billion. The market is set to grow rapidly in the next decade, estimated to be valued at EUR 23.5 billion by 2022.” Stakeholders have shown tremendous interest in bringing the Retap Pure Machine to market, and RE-WATER plans to achieve that by 2021. Revolutionising the way purified mineral water is produced, RE-WATER outcomes could

have far-reaching and nearly inestimable impacts on the environment, ecosystems and human health.

RE-WATER

- Coordinated by RETAP APS in Denmark.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-LEIT.
- cordis.europa.eu/project/id/828079
- Project website: retap.com





SPECIAL FEATURE

HOW TECH IS TAKING ON TERRORISM

Editorial

Innovative solutions to keep us all safe

In less than 2 years the world will be commemorating the 20th anniversary of the cataclysmic events that brought what many historians are now referring to as the 'Long Nineties' (1989-2001) to a screeching end. The 9/11 attacks radically shifted the course of world political history, spearheaded by the launch of the US-led 'War on Terror'. Indeed, the felling of the twin towers of the World Trade Center resulted in some of the most horrific, tragic and yet instantly recognisable images that characterise the dawn of the 21st century.

In short, everyone old enough to remember can recall exactly where they were and what they were doing when they first heard of the terrifying news coming out of the United States on that cold, crisp and clear autumn day.

Europe has of course suffered its fair share of terrorist atrocities both before and since 9/11. This special feature is being published in the November 2019 issue, marking the 4th anniversary of the series of coordinated attacks in Paris that killed 138 people and left 413 injured, some critically. Other recent European attacks include the Norway attacks of 2011, the Brussels bombings and Berlin Christmas Market attacks in 2016, and the Manchester arena bombing and Barcelona attacks in 2017.

So, in a dangerous and polarised world, security remains at the top of the political priority list. In fact, ensuring safety and security for European citizens is an EU obligation under the Treaties. It's also a common responsibility – in our interconnected and digital world, no one country can

enact a 100% successful security policy without cooperation and collaboration with other countries.

To facilitate this cooperation and collaboration, innovative and world-beating research and technological development is absolutely essential and much of this research, as can be expected, focuses on developing online and digital methods and/or tools to combat terrorism. Over the past 15 years, terrorists of all political persuasions are increasingly using the internet as a means to coordinate their plans, recruit members and spread their ideology.

A majority of EU Member States actually depend on the EU's Horizon 2020 programme to fund their needs for innovative security solutions, with the programme representing 50% of the overall public funding for security research in the EU. Whilst new tech solutions are only a part of the puzzle in effectively tackling terrorism (alongside equally important social sciences research to help us better understand the socio-economic conditions that feed and promote terrorism as an ideology), they are still an undeniably crucial part of that puzzle.

In this special feature, we meet seven EU-funded projects that have contributed to the development of new technologies that can effectively take on terrorism and help to make all of us safer and more secure as we go about our daily lives.

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

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New tools for investigating – and stopping – cybercrimes

A critical discourse approach offers insights into terrorist movements' social media use

Social media have provided many social, religious and political movements an effective means for networking and communicating with diverse stakeholders. EU researchers examined Islamic State's (IS) own use of online platforms to reinforce its ideologies.

MWDIR (Media Warfare and the Discourse of Islamic Revival: The Case of the Islamic State (IS)) project coordinator Majid KhosraviNik makes the introduction: "IS has enthusiastically embraced and capitalised on new communicative affordances of the participatory web." KhosraviNik and the project's Marie Skłodowska-Curie research fellow Wesam Amer delved into the social media practices of IS's members, followers and supporters. This involved examining online communicative practices and patterns of rhetorical propaganda (overlapping discourses).

COMMUNICATION ANALYSIS FROM A SOCIOLOGICAL PERSPECTIVE

MWDIR employed social media critical discourse studies (SM-CDS). "CDS offers interpretations and explanations of the meaning-making processes by situating the content materials in both the digital media and social contexts in which they occur," KhosraviNik explains. His published book chapter 'Social media critical discourse studies' elaborates on the approach, which offers a sociological take on communication analysis. KhosraviNik notes: "By employing SM-CDS, the project has identified patterns of similarities and differences in the way IS constructs itself, its purported enemies as well as digital practices employed for propaganda and recruitment."

Data analysis revealed and explained why IS's communicative strategies appear to resonate with an important portion of Muslim youth both in Europe and worldwide. "Examination of discursive practices showed how the discursive politics of self-representation and identity in general play a role in such a movement," KhosraviNik reports. The research also analysed visual media content, utilising

a visual framing model to examine visualisation and other modalities of discourse.

THE FUNDAMENTALS OF 'IS' STRATEGY

MWDIR researchers present the ensemble of discourses that frame Islamic fundamentalism in two points. The first covers IS's reworkings of foundational myths of traditional religious symbols to appropriate an imagined past community in a politically charged and conflict-ridden context.

The second point refers to the strategic rhetorical propaganda IS employs to attract individuals from the EU, Middle East and United States, and many other regions. "IS's discourse pivots around combating the constructed/perceived threat to its most sacred values in the context of a confrontation with an 'other' in a process one could call 'mimetic violence'," KhosraviNik sums up.

CONTRIBUTIONS AND ACCOMPLISHMENTS

MWDIR outcomes contribute to our understanding of how IS constructs itself on the socio-political and cultural-religious dimensions of conflict with the 'other'. Against this background, KhosraviNik and Amer underline the need to consider the context of use and circularity of data. It is not coming from just one concentrated source, and there is no clear notion of what is and what can be considered IS materials, or what is coming from sympathisers or what constitutes a harmless religious opinion.

“The project contributes to European excellence and European competitiveness by diminishing the fragmentation of terrorism in social media studies from linguistic, media and security dimensions.”

Project accomplishments go beyond topic-specific research. "This project has contributed to ongoing debate on how to do CDS in social media research within a contextual approach to meaning-making," KhosraviNik expresses. It also provided the researcher with advanced analytical skills as well as competences in applying CDS in social media discourse as an emerging and essential field.

"The project contributes to European excellence and European competitiveness by diminishing the fragmentation of terrorism in social media studies from linguistic, media and security dimensions," KhosraviNik concludes. MWDIR brings forward new ideas and represents an important step forward in scientific knowledge regarding the social media practices of terrorist movements.

MWDIR

- Coordinated by the University of Newcastle Upon Tyne in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/707482
- Project website: ncl.ac.uk/sacs/staff/profile/mohammedwesamamer.html



Safer crowds in mass gatherings

Mass gatherings have historically been synonymous with festivities. However, terrorist attacks at recent gatherings have instigated fear among citizens. LETS-CROWD plans to ease these concerns with better planning and monitoring tools for both law enforcement agencies and policy-makers.

Tragic attacks taking place across Europe over the past few years have often caught law enforcement agencies (LEAs) off-guard. Terrorists' operating methods have never been so unpredictable, and any mass gathering now has authorities on edge. LEAs have a desperate need for innovative security tools and methodologies to help them face these threats.

The LETS-CROWD (Law Enforcement agencies human factor methods and Toolkit for the Security and protection of CROWDs in mass gatherings) project was inspired by the European Security Model (ESM), which defines central challenges, priorities, principles and guidelines to deal with security issues within the EU. The project, which focuses on mass gatherings, has been following the ESM's main principle to create guidelines and support tools, with emphasis being put on prevention and anticipation.

Jordi Arias Martí, project manager at ETRA I+D and coordinator of LETS-CROWD, discusses the expected contribution of the project to making mass gathering events across Europe more secure for citizens.

What are the potential benefits of the European Security Model in handling mass gatherings?

The ESM is particularly important for the management of such events as they are a frequent target for criminal or terrorist actions. There is a need to achieve the best possible protection for people gathering in a specific area.

The key point here is to deter, prevent, protect people from, pursue and effectively respond to criminal and/or terrorist actions, thus increasing the sense of security while balancing security and citizen rights.

What do you think are the main challenges to its implementation and what makes them particularly difficult to overcome? Also, how does LETS-CROWD fill these gaps?

To implement the ESM, LEAs need to be able to control the different phases of an event (planning, execution and post-execution) with a dedicated set of tools.

LETS-CROWD helps them by enabling the creation of signals and the modelling of venues and incidents, as well as by including relevant information such as voice recordings, images and videos.

Our Semantic Intelligence Engine (SIE) is a perfect example of LETS-CROWD's contribution. It can gather, monitor and analyse information published online in relation to a mass gathering, before and during a given event. Our system also uses machine learning techniques for a human-centred computer vision (HCV) prototype that supports LEAs in the use of video surveillance systems.

Can you tell us more about the other tools you developed? What makes them particularly innovative?

Our main tool is the LETS-CROWD Server: agencies create an event and complement it with relevant information such as incidence, location and other information brought by specific modules.

We propose a total of seven tools. Besides the SIE and HCV, we also have the Dynamic Risk Assessment (DRA) which will dynamically assess risk by processing weak signals – suspicious signs of activity that individually do not



**60% considered
the LETS-CROWD tools
very useful**



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constitute a threat but can become a risk when considered together – and other varying events.

The Policy Making Toolkit (PMT) will help decision-makers in defining clearance and policies for a specific event. The tool covers data management, approval, policy creation and implementation for an event. Then we have the Crowd Modelling and Planning (CMP) tool which allows users to plan ahead for crowds attending a mass gathering event, run scenarios during its execution, and use these scenarios in post-event analysis and training.

The Real-Time Evacuation (RTE) tool allows LEAs to plan and find out about the potential evacuation times for crowds. It can assess the impact of a certain evacuation strategy within a few seconds. Finally, our Innovative Communication procedures (ICP-Communication toolkit) aim at raising awareness among event organisers, security officers and first responders.

How did you proceed to test these tools?

The LETS-CROWD validation process is based on the human-centred design (HCD) approach. It integrates the user's perspective, needs and requirements into the development phases in order to collect their feedback at key points in the project's lifecycle.

As each tool is characterised by specific and unique features and components, we developed a validation toolkit to facilitate data collection during practical demonstrations. It includes several instruments, such as a validation questionnaire, a debriefing template and a requirement acceptance scale.



Jordi Arias Martí
Project Manager at ETRA I+D and
project coordinator of LETS-CROWD
© Jordi Arias Martí

“The key point here is to deter, prevent, protect people from, pursue and effectively respond to criminal and/or terrorist actions, thus increasing the sense of security while balancing security and citizen rights.”

