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Research*eu

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Why possessing a 'gay voice' can lead to discrimination

Towards a safer and more robust European railway sector

Cutting-edge toolset creates immersive multiscreen video experiences

SPECIAL FEATURE

DEFINING EUROPE'S ROLE IN A COMPLEX INTERNATIONAL ORDER

Editorial

The EU's role as an international actor, new technology to make your train journey a bit more pleasant and showcasing SmartPodX –

welcome to this month's Research*eu magazine

"The night is dark and full of terrors."

Some of our readers will immediately recognise this as a key phrase from George R. R. Martin's 'A Song of Ice and Fire' fantasy book series and its accompanying hit HBO TV series 'Game of Thrones' which has just begun its long-awaited final season. But one who is both overdramatic and pessimistically-minded could also argue that this fictional phrase amply summarises the current state of the world's international order.

The 'unipolar moment' of supreme US dominance at the end of the Cold War has become fractured, with ongoing trade disputes threatening global prosperity, the rise of populist politics in democracies spanning the world, continued crises in the Middle East and the jostle for influence between the US and other powers such as Russia, India, China and the EU. Not since the beginning of the new millennium have the foundations of the international system felt so shaky and uncertain.

In this month's special feature, we highlight eight EU-funded projects that have been working hard to, in one way or another, address the following question: What positive and influential role can the EU have in today's world order (and especially in such turbulent times) with the tools currently at its disposal? Whilst foreign policy remains a closely-guarded competence of the EU Member States, the Union has increasingly built up its external policy instruments since the ratification of the Maastricht Treaty.

Whilst many traditional adherents to *realpolitik* would argue that since the EU is not a nation-state then it can't feasibly act as a true international influencer due to its lack of 'hard' power. However, as our eight projects highlight, the EU does have a valuable role to play on the world stage, such as in the spheres of peacekeeping, conflict prevention and 'soft' power. But our projects also point out more than once that the EU could – and should – be doing more to bolster its international position, especially in its bilateral relations with several crucial countries and regions, such as Turkey, Russia, the Middle East and the Eastern Partnership countries.

Meanwhile, away from the cut-throat world of international politics, in **Life After** we reconnect with the Greenrail project that has pioneered new and smart railway sleepers that promise not only to increase the comfort levels of your rail journey but also to help engineers modernise and future-proof Europe's vast railway infrastructure to upgrade it for the challenges of the 21st century.

Project of the Month also returns after a brief hiatus, where we highlight innovative Spanish SME Submer and its SmartPodX, an Immersion Cooling solution for Hyperscalers, HPC and Data Centres that has been hailed as a 'game-changer' for the industry.

And last but certainly not least, **EU Agenda** rounds up the latest EU-funded project events and conferences, and as always we welcome you to dip in and out of our regular nine thematic sections.

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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HEALTH

Personalised, adaptive, socially inclusive home-based cardiac rehabilitation

Cardiovascular disease (CVD), according to the World Health Organisation, is globally the leading cause of premature death, and one recent estimate puts the cost to the EU economy at EUR 210 billion a year. Changing demographics and deteriorating lifestyles could worsen this, unless solutions such as those developed by the EU's PATHway project turn the tide.

Despite the success of cardiac rehabilitation (CR) in reducing mortality and morbidity rates, community-based CR uptake and adherence is low across the EU.

The EU-supported PATHway (Technology enabled behavioural change as a pathway towards better self-management of CVD) project proposes a paradigm shift which empowers patients to better self-manage CVD within a collaborative care context. The project developed a sensor-based, internet-enabled, home exercise platform that allows remote participation in tailored and adaptive exercises.

The team recently completed a trial involving 120 participants (60 using PATHway and 60 controls), from Belgium and Ireland, who were undertaking phase 3 community-based CR. They found that not only was the system accepted by most of the patients and clinicians, but its Decision Support System also increased the time patients spent exercising and being physically active. This led to favourable heart health measurements compared to the control group.

A FLEXIBLE, USER-CENTRED APPROACH

European uptake of community-based CR has been estimated at as low as 11 %. Some people are too far away from programmes or have limited available options, some experience scheduling problems and some feel intimidated participating in a group setting.

"Our person-centred approach involved a four-stage, iterative co-design process, with user testing," says Dr Kieran Moran. "Guided by behavioural change theory, we incorporated 22 techniques into the final design, alongside technological solutions to fulfil user identified needs."

PATHway worked with over 400 potential users and 50 clinical professionals using questionnaires, focus groups and one-on-one interviews to design the rehabilitation platform which delivers a 'virtual coach' exercise programme on Windows-based PCs.

Exercisers wear a wrist monitor to measure heart rate. If it is too high, PATHway automatically lowers exercise intensity, if too low, it increases intensity – keeping the user's heart rate in the ideal range.

Cardiovascular disease, the leading cause of premature death globally,

costs the EU economy €210 billion a year

The system uses a depth-camera (Microsoft Kinect) to capture the exerciser's movements (viewable beside the virtual coach), as they receive motivational feedback. The complexity of the exercises is automatically matched to user ability, which is monitored over time. All activity information is collated and made