What were the results of these tests?

Over 60 % of LEA participants considered the LETS-CROWD tools very useful. They rather praised its usability too, with a System Usability Scale (SUS) score above the average 68 out of 100 for most tools. We also received feedback related to effectiveness: The majority of participants find LETS-CROWD's tools effective and efficient in helping them complete their daily working tasks.

Two other major feedback criteria were related to compatibility and maturity. More than 70% of the experts found the tools compatible with already existing practices and procedures, and most tools were rated as TRL 4 or 5. This means that participants consider the main components as well-integrated and ready to be used in simulated operational environments.

What are your follow-up plans, notably with regards to commercialisation?

Some additional work must be carried out with regards to business strategy and commercialisation. A detailed market analysis will be conducted in the final stage of the project, along with a business plan with predictions for investment and revenues.

Our goal is to shape the market and to engage with more end users in order to gather intelligence and attract further customer interest. Possible mechanisms include 1-1 discussions, workshops, conferences, demonstrations and targeted documents.

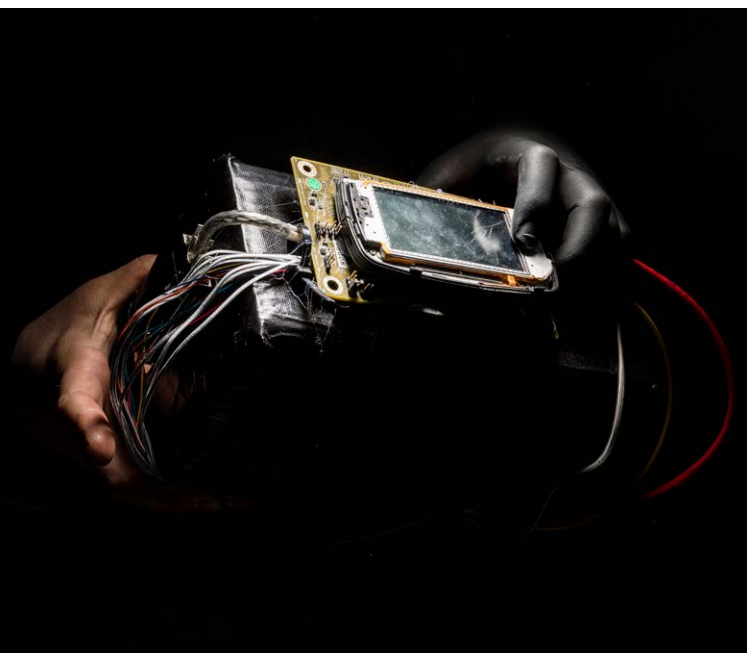
LETS-CROWD

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- Coordinated by ETRA I+D in Spain.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/740466
- Project website: letscrowd.eu/
- bit.ly/2MobzQZ

How to best neutralise explosive threats

Technological innovation can be a blessing, but it's not always easy for stakeholders to identify the most suitable innovation for their needs. When dealing with improvised explosive devices (IEDs), the consequences can be devastating. ENTRAP aims to help with new methods to assess and identify emerging and future counter-measures.



Combined with the project's terrorism timeline, the tree-chart can help tell which counter-tools should be deployed to prevent and mitigate attacks.

To populate the tree-chart, the project team has listed all emerging tools developed under EU-funded research projects. These tools were then compared with their commercially-available counterparts. This provides stakeholders with effectiveness assessments and gap analyses, not only between lab and commercial tools, but also those left open even when considering emerging solutions.

"There are gaps between emerging capabilities in the research world and actual capability to improve societal resilience," comments Önnérud. "To give you an example, there is a precursor regulation in place that specifies the quality of certain chemicals available for consumers, to prevent the preparation of home-made explosives (HMEs). In parallel, research on the inhibition of precursors enables the addition of chemicals that hinder certain chemical reactions. If this research could reach the market, it would make it very difficult to manufacture HMEs and consequently the IEDs."

Another example of comparison between upcoming and current counter-tools relates to swabs taken at an airport security checkpoint and inserted into an apparatus for analysis. An alternative, laser-based detection of explosives has extensively been investigated in research projects: by illuminating a surface and recording a compound's specific signal, it is possible to analyse trace amounts of explosive residues on a surface. However, this technology has yet to be commercialised.

The fight against – and prevention of – terrorism is high on the Horizon 2020 agenda. Various methods and technologies have been developed over the past few years, so many in fact that the list of recent research results could easily make stakeholders' heads spin.

To help them identify the most effective and cost-efficient solutions, ENTRAP (Enhanced Neutralisation of explosive Threats Reaching Across the Plot) initiated a large-scale assessment in 2017. The consortium has been investigating the timeline of key terrorist activities and created a tree-chart linking counter-tools with capabilities. They analysed gaps in existing counter-measures, and conducted effectiveness assessments based on operational research.

The tree-chart is one of ENTRAP's most important contributions. "Its hierarchy consists of four main capabilities: prevent, detect, react and mitigate. Their aim is to optimise societal resilience to explosive threats by reducing the probability of a bomb-attack (prevent, detect) or by reducing its impact (react, mitigate)," says Hans Önnérud, Deputy Research Director of the Swedish Defence Research Agency and coordinator of ENTRAP.

“The tree-chart can help tell which counter-tools should be deployed to prevent and mitigate attacks.”

“Likewise, a technology able to localise bomb factories would be a game changer. It is known that normal apartments have been used as bomb-factories, solely with simple kitchen utensils and commercially-available chemicals. A sensor system capable of picking up traces of such chemicals would enable an early warning and thus provide law enforcement teams with time to intervene,” says Önnerud.

All in all, ENTRAP’s research puts the finger on critical gaps for which new counter-tools are required. As it ends

in April 2020, it is also expected to provide precious recommendations for future research.

ENTRAP

- Coordinated by the Swedish Defence Research Agency in Sweden.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/740560
- Project website: entrap-h2020.eu/en

Electronic explosive sniffer tracks down weird smelling shoes

Increasingly stringent security measures are pushing terrorists to come up with new ways of bringing explosives onto airplanes. Thanks to innovation brought by the AirBrush project, shoes won’t be an option anymore.

It was just a few months after the horrifying attacks on the World Trade Centre. On 22 December 2001, Richard Reid steps onto American Airlines flight 63 from Paris to Miami. It’s raining outside, and the flight has been delayed. But what was then an annoyance to passengers turned out to be a blessing: Reid’s shoes were packed with plastic explosives, and the rainy weather prevented them from detonating and killing the 200 passengers on board. A burning smell alerted a passenger, Reid was overpowered and currently serves a life sentence in the US.

Things have changed quite drastically in airports since the infamous ‘shoe bomber’ was apprehended. X-raying footwear has become mandatory in the US, making airports safer but also causing long queues and substantially increasing the cost of security.

“Forcing people to walk barefoot on board would be a lot like Henry IV’s Road to Canossa. On the other hand, the X-ray technology currently used for footwear screening comes with a major price tag. Here, security and cost-cutting are two sides of the same coin,” says Yuri Udalov, Chief Technology Officer and Co-Founder of Eye on Air.

Eye on Air received EU funding for the AirBrush (A fast non-intrusive vapour detection system that rapidly identifies explosives in public areas) project in 2018. Their objective: developing and commercialising an ‘electronic

sniffing’ technology based on Ion Mobility Spectrometry (IMS). Whilst such technology has already been applied successfully to the detection of explosive traces, it wasn’t sensitive enough for application to shoe scanning.

“Our spectrometer differs substantially from existing devices. Unlike regular IMS devices, it detects vapours of



explosives instead of traces. Its sensing modules have a drift space of 10 mm, which is an order of magnitude less than regular IMS spectrometers. The device can record the complete ion spectrum within less than a millisecond without any deterioration of the signal, and it can detect explosive masses of less than a pictogram,” Udalov enthuses.

The Eye on Air system works as follows: explosive vapours are collected and introduced into the sensing unit. When the expected concentration of energetic materials is low, sampled molecules might initially be collected on a pre-concentrator. Under the influence of an external ionisation source, the molecules of the test sample are ionised. These ions drift in an electric field and land on a collector electrode – an ion current detector. The drift of ions in a neutral gas flow under the influence of an electric field makes it possible to separate ions based on their mobility.

“Heavy ions move slower and thus get to the collector electrode later. As a result, ion current is measured as a function of time and the spectrum of ion arrival time can be obtained. AirBrush has a comprehensive database and is able to identify specific explosives by using its sensing unit and tracking the arrival time of each explosive. It is

“Our spectrometer differs substantially from existing devices. Unlike regular IMS devices, it detects vapours of explosives instead of traces.”

possible to extend the database with the desired list of target materials provided by the customer,” Udalov explains.

Eye on Air has already received several purchase orders for its device and is confident that AirBrush will be available in airports in 2020. According to Udalov, an interesting option would be an integration of the device in a security screening portal, where passengers will be simultaneously scanned by microwave or terahertz full-body scanners, metal detectors and a customised version of AirBrush.

AIRBRUSH

- Coordinated by Eye on Air in the Netherlands.
- Funded under H2020-LEIT, H2020-Societal Challenges and H2020-SME.
- cordis.europa.eu/project/id/811977
- Project website: eyeonair.nl

Advanced technology helps law enforcement automatically detect online terrorist activity

The EU-funded RED-Alert project is developing new online content monitoring and analysis tools to help law enforcement agencies fight terrorism.

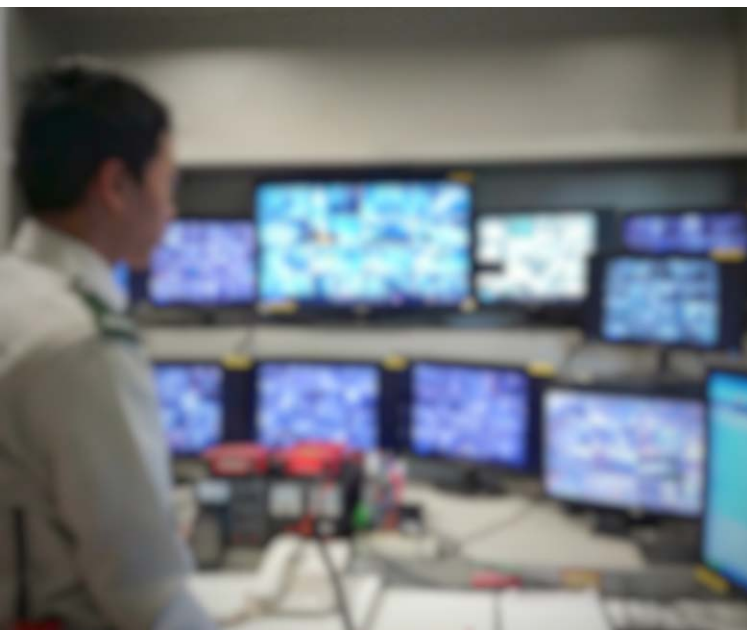
For extremists and terrorist organisations, the internet is a tool for conducting psychological warfare, spreading propaganda and misinformation, and attracting new recruits. Social media in particular has become the tool of choice for recruiting vulnerable individuals.

Lacking the proper tools to efficiently identify such terrorist-related online content, law enforcement must rely on inefficient proprietary spam-fighting tools, user reports and human analysis. This can result in some terrorist activity going unnoticed, sometimes leading to dramatic consequences for European citizens – such as the over 40 terrorist attacks carried out by radicalised individuals on European soil since 2015.

This ongoing threat of terrorism prompted the European Council to challenge European industry to develop new technology and tools that can automatically detect and



**Number of terrorist attacks
carried out by radicalised individuals
on European soil since 2015**



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remove content that incites terrorism and terrorist acts. In response to this call, the EU-funded RED-Alert (Real-time Early Detection and Alert System for Online Terrorist Content based on Natural Language Processing, Social Network Analysis, Artificial Intelligence and Complex Event Processing) project is developing technologies capable of providing early detection of online radicalisation and supporting global counter-terrorism efforts.

“RED-Alert is one of the first European initiatives to respond to the challenge of automated detection of terrorist propaganda while preserving the privacy of citizens,” says Monica Florea, project coordinator. “By leveraging the most advanced technologies to fight terrorism and prevent future attacks, we will provide European law enforcement agencies with a key intelligence asset.”

STOPPING TERRORISM IN ITS TRACKS

Harnessing the power of artificial intelligence, the RED-Alert toolkit helps law enforcement agencies keep up with the abundance of information within the terrorist domain and the widespread dissemination of disinformation. “RED-Alert involves a lot more than a computer recognising certain words,” explains Florea. “The technology we are building will process massive amounts of unstructured data, such as social media posts, to identify meaningful relationships and spot potential threats.”

Using a unique combination of technologies – including natural language processing, semantic media analysis, social network analysis and complex event processing – the

“RED-Alert is one of the first European initiatives to respond to the challenge of automated detection of terrorist propaganda while preserving the privacy of citizens.”

system collects, processes, visualises and stores online data related to terrorist groups. With this data in-hand, law enforcement agencies are well-positioned to take coordinated, near real-time action to stop terrorist activity in its tracks.

BENEFITING EUROPE

Although a work-in-progress, the RED-Alert project is well on its way to providing law enforcement agencies with an effective tool for identifying terrorist-related online content. “By providing a solution to a real law enforcement need, the RED-Alert project is helping to prevent future terrorist activity – something that everyone will benefit from,” adds Florea.

After the completion of the project in May 2020, participating law enforcement agencies will continue to use the RED-Alert tool. There are also plans to build a strong community of users around the RED-Alert solution.

RED-ALERT

- Coordinated by SIVECO Romania SA in Romania.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/740688
- Project website: redalertproject.eu/
- ▶ bit.ly/2AGU4EY

Video analytics for faster criminal investigation

To this day, processing video footage has been a hassle for investigators in charge of preventing or solving criminal and terrorist cases. The only available technology to speed up their analysis was the... fast-forward button. Soon, video analytics technology brought by the VICTORIA project could substantially ease their jobs.

Smile, you're being recorded. From surveillance cameras to smartphones, dash cams, drones and body-worn devices, the odds of public urban life being caught on tape these days are quite high. At first, these new sources of recordings came in particularly handy for law enforcement agencies (LEAs) dealing with criminal or terrorist attacks. But now, they are simply overwhelmed. From minutes in the early days, the amount of video recordings to process for a specific event now reaches thousands of hours to be reviewed manually.

"After the Toulouse and Montauban shootings in France in 2012 – known as the Merah case – 35 terabytes of video footage were collected from various sources. This represented 10 000 hours of recordings to be analysed," explains Stéphane Caillebotte, programme manager at IDEMIA. "It has clearly become impossible for LEAs to process all available video material."

With the VICTORIA (Video analysis for Investigation of Criminal and Terrorist Activities) project, IDEMIA and its 13 partners aim to enable a switch from manual work

to automation. By April 2020, the consortium expects to deliver an ethical and legally-compliant video analysis platform (VAP) prototype that will considerably speed up video analysis.

The VICTORIA VAP is advanced, open-source video analytic software that can be used in post-event processing and investigation. The VAP processes and analyses large quantities of raw video data, and it automatically provides insights by identifying points of interest throughout video recordings. Evidence – which can include faces, persons, vehicles, generic objects or audio events – is then classified and labelled with the corresponding timestamps, to facilitate the work of investigators.

"Previous projects had already worked on video analytics for other applications. Yet, none of these tools had a sufficient technology readiness level (TRL) to be used on footage obtained in conditions and from sources as diverse as those received by LEAs. We needed a tool that could adapt to varying camera specifications, image quality, viewing angles, movement, etc.," says Caillebotte.



“Previous projects had already worked on video analytics for other applications. Yet, none of these tools had a sufficient technology readiness level (TRL) to be used on footage obtained in conditions and from sources as diverse as those received by LEAs.”

This is just one of many long-standing obstacles to higher TRL for these tools. Another one relates to error rates, which are still way too high to inspire trust among LEA investigators. This can hardly be helped, too, as developers cannot easily access representative footage for legal reasons.

“To overcome these problems, we have selected six operational scenarios covering the majority of cases encountered by LEAs,” Caillebotte explains. “These scenarios and their variations were then staged and filmed with actors. We also made sure to use alternative light and weather settings, camera resolutions and video qualities that could be encountered in real conditions. These video datasets were crucial for the development of improved, robust algorithms and the testing of our VAP.”

VICTORIA has hosted two workshops to test their solutions with LEAs. The first one generated feedback that led to the development of a V2.0, whilst the second one aimed at training investigators before the solution was installed at their premises. This installation started in September 2019 and should be completed in January 2020.

The consortium intends to deliver a tested prototype by the end of April 2020. An online community of video analysis for investigation (VAFI) experts has already been launched to discuss best practices and share experiences. It will feature a marketplace where third-party developers can make their own plugins available.

VICTORIA

- Coordinated by IDEMIA in France.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/740754
- Project website: victoria-project.eu/
▶ bit.ly/2qqYT3p

New tools for investigating – and stopping – cybercrimes

The EU-funded TITANIUM project is providing European law enforcement agencies with the tools they need to identify cybercriminals – even when they operate behind the pseudo-anonymity of virtual currencies.

From launching ransomware attacks that demand users pay a ransom in Bitcoin, to extorting virtual currencies with the threat of sabotage, criminal organisations continue to find new ways to exploit cryptocurrencies. But they don't stop there. These currencies are then used in the dark market to facilitate the trafficking of illicit goods, data and services.

Wishing to remain anonymous and undetected, cybercriminals are particularly attracted to the anonymity offered by cyber currencies and the dark web. To detect, track and prosecute cybercrimes, law enforcement needs new, data-driven tools and technology-based techniques. The challenge, however, is to ensure that these new tools don't violate an individual's fundamental right to privacy.

This is where the EU-funded TITANIUM (Tools for the Investigation of Transactions in Underground Markets)

comes into play. “The TITANIUM project aims to provide law enforcement agencies with the research they need to develop new techniques for identifying criminals, even when they operate behind the pseudo-anonymity provided by virtual currencies,” says Ross King, project coordinator and data scientist at the Austrian Institute of Technology (AIT) Centre for Digital Safety & Security. “By ensuring that these tools include relevant safeguards, we'll be able to balance the need for privacy and protection.”

A SUITE OF NEW TOOLS

Although still a work-in-progress, the TITANIUM project has already developed a number of low-cost and open source tools for cryptocurrency forensics. These include tools for automated privacy-preserving data collection, along with forensic tools to analyse data associated with darknet market and virtual currency transactions. Furthermore,



“By ensuring that these tools include relevant safeguards, we’ll be able to balance the need for privacy and protection.”

by analysing emerging trends in internet-organised crime and terrorism (IOCT), researchers have created associated requirements for conducting such investigations.

“Each of these tools is designed to allow any law enforcement team – not just those at large federal agencies – to carry out cryptocurrency investigations,” explains King. “In addition, our work on cryptocurrency metadata standards will enable improved information exchange between tools and agencies.”

All TITANIUM tools have undergone rigorous field testing. Once finalised, the tools will be made available either as open source solutions or as products supported by European SMEs. As part of its work, the project is preparing training sessions that will facilitate the proper uptake and use of all TITANIUM tools.

PROTECTING PRIVACY

The project has taken significant steps to ensure its tools are legally compliant with all EU data privacy regulations, including the GDPR. Tools will also provide standardised logging for all activities undertaken by an investigator.

This makes legal compliance verifiable for supervisory authorities and supports so-called ‘court-proof’ evidence in legal prosecutions.

“We have created a strict firewall between our research and law enforcement work, meaning no data is shared between these groups,” adds King. “Exchanges only take place at the level of the tools and related training.”

MAKING EUROPE SAFER

TITANIUM’s work is setting the basis for a future where criminals will no longer be able to exploit internet technologies and go unpunished. “Backed by the TITANIUM suite of tools, European law enforcement will be better equipped to investigate crimes involving virtual currencies and darknet markets,” concludes King. “As a result, more law enforcement organisations will have access to the tools needed to investigate these crimes more effectively and more efficiently.”

TITANIUM

- Coordinated by the Austrian Institute of Technology (AIT) GmbH in Austria.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/740558
- Project website: titanium-project.eu/
- bit.ly/2nR6PcR



New livestock vaccines and better vaccine strategies reduce antibiotic use

EU-funded scientists are using cutting-edge biotechnologies, genomic analyses and mathematic modelling methods to improve livestock immunisation to help reduce soaring veterinary use of antibiotics.

The use of antibiotics in livestock production is as problematic as in human disease and resistance is building up very swiftly. “We do not have the throughput of antibiotics to tackle this,” says project coordinator Isabelle Schwartz from the molecular virology and immunology department at the National Institute for Agricultural Research in France.

“Antibiotic use also has a significant environmental impact, so we need to reduce its use in livestock. We can do this with the right kind of vaccination strategy that we adapt to

the pathogen and to the animal depending on its age and its production type. In the future, the aim is to also adapt it to the animal's gene activity,” Schwartz says.

CANDIDATE VACCINES

The EU SAPHIR (Strengthening Animal Production and Health through the Immune Response) project has laboratory-tested six promising candidate vaccines to protect against six major pathogen strains affecting cattle, pigs



“*The use of antibiotics in livestock production is as problematic as in human disease and resistance is building up very swiftly.*”

and poultry, with one already licensed to a pharmaceutical company for commercial development and other companies interested in two others.

One of the best vaccine candidates was made up of just one protein from a virus and was highly efficient in calves that had maternal antibodies.

“Normally with maternal antibodies, animals do not respond well to vaccines,” Schwartz notes. “But our vaccine provided full protection with only one intramuscular administration, which is convenient for the farmer.”

CANDIDATE BIOMARKERS FOR IMMUNE RESPONSE

The project identified genetic marker and blood biomarker candidates that correlate with a good or bad immune response to vaccines. “This finding opens the way to stratify animal populations according to their responses to certain vaccine types,” Schwartz says. In time, selective breeding of those animals with a better immune response to vaccination will produce more resistant herds and reduce the need for antibiotics.

Three hundred candidate biomarkers were identified by the project, taking blood samples from hundreds of vaccinated animals and doing entire RNA sequencing for each animal to correlate the basal gene expression with the animal's capacity to respond well to vaccines.

“From this high-throughput approach, we identified genes that we would never have imagined were involved in the capacity to respond to vaccines,” adds Schwartz.

Analysing the data was a huge undertaking requiring more than two people working full time over 4 years and is still ongoing. “The goal is to cut down the 100 genes to a minimal combination of biomarkers that provides a prediction of high response to vaccines,” Schwartz explains.

VACCINATION IN THE FIELD

In the case of a major viral disease in pigs, mathematical modelling compared the impact of regularly vaccinating all animals in an infected herd to vaccinating only when a problem emerges. The project found that a regular vaccination schedule can fully control the infection even if the vaccine is only partially protective. As Schwartz explains: “We did not expect this, and it shows the importance of vaccination schedules.”

As livestock farmers tend to be reluctant to invest in vaccines, the project's economists also modelled the effect of vaccine use as it benefits animal production, which depends on vaccine efficacy and on an optimal vaccine price.

Finally, the project's sociologists identified that educating consumers and large retailers can have a great impact in avoiding antimicrobial use and in promoting the use of vaccines in farms.

SAPHIR

→ Coordinated by the National Institute for Agricultural Research in France.

→ Funded under H2020-FOOD.

→ cordis.europa.eu/project/id/633184

Wild tomatoes reveal how plant roots cope with difficult conditions

Climate change means the soil available for growing crops may become drier and more saline. European scientists have investigated the molecular mechanisms implicated in root development in saline conditions.

Plant roots have developed mechanisms to control the entrance of solutes and water. Take for example the modification of the cell wall in specific root cell types that serve as physical barriers to control uptake from soil. These modifications involve, among other compounds, polymers of lignin and suberin.

One of these cell types is the endodermis, which forms a lignin ring-like structure known as the Casparian strip. The deposition of lignin and suberin is regulated to help plants respond and adapt to those conditions.

The development of endodermis differentiation, whereby cells grow and develop, and the controlling genes have been investigated in recent years using *Arabidopsis thaliana* as a model system. However, the majority of plants also have another root cell type called exodermis, which also produces barriers made of lignin and suberin. The mechanisms controlling exodermis differentiation and its response to abiotic stress are poorly understood at the molecular level, since *Arabidopsis* does not possess an exodermis.

WILD AND DOMESTIC TYPES COMPARED

The EU-funded ROOT BARRIERS (Molecular mechanisms controlling endodermis and exodermis differentiation in tomato roots) project addressed this knowledge gap, using two tomato species as a model system to investigate exodermis differentiation. “The aim was to determine if they are similar or distinct to the endodermis and how salinity influences their differentiation at the molecular level,” says project coordinator Juan Carlos del Pozo. This research was undertaken with the support of the Marie Skłodowska-Curie programme.

Researchers studied endodermis and exodermis differentiation in domesticated and wild tomato species, *Solanum lycopersicum* and *Solanum pennellii*, respectively. Gene expression data was also collated to discover how these cell types respond in *S. pennellii*, which is endemic to Andean regions in South America, and has evolved to adapt to drought conditions.

The team tested the ability of the two species to tolerate salt stress and confirmed *S. pennellii* is able to grow in high salt concentrations. “We found the root barriers



“This knowledge will be of enormous interest to the scientific community, helping improve plant growth in adverse conditions.”

formation in these two species differs as well as how salt stress influences their differentiation,” explains Siobhan Brady, researcher at the partner institution, the University of California, Davis.

IMPORTANT NEW DATA

Confocal microscopy images of lignin deposition in the tomato root allowed scientists to fully describe the developmental framework of exodermis differentiation. Scientists also produced CRISPR/Cas9 mutants for the putative candidate genes implicated in exodermis differentiation. This helped prove their function in barrier formation in the exodermis through phenotypic analyses, which indicated defects in lignin deposition.

In addition, researchers used state-of-the-art translating ribosome affinity purification technology to specifically profile the messenger RNA (mRNA) from the endodermis and exodermis in control and salt stress conditions.

“This gives an indication of the genes that are responding to modify the root barriers in these two cell types in response to salt stress. It will be the first data set to date where mRNA from specific cell types was obtained from a crop species profiled in abiotic stress conditions,” the Marie Skłodowska-Curie Individual Fellowship researcher Concepción Manzano points out.

ROOT BARRIERS showed that endodermis and exodermis differentiation develop differently in terms of lignin deposition, increasing understanding of how two important root cell types are regulated at the molecular level. Furthermore, results concerning the genes implicated in endodermis and exodermis differentiation can be applied to other crop species. Del Pozo concludes: “This knowledge will be of enormous interest to the scientific community, helping improve plant growth in adverse conditions.”

ROOT BARRIERS

- Coordinated by the National Institute for Agricultural and Food Research and Technology in Spain.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/655406

FOOD AND NATURAL RESOURCES

Improved understanding of fish digestion helps aquaculture swallow sustainable feeds

Optimised feeding strategies are crucial for sustainable fish farming. EU-funded researchers addressed the fragmented knowledge of aquafeeds' impact on digestive function via experiments and simulation models to improve feeding strategies.

Fish farms are set to become the main producers of seafood, overtaking traditional capture fishery. They have the potential to relieve the pressure on dwindling fish stocks, but the feed used (aquafeed) is often based on smaller, wild species.

More sustainable plant-based options are available, but the nutritional content is not the same, and can impact fish production. Fortunately, aquafeeds are becoming more sustainable, as fish meal and fish oil are increasingly replaced by alternative ingredients for the main

farmed species. In addition, there is an increased focus on reducing nitrogen and phosphorus waste and improving feeding strategies. However, work still needs to be conducted on aquafeeds to better understand their impact on production and optimise the digestion process to promote lean growth among farmed fish.

KNOWLEDGE GAP ADDRESSED

The EU-funded WiseFeed (Improving sustainability and performance of aquafeeds) project addressed this challenge by building an integrated network of research groups drawn from academia as well as partners from SMEs and large enterprises. Their overall aim was to improve the performance and sustainability of aquafeeds for fish production. This research was undertaken with the support of the Marie Skłodowska-Curie programme.

Optimisation of the digestion process is crucial for sustainable fish farming and depends on a series of integrated physiological processes including ingestion, secretion, digestion, absorption, motility and evacuation. “However, knowledge of the overall processing capacity of the digestive system for nutrients in key aquaculture fish species is still fragmentary and incomplete and therefore limited. There is the lack of a global perspective on the different mechanisms modulating nutrients absorption and utilisation,” says project coordinator Ivar Rønnestad.

MULTIPLE BENEFITS

Project partners developed simulation models and a software package to optimise feeding strategies. “We created new and improved models for measuring the digestion, absorption and retention efficiency of selected macro nutrients in key cultured fish species,” explains Rønnestad. “We also studied in detail the role of methionine, an essential amino acid, and integrated this knowledge into our software models,” he adds.

An important part of WiseFeed has been the collaboration with partners in Vietnam, enabling European researchers to study cobia, a fast-growing tropical marine species.



Warm water species are growing in importance as alternative farmed species in southern Europe and non-continental territories with sub-tropical weather. Their software package “enables users to test the effects of specific amino acids and dietary supplements for enhancing metabolism, growth and nitrogen retention, including the effects of elevated temperatures due to climate changes,” Rønnestad states.

WiseFeed benefits the aquaculture sector by enhancing the utilisation of nutrients, thereby improving production yields while reducing feeding costs, and reducing the environmental impact of released nutrients. “The project will make aquaculture an ever more environmentally friendly industry, while increasing the economic results of fish farming enterprises. It also contributes to the implementation of research findings into the commercialisation of innovative products and services, thereby increasing the competitiveness of European aquaculture,” Rønnestad comments.

WISEFEED

- Coordinated by the University of Bergen in Norway.
- Funded under H2020-MSCA-RISE.
- cordis.europa.eu/project/id/691150
- Project website: wisefeed.w.uib.no

“The project will make aquaculture an ever more environmentally friendly industry, while increasing the economic results of fish farming enterprises.”



INDUSTRIAL TECHNOLOGIES

Assembly tasks made faster, more accurate and economical thanks to next-gen robotic workstation

Although industrial robots execute complex repetitive tasks more efficiently, reliably and precisely than humans, SMEs are reluctant to use them because of complicated and expensive set-up and maintenance. An EU initiative has overcome these hurdles with a new-fangled robot workcell.

Setting up robot-supported production processes demands expert knowledge. It also requires significant time for configuration, programming, testing and fine-tuning, all of which are very costly for SMEs. On the whole, robotic automation isn't economically feasible for SMEs, especially for small batch sizes.

RAPID, SELF-ADAPTABLE AND AFFORDABLE AUTOMATED ASSEMBLY PROCESSES

The EU-funded ReconCell (A Reconfigurable robot workCell for fast set-up of automated assembly processes in SMEs) project has developed a workcell designed specifically for the needs of SMEs to substantially reduce set-up and maintenance time. "This cutting-edge workcell makes robot solutions commercially viable, even for small batch sizes of about 1 000 units in some cases," says project coordinator Ales Ude. The workcell is able to autonomously pick parts from a tray or conveyor belt, place them into reconfigurable fixtures that adapt to the particular geometry of the workpiece, and hold them in a precise position during the assembly process.

As part of the modular software and hardware design phase, project partners introduced several innovations. Reconfigurable fixtures (hexapods) with pneumatic brakes are used to increase flexibility for assembly processes in robotic workcells. They devised novel ways to programme robot assembly applications based on kin-aesthetic teaching, where the human worker guides the robot through the desired task with his or her own hands instead of programming the task manually. The developed workcell control system is based on ROS robot middleware that fully supports the system's modular design, including communication between all workcell elements.

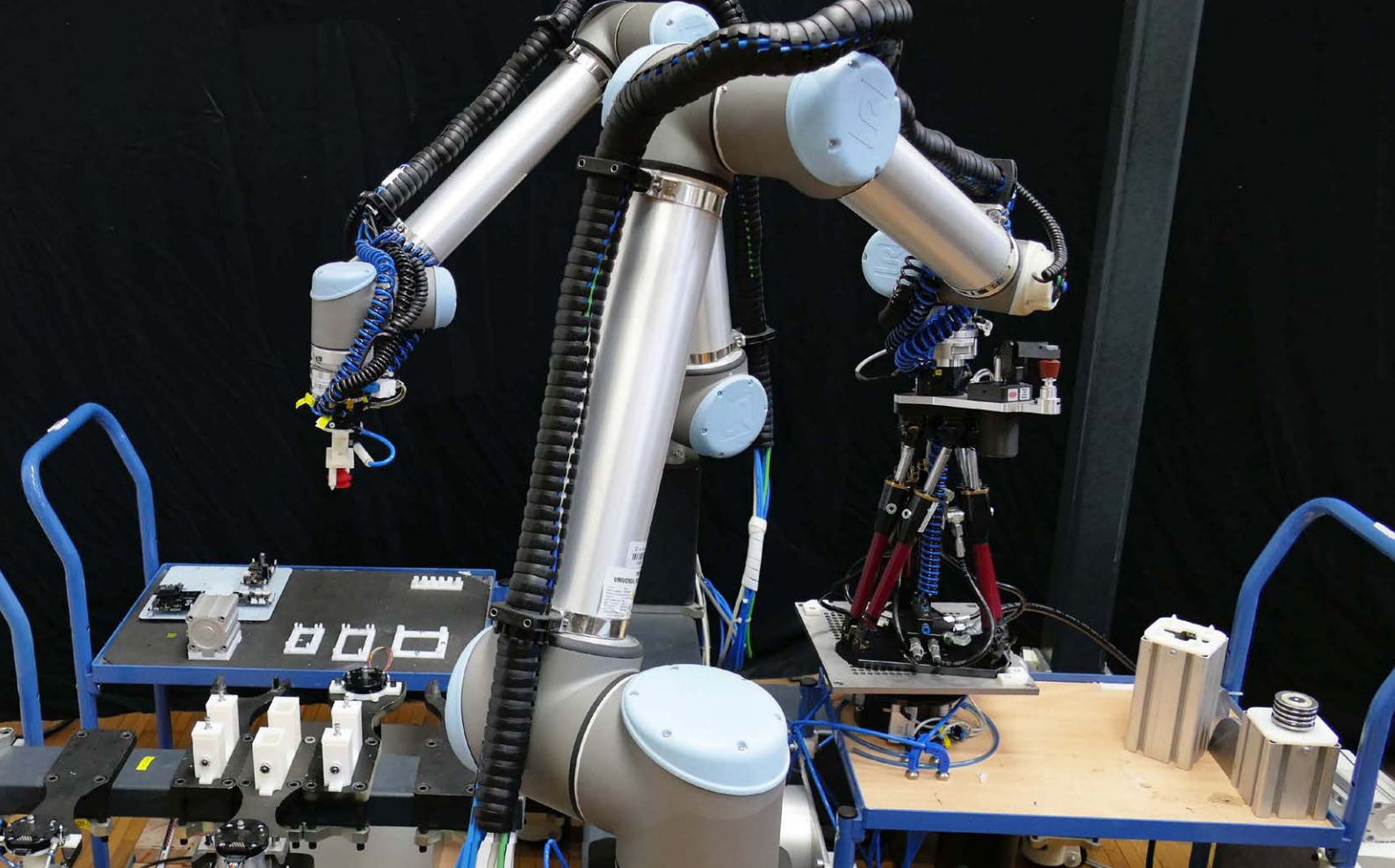
AUTONOMOUS ROBOT WORKCELL FOR LARGE AND SMALL PRODUCTION LINES

A series of automated robot assembly experiments provided by SMEs from five European countries demonstrated the feasibility of automated robot assembly in these companies. ReconCell showed that robotic cells can be automatically reconfigured without using many active hardware parts with motors and sensors. By equipping the workcell's building blocks with passively moveable parts, the robot can use its own manipulation capabilities to automatically reconfigure its workspace from one production process to another. Passively reconfigurable hardware is much cheaper than hardware with active components.

The ReconCell team also showed that new technologies such as 3D printing can significantly contribute to the successful implementation of robot assembly applications. 3D printing enables rapid prototyping of grippers, fixtures and other tools needed for assembly. In this way, task-specific hardware solutions can quickly be developed, making programming of assembly tasks much faster and easier than when general purpose hardware solutions are used.

Commercialisation efforts are well underway. A spin-out company called FlexHex has been created for the hexapod, the workcell's component. The consortium is also looking into other investment and funding opportunities to commercialise the entire workcell.

"ReconCell's technological advances show that manufacturing companies with typical SME-like assembly procedures can achieve a significant boost in productivity and reduction in production costs, as well as become more



© Ales Ude

competitive by introducing an easy-to-use, reconfigurable and reprogrammable workcell," concludes Ude. "By introducing a new generation of robotic workcells to the European SME manufacturing industry, the number of SMEs that are able to exploit robotic solutions in their production processes will increase."

RECONCELL

- Coordinated by the Jožef Stefan Institute in Slovenia.
- Funded under H2020-LEIT-ICT and H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/680431
- Project website: reconcell.eu

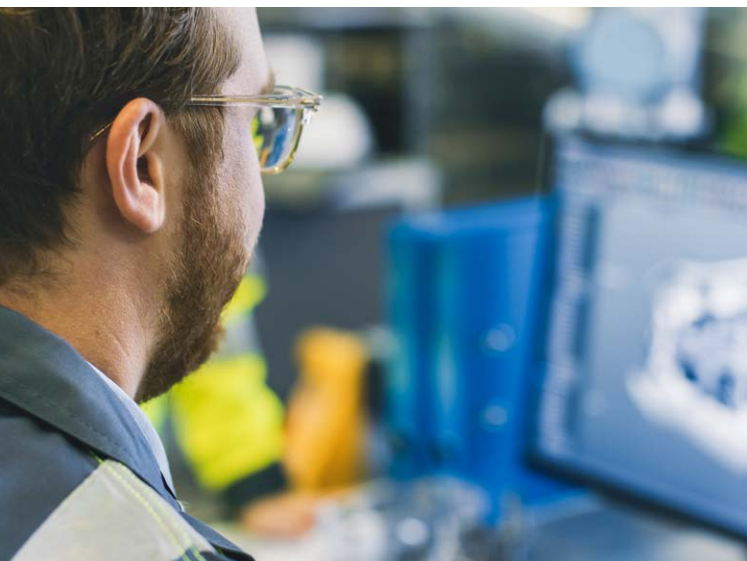
INDUSTRIAL TECHNOLOGIES

New models help create stronger and more ductile metal alloys

While mixing innovative semiconductor materials holds the key to keeping Moore's Law on track, metal alloys have not yet experienced a similar exponential improvement in performance. New computational models linking materials at different scales provide the key to developing stronger and more durable metal alloys highly valued in engineering applications.

Computer models are increasingly being used in a number of industries to assist in evaluating product performance, the material synthesis and selection processes, as well as material fabrication into components. Testing

material properties is not simple, as the underlying phenomena extend across a vast range of length and time scales. Combining information at the quantum, atomistic, mesoscopic and macroscopic levels is vital for developing



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multi-scale models that describe and even predict material behaviour.

Metallurgists have introduced a great variety of new alloys over the last 60 years. “Developing new or better metal alloys relies crucially on thoroughly understanding the fundamental physical phenomena underlying their impressive properties, or conversely, factors that negatively impact their properties. Due to the complexity, the field has only seen incremental improvements to existing alloys or serendipitous improvements from materials that are developed experimentally,” notes Bill Curtin, coordinator of the EU-funded PreCoMet (Predictive Computational Metallurgy) project. Project research successfully uncovered important physical phenomena affecting the strength and ductility of certain metal classes.

THE PATH TO MORE DUCTILE MAGNESIUM ALLOYS

In its pure form, magnesium is hard to stretch and form, and also lacks sufficient strength for many structural applications. PreCoMet researchers focused on identifying the atomistic origins of this unusual behaviour. Simulations of magnesium interactions at the atomic scale helped them establish a picture that unified decades of experimentation on the material’s macroscopic property.

“The key atomistic defects, called dislocations, are the ‘carrier’ of plastic deformation; they allow neighbouring crystal planes to slip over each other. However, we noticed an unusual behaviour when studying the structure of an important dislocation, which started morphing

into several possible geometries that locked it in place so that it could not move. These new structures had been observed experimentally before but they were considered to be experimental anomalies,” explains Curtin. Researchers showed that this immovable structure is intrinsic to magnesium and accounts for its low ductility.

The team then found that adding rare-earth elements such as yttrium, neodymium and gadolinium even at low concentrations substantially increases the number of moveable dislocations and therefore enhances magnesium’s ductility. Using their models, the team predicted new alloys with good ductile properties, avoiding the use of the less-desirable rare-earth elements.

TAKING THE GUESSWORK OUT OF NEW HIGH-ENTROPY ALLOYS

Consisting of multiple elements, the new class of high-entropy alloys are highly sought after, amongst others, for their high strength and high fracture resistance over a wide range of temperatures. Despite 70 years of experiments, there have been no models that could accurately predict alloy strength in even simple structures where a single element dominates.

Researchers extended their work towards modelling alloy classes having two common crystal structures, independent of the number of elements as well as their concentrations. Using their models, they can successfully predict the strength of many alloys based on some fundamental atomic properties.

“We can now design new high-strength alloys that have never been made before. Given the sheer number of possible composition combinations, this is a major feat, as it is difficult for material scientists to know where to look for new high-entropy alloys,” concludes Curtin.

The project work could help engineers develop special alloys for a wide range of applications from the aerospace and automotive to the biomedical industry.

PRECOMET

→ Hosted by the EPFL in Switzerland.

→ Funded under FP7-IDEAS-ERC.

→ cordis.europa.eu/project/id/339081



PROJECT OF THE MONTH

New research makes factories more attractive as workplaces

A new European study breathes new life into factory work by proposing novel ways to engage and motivate workers. Manufacturing environments are changing, and smart factories with new technologies are being introduced to allow humans and machines to increasingly work side-by-side.



© Prima Power

The partners in the Factory2Fit project, funded through the Horizon 2020 programme, have spent the last 3 years developing and piloting worker-centred solutions that feed into the current transformative phase in the Industrial Revolution known as Industry 4.0, with Operator 4.0 solutions. A package of seven innovative tools is now ready for market uptake.

Workers who have participated in this research are happy to be involved in reshaping their workplace. The tools allow inexperienced workers to upskill quickly and expert workers to share their valuable knowledge. One of the tools is an app collecting and offering workers private, real-time feedback on their work wellbeing and achievements, and insights into how these are related. Another one is a virtual factory-based software product allowing workers to participate in designing their own work. For more information, see: factory2fit.eu/

FACTORY2FIT

- Coordinated by VTT Technical Research Centre of Finland.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/723277

“We have effectively been looking to change the way factories operate. The Factory2Fit solutions will radically increase the possibilities for workers to influence their work and engage workers in taking responsibility for their own learning and skills development. The results of our industrial pilots show that the solutions are well accepted and they have potential to increase both work wellbeing and productivity.”

Eija Kaasinen, Factory2Fit project coordinator
VTT Technical Research Centre of Finland

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!



New sensors usher in next-generation vision systems in security, medicine and automotive applications

Demand for image sensors in automobiles, the Internet of Things, medicine and security and surveillance applications is challenging businesses to improve the performance of their integrated systems. An EU-funded project developed breakthrough image sensors that should expand the functionality of future vision systems.

The next generation of camera systems entering the market after 5 years will rely entirely on novel cutting-edge technologies. With this in mind, the EU-funded project EXIST (Extended Image Sensing Technologies) investigated and developed new technologies for image sensors and systems for future applications. The new solutions combine high performance in terms of speed, compactness, band selection and cost.

IMAGE SENSOR COMBINES THE BEST OF DIFFERENT WORLDS

Time delay and integration (TDI) is an imaging technique used when an object or scene is moving linearly over an imager and when the content of the scene is not changing within a short period of time. The technology of choice for handling analogue TDI pixel data is charge-coupled-device (CCD) technology. Applications mainly include industrial inspection, life sciences and machine vision.

Project partners have developed a new solution that combines CCD TDI pixels together with advanced complementary metal-oxide-semiconductor (CMOS) drivers and readout in one single chip, enabling a single imager chip with both CCD and CMOS functionality. "This unique technology combines the noiseless collection and transfer in charge domain of the CCD technology, and the system integration potential and fast readout that only CMOS can deliver," notes Piet De Moor, business developer at imec.

OTHER HIGH-RESOLUTION SENSORS

A new 4K sensor has been developed together with the image processing chain for 4K. This work resulted in the launch of the LDX86N broadcast camera product.

Two other high-resolution sensors were also built: a 32MP sensor and a 14MP sensor. A rugged UHDTV zoom lens and digital hardware image processing in FPGA were developed for high-resolution image processing.

Multiple products are already or will soon be on the market such as the new 4K broadcasting camera, full frame cinema zoom lens, 4K and 8K UHDTV small outline cameras for security and industrial vision, the new 14MP global shutter imager for industrial vision, and the new high-speed multi-band TDI imager. Compact high-resolution cameras and sensors can be used in security applications or machine vision. "Enhancements in broadcasting are obvious in our evolving quest for better TV resolution," notes De Moor.

BACK-SIDE ILLUMINATION FOR MAXIMUM SENSITIVITY

The vast majority of image sensors are designed to convert the light falling on the front side of the sensor to electrons. Recent design breakthroughs in the arrangement of imaging elements have made back-illuminated image sensors increase the amount of light that is captured, leading to improved low-light performance.

Capitalising on the latest advances, project partners developed hyperspectral filter structures processed at wafer-level on commercially available image sensor wafers. These filters can be added to increase TDI imaging performance.

COMBINING COLOUR AND NEAR-INFRARED IMAGING

EXIST also introduced a new time-of-flight image sensor combining RGB colour filters and narrow-band



near-infrared filters. This breakthrough optical filter integration platform will enable many applications in fields ranging from medical, industrial, security surveillance and automotive areas to virtual and augmented reality, where near-infrared signals need to be extracted and overlaid on top of colour images.

Project partners have already unveiled a multispectral filter stack combining near-infrared and visual light on an imager for use in laparoscopy.

By introducing new technologies based on innovative materials, designs and concepts into image sensor process technology, EXIST will promote a growing market share and increase employment and investment in innovative equipment, materials and semiconductor device manufacturing.

EXIST

- Coordinated by imec in Belgium.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/id/662222

DIGITAL ECONOMY

Drones, smartphones and cloud technologies support smart construction decisions

The construction sector is in a unique position to address challenges related to climate change and energy efficiency. High-tech innovations for rapid and accurate on-site inspection will streamline that process.

Construction generates 9% of the EU's gross domestic product (GDP) and accounts for 31% of industrial

employment, or 18 million jobs. Despite this critical role, the field has lagged behind others in generating new

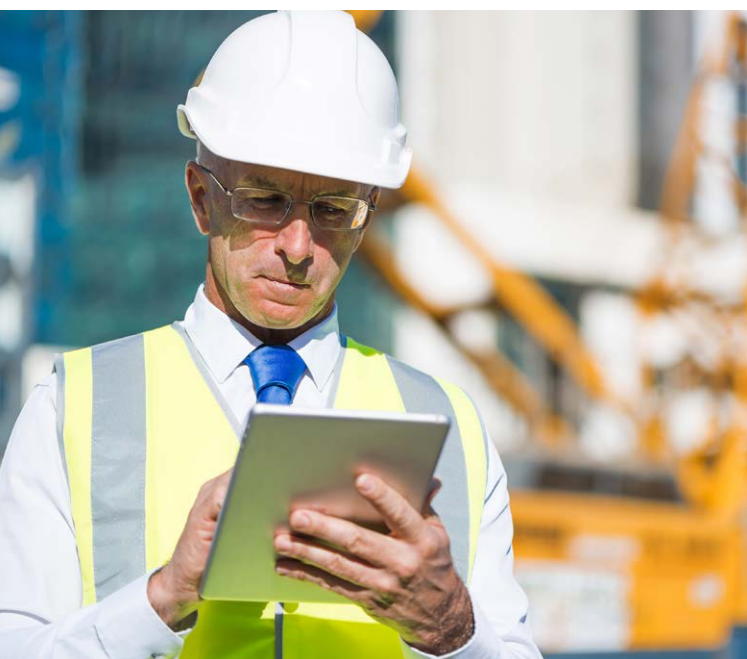
technology for enhancing productivity. The EU-funded Built2Spec (Built to Specifications: Self-Inspection, 3D Modelling, Management and Quality-Check Tools for the 21st Century Construction Worksite) project set out to remedy that.

ON THE GROUND AND IN THE CLOUD

As project coordinator Germain Adell explains: “Built2Spec brings together breakthrough technological advances for self-inspection and quality assurance that will help meet EU energy efficiency targets, new build standards, and related policy ambitions.” Much more than individual high-tech construction and inspection tools, their holistic solution includes centralised data storage and real-time information sharing with the cloud-based virtual construction management platform (VCMP).

Rapid building information modelling (BIM) utilises 3D scanning via a variety of devices including drones, cameras and the Microsoft HoloLens. Instant and accurate energy-efficiency evaluation and quality checks on-site can be transferred to the back office via the VCMP to streamline the quotation process.

The toolbox includes portable devices for acoustics, air-tightness and thermal testing as well as a single device for multi-gas evaluation of the most harmful gas pollutants. Smart building materials with embedded sensors or radio-frequency identification (RFID) support real-time monitoring of the physical and thermal behaviour of structures.



“*The company has transformed itself to become the leading specialist contractor in Ireland of high-performance, low-energy building envelopes.*”

A NEW DAY DAWNS FOR RAPID ON-SITE INSPECTION AND QUALITY ASSURANCE

Adell explained what a typical inspection might look like with Built2Spec's technologies.

Arriving at the work site with a smartphone or tablet, the engineer syncs the device with the Built2Spec's VCMP. Data from a drone's aerial thermal survey flags a window on the third floor, so the engineer heads up to investigate.

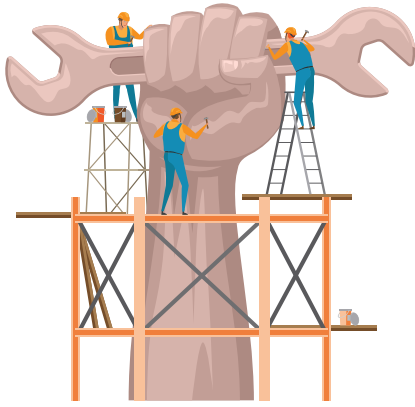
The smartphone RFID reader identifies which window systems were used, and the BIM model checks compliance between the design specifications and the actual model installed. Installation guidelines from the manufacturer specifications as well as installation and self-inspection processes can be reviewed on the tablet. The engineer can also see when the job was done, who did it, and the results of self-inspection testing.

After determining the flag is caused by unfinished work, the engineer can message the subcontractor to determine why, document the inspection, including an image of the window installation, sign the documentation electronically and send it to the project manager and the quality assurance department.

EUROPE'S SMES TAKE THE BALL AND RUN WITH IT

Built2Spec advances are enhancing partners' positions in the competitive construction market. A prime example is Ecofix, an Irish SME construction company. According to Adell: “The company has transformed itself to become the leading specialist contractor in Ireland of high-performance, low-energy building envelopes.”

Following on the heels of its 59-unit demonstration site for Built2Spec's technologies, Ecofix has contracted to build 4500 dwellings over the next 5 to 7 years. This could increase revenue more than 10-fold.



Construction generates 9% of the EU's GDP and accounts for 31 % of industrial employment, or 18 million jobs

According to Adell: "Opening new markets for the project partners and transferring the technologies to the construction sector is the only way to ensure your project has a real impact. And it is happening now." Built2Spec's toolbox of cloud-connected inspection tools is revolutionising the way the construction industry does business.

BUILT2SPEC

- Coordinated by NOBATEK/INEF4 in France.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/637221
- Project website: built2spec-project.eu
- ▶ bit.ly/2ktl3iF

DIGITAL ECONOMY

High-performance cloud platform reduces circuit design costs for industry and businesses

Physical verification of an integrated circuit design is a critical step prior to handing it to the foundry for manufacturing. Ukraine-based start-up POLYTEDA CLOUD developed secure, cost-effective cloud-based software for circuit verification that checks microchip design for violations before they go for manufacture.

As integrated circuit design becomes more complex and computing increasingly accessible, electronics developers seek innovative solutions to gain a competitive edge. Great effort has been dedicated to automating manual and labour-intensive phases of the integrated circuit design cycle through electronic design automation (EDA) software. Such automated tools help developers ensure electrical and logical functionality and manufacturability of their products.

With EU funding of the project PVCLOUD (Innovative Cloud-Based PV Workflow for Semiconductor Foundries), Ukrainian company POLYTEDA CLOUD has applied the power of cloud to EDA to greatly boost productivity. PVCLOUD's ground-breaking solution is an EDA service

that offers an integrated cloud environment to jump-start semiconductor design, verification and implementation.

OVERCOMING LIMITATIONS IN EXISTING PHYSICAL VERIFICATION TOOLS

Accurate physical verification is a prerequisite for successfully designing semiconductor devices. Layout designs are checked to find and fix violations made by developers before being processed for manufacturing at a semiconductor fabrication plant (fab). The check is performed with special EDA tools to test whether the layout meets a certain range of performance and size characteristics specified by the selected process node.

“Our solution gives electronics engineers more control over the cost, by enabling them to use the service on an hourly pay-per-use basis.”

Finding violations as soon as they are introduced into the design phase prevents them from propagating into the manufacturing phase. “A violation overlooked at the microchip design stage can cause a million-euro loss for industries. In the automotive industry for example, malfunctioning electronics can result in product recalls or even worse contribute to serious accidents,” notes Alexander Grudanov, POLYTEDA’s Chief Executive Officer.

What’s more, physical verification is a time-consuming stage of the design process. “It takes several days for an EDA tool to make an iteration on modern super-large microchips. This significantly limits the capacity and efficiency of the fabs and the semiconductor industry,” adds Grudanov.

POLYTEDA CLOUD is addressing these challenges by developing software that centralises at fabs both the preliminary block-level design and the final approved sign-off design of circuits. The customised microcircuit checking tool identifies violations and verifies semiconductor circuit designs before microchips are committed to production.

Leveraging the availability of secure, readily available cloud computing technology, it provides a high-performance, highly accurate scalable solution for circuit physical verification that competing tools cannot deliver. Strip processing supports parallel processing scalability on up to 128 central processing units (CPUs) delivering throughput of up to 5 million devices per hour per CPU. This scalability allows design teams to make intelligent trade-offs in processing performance, schedule and budget. Unlike competing solutions, the efficiency of the PV CLOUD platform on multiple CPUs may be evaluated within a few minutes free of charge.

PAY-PER-USE ELECTRONICS DESIGN

While on-demand cloud-based software solutions have long served other industries, circuit design has lagged due to security concerns. POLYTEDA’s software addresses this concern by allowing electronics engineers to test circuit design right where they are fabricated.



Currently, major EDA tool vendors are using a per-seat licence model, a subscription-based solution that depends on the number of users who access the digital service. “Our solution gives electronics engineers more control over the cost, by enabling them to use the service on an hourly pay-per-use basis,” explains Grudanov.

POLYTEDA CLOUD is the first company that introduces a pay-per-use model to the EDA world. This opens up an entirely new ecosystem aimed at SMEs, which have not been able to meet the high cost barriers of the traditional licence-based models.

PV CLOUD

- Coordinated by POLYTEDA CLOUD in Ukraine.
- Funded under H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/id/738922
- Project website: polyteda-cloud.com



SECURITY

Cutting-edge fire propagation model balances speed and accuracy

*Fires are difficult and costly to model, so engineers seldom bother.
A new system makes it easier.*

Fires have always been a serious safety concern, and remain so in Europe. Although the trend is broadly downwards, Europe still suffers around 4000 deaths annually from tens of thousands of building or house fires. These cost Europe over EUR 100 billion per year.

Therefore, fire safety engineers regularly need to model fire behaviour as a substitute for expensive and complicated experiments. However, doing so poses many computational challenges.

The EU-funded RAD-FIRE (Efficient methods for radiative heat transfer analysis in fires and water sprays for fire suppression) project, undertaken with the support of the Marie Skłodowska-Curie programme, developed accurate and efficient fire behaviour models for engineering use. The innovation resolves the difficulties faced by earlier forms of fire modelling.

Modelling fire behaviour involves a branch of computing called computational fluid dynamics (CFD), which simulates the whole process, taking into consideration the interaction of many complex variables. The most

important aspect for fires is thermal radiation, meaning heat travelling directly from the source instead of via air currents or conduction.

THE MODELLING CHALLENGE

“Modelling of thermal radiation in CFD codes for fire simulation has always been a real challenge for fire scientists and modellers,” says Siaka Dembele, project coordinator. “Simple models, that estimate the radiative heat fraction, can be easily run on computers, yet they provide inaccurate results due to their simplifications.” Predictions from these simple models are not very reliable.

Conversely, computational techniques including the discrete ordinates model or the finite volume method are far more advanced and accurate, but also extremely demanding in terms of computing requirements. These methods require long calculation times, which is very expensive and impractical for engineers needing to run many simulations quickly.





Building or house fires
cause **4 000 deaths annually** in Europe.

The cost:
over **EUR 100 billion** per year.

SIMPLE YET ACCURATE

As Dembele explains: “What’s missing in current fire safety CFD codes is a credible in-between solution.” This is what RAD-FIRE provided. “Our new model keeps the rigour and accuracy of the advanced models, while also offering reduced computing times.” This means a convenient solution for engineers that is reliable and acceptably accurate.

One key to improvement is the calculation of radiative properties of combustion gases (mostly water vapour, carbon dioxide and carbon monoxide). Heat energy is transferred mainly as infrared radiation; like light, infrared wave comes in many distinct wavelengths, analogous to colours, which spread out like a rainbow in the visible spectrum. Hot gases emit energy as emission lines and also absorb energy in lines. Combustion could produce thousands of emission and absorption spectral lines. Current advanced approaches for gas radiation model each

line separately, hence the long computing times. RAD-FIRE researchers simplified the spectral calculations from thousands of lines to a few large bands of similar lines.

A second element of the improved modelling is simplification of key calculations. The team developed a method involving two approximations for calculating a fire’s radiative heat transfer. Dividing the calculations results in a much simpler algorithm compared to earlier methods. Researchers found it sufficiently able to determine flame characteristics.

RAD-FIRE’s new models decrease computational times by more than 100 times in some cases. Yet, the accuracy of the new method is comparable to the old.

The considerable time and monetary costs of current fire simulation methods have deterred engineers from using them. Now, thanks to RAD-FIRE’s new compromise algorithm, engineers will be able to economically and accurately model fire, leading to better predictions and safer buildings.

RAD-FIRE

- Coordinated by Kingston University Higher Education Corporation in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/749220
- Project website: kingston.ac.uk/faculties/science-engineering-and-computing/research/research-centres/ceesr/fire-explosion-and-fluid-dynamics/rad-fire/

SECURITY

Spray-on reagent helps convict sex offenders

An EU-funded research initiative has developed a new test for identifying semen stains to use as evidence in cases of sexual assault.

Crime scene investigation (CSI) technology must provide fast, accurate, non-destructive detection of a wide range of evidence, including invisible stains caused by

bodily fluids. Particularly important is the ability to identify semen stains for evidence from sexual assault cases, as it is likely to contain samples of the assailant’s DNA.

The EU-funded Sex-Assault-ID (Crime Scene Presumptive Sperm Identification Test for Sexual Assault Evidence and DNA Collection) project addressed this need by developing a sperm identification test to gain evidence of sexual assault via DNA detection and collection. The test involves a biochemical reagent for semen stain mapping that will be part of the crime scene technician's (CST) tool box.

An ultra-specific molecule that only reacts with enzymes contained in human semen forms the basis of the technology. "It works because of the combination of the enzyme targeted, and the molecule chosen is extremely robust against external conditions like dryness and temperature," says project coordinator Benjamin Corgier.

IMPROVED RESULTS

The reagent comes in the form of a dissolvable powder, which produces a ready to use sprayable solution. After spraying the solution over suspected materials like carpets, sofas, bedding or car seats, a portable ultraviolet light can reveal the presence of semen within a minute.

Stains can then be sampled by the CST and sent for DNA profiling. "Key results were the first positive tests on material where sperm stains had never been so specifically identified as compared to other screening techniques, like on grass, stone and car interiors made of plastic," Corgier explains.

The main challenge faced by Sex-Assault-ID involved transferring the concept from the laboratory to the market place. They had to provide a dry, stable powder that

“Key results were the first positive tests on material where sperm stains had never been so specifically identified as compared to other screening techniques, like on grass, stone and car interiors made of plastic.”

enables the specific detection of prostatic acid phosphatase contained in semen. In addition, it must not affect DNA and sampling, while complying with the routine production.

INTERNATIONAL INTEREST

Researchers tested and validated the spray formulation for the detection of semen in the laboratory and found it to be compatible with DNA sampling and profiling. A business plan has also been drawn up to address customers in Europe, North America and the rest of the world, and critical suppliers identified.

Lastly, a cost, pricing and profitability model has also been evaluated. Interest in the product has already been expressed by a wide variety of countries including China, France, Germany, Japan, New Zealand, Sweden, the United Kingdom and the USA.

Sex-Assault-ID successfully developed a stable, simple to use reagent in spray form that will benefit users by replacing the previous toxic products and reducing screening time. The judiciary system and the wider society will also benefit from an improvement of over 50 % in accuracy as well as frequency of DNA collection in sex assault cases.

Furthermore, the Sex-Assault-ID solution will help solve cases more efficiently and bring assailants to justice more quickly before they can offend again, thereby reducing the rate of sexual assault. "The systematic use of the spray will improve collection, the investigation, and the judiciary system, saving direct and indirect costs for every stakeholder," Corgier concludes.

SEX-ASSAULT-ID

- Coordinated by AXO Science SAS in France.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-LEIT.
- cordis.europa.eu/project/id/815553
- Project website: axoscience.com/company/news





FUNDAMENTAL RESEARCH

What can a 14 000-year-old puppy tell us about the impact of domestication and environmental stress on DNA?

There is evidence, especially in plants, that epigenetic changes, created in individual organisms because of environmental stresses, can be passed down through the generations and become fixed. Would harsh environments surrounding early dogs, combined with selective breeding, show traces of this epigenetically-mediated evolution? One project set out to answer the question.

DNA methylation patterns (which determine whether a gene is 'switched on' or 'switched off') are the epigenetic modification most seen as a result of environmental stress. While this is clearly seen in plants, there is a growing body of evidence suggesting this is also the case in animals.

To find out if this is the case, and to analyse the relationship between stress-induced modification and the DNA methylation patterns that could have been caused during early domestication, EpiCDomestic (Epigenetics of Canine Domestication from the Upper Paleolithic onwards) considered bone fragments.

A collection of such remains from different environments (Siberia, Greenland and Denmark) spanning a large time-scale, from the Upper Palaeolithic (around 30 000 years before now) to the second millennium CE, gave the EpiCDomestic project the chance to identify molecular variation where domestication has taken different regional trajectories.

"We have to work with what we've got," says principal investigator Oliver Smith, who conducted the research with the support of the Marie Skłodowska-Curie programme. "In the majority of cases, that was bone. We were looking for something to do primarily with skeletal morphology, but this kind of work always throws up unexpected results – so we are looking at all genes with known functions."

One of the challenges they faced was the fact that patterns of epigenetic modification vary among individuals, different tissues within an individual, and even different

cells. This makes it difficult to build up a coherent picture. To keep things as simple as possible, the team decided to begin by using the same tissue type between samples.

"The vast majority of archaeological tissues are bone, so we thought we could look for genes associated with morphological development relevant to breeding purposes, at least to begin with. An exception to this was a frozen, 14 000-year-old puppy, whelped from a domesticated dog from Tumat, a village in Siberia," Smith explains. The remains were so well preserved that it gave Smith the chance to come at the question from another angle.

"Since this was such an opportunity, we looked to see if the epigenome of different tissues could match their respective transcriptomes – that is to say, if the 'switched on or off' state of the genes would match the expressed level of those genes we saw in the RNA (transcriptome), for each of those tissues," Smith says.

It's early days, but the researchers' initial analysis leads them to believe that, even after all this time, it is still possible to tease out these complementary signals. "These are very preliminary analyses and we are in uncharted waters, so we can't make any grand claims yet!" Smith adds.

This work is innovative and possible now due to our improved understanding of ancient DNA, in particular how it becomes damaged and degraded. Researchers only recently realised that they could use the damage patterns as a guide to DNA methylation. Some have done



“14 000-year-old RNA from animal tissue, which is preserved enough to show biologically meaningful tissue-specific profiles, is a methodological milestone.”

© Jef Wodniak, Shutterstock

so before, on humans (Neanderthals and Denisovans), and Smith previously worked on barley. “But the work was done more as a proof-of-principle than with a specific evolutionary question in mind,” Smith explains. Now research in the field is gathering momentum, meaning analysis of such damage patterns could shine a light on other interesting aspects of DNA methylation.

Smith is particularly interested in the ancient RNA aspect: “14 000-year-old RNA from animal tissue, which is preserved enough to show biologically meaningful tissue-specific profiles, is a methodological milestone. When we consider the huge numbers of RNA viruses, for

example HIV, rabies and measles, we have a potentially new and exciting source of biomolecular information about the past.”

EPICDOMESTIC

- Coordinated by the University of Copenhagen in Denmark.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/704254
- Project website: sites.google.com/palaeome.org/epicdomestic

FUNDAMENTAL RESEARCH

The complete guide to studying fossils in the making

EU researchers have turned the Doñana National Park into a real-life natural laboratory to evaluate the conditions needed to make fossils.

The fossil record is the main window for studying the past biodiversity of our planet and faunal and floral changes

associated with previous environmental shifts. However, there is a need to look beyond face value when



reconstructing the past. The EU-funded LiveDeadFossil (Life and death in Doñana National Park (Spain): palaeontological and ecological insights from the study of modern vertebrate death assemblages) project undertaken with the support of the Marie Skłodowska-Curie programme turned to taphonomy, or the study of how fossil bones come to exist, to supply the answers.

DOÑANA NATIONAL PARK – A DIVERSE RANGE OF NATURAL HABITATS

As Juan José Negro, project coordinator, together with Catherine Badgley, external advisor, explains: “Doñana National Park, on the south coast of Spain, constitutes an extraordinary natural laboratory for carrying out this type of study due to its rich biodiversity and variety of habitats – marshes, dunes, riverbanks, lake margins, shrubland, beach as well as woodland. It’s a restricted area devoted to conservation and research. Tourism takes place mainly in the periphery of the park.”

“We carried out two field campaigns and sampled and analysed 33 transects belonging to 10 different habitats,” Soledad Domingo, the Marie Skłodowska-Curie fellow, told us. Altogether, they studied 3 796 bones belonging to 344 individuals to predict the environments favourable for creating fossils.

FOSSIL-MAKING STEPS

Early destruction of bones usually comes from predators. Nevertheless, there has been low predator pressure in Doñana ever since the extinction of the wolf in the 1950s, resulting in good preservation and high survival probability of bones compared to other natural areas. In any event, the team observed that the wild boar is a very frequent scavenger and bone modification agent.

Of all the investigated habitats, prime locations for potential fossil formation at Doñana are the lake margin habitats. Here, bone remains are abundant and become buried relatively rapidly, particularly from trampling in soft wet substrate.

Apart from offering important insights on fossilisation, recent death assemblage surveys are useful for tracking different aspects of living populations such as habitat change and resource utilisation, or mortality through time. They can therefore provide interesting information to conservation biologists and wildlife managers. “For example, we identified a specific area of the park preferred by male deer in the late winter in view of the high amount of shed antlers found there,” Negro reveals.

WILD TERRITORY

Domingo describes the adventure: “A lot of Doñana remains in wild conditions with no road or signs, although thanks to technology we got used to using offline maps saving a lot of time driving in the park. Negotiating loose sand in the vehicles also proved challenging, but working in these formidable landscapes was rewarding, not least for the amazing sunsets!”

When not skidding through sand, the researchers investigated the transects on foot. Most of the bones found belonged to mammals weighing more than 5 kg, such as horses, cattle, wild boar, red deer and fallow deer. At the beach, they came across dolphin, sea turtle and whale bones.

LiveDeadFossil was inspired by a 40-year-long running project in Amboseli National Park (Kenya) headed by vertebrate palaeontologist Anna K. Behrensmeyer. Negro describes his vision: “We want the LiveDeadFossil project to become the seed of a similar long-term and powerful taphonomic monitoring programme at Doñana National Park.”

LIVEDEADFOSSIL

- Coordinated by the Spanish National Research Council (CSIC) in Spain.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/700196
- Project website: soledaddomingo.weebly.com/livedeadfossil-project.html



AGENDA

DECEMBER 2019

WORLDWIDE
World AIDS Day

**1
DEC**

**3
DEC**

WORLDWIDE
International Day of Persons
with Disabilities

BEIJING, CHINA
EU-China Smart City Summit & Guided Tour
→ [urbaneuchina.eu/en/event/
eu-china-smart-city-summit-guided-tour/](http://urbaneuchina.eu/en/event/eu-china-smart-city-summit-guided-tour/)

**3→5
DEC**

**5→6
DEC**

NEUCHÂTEL, SWITZERLAND
Sharing the experience: Workflows for
the Digital Humanities
→ [dariah.eu/event/dariah-ch-workshop-
2-sharing-the-experience-workflows-
for-the-digital-humanities/](http://dariah.eu/event/dariah-ch-workshop-2-sharing-the-experience-workflows-for-the-digital-humanities/)

LYON, FRANCE
Surreal-23 Final Workshop
→ [surreal-23.cperi.certh.gr/
invitation-surreal-23-final-workshop-lyon/](http://surreal-23.cperi.certh.gr/invitation-surreal-23-final-workshop-lyon/)

**10
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**10→11
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BRUSSELS, BELGIUM
The 2019 EU Agricultural Outlook
Conference
→ [ec.europa.eu/info/events/2019-eu-
agricultural-outlook-conference-
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RESULTS PACK ON DIGITAL GOVERNMENT

Our latest Results Pack highlights 10 EU-funded projects that are bringing eGovernment closer to the citizens of Europe. Delivering innovative eGovernment solutions and applying principles such as 'digital-by-default', 'user-centricity' – in particular 'citizen engagement' – and 'once-only' are just some of the ambitious goals these projects set out to achieve.



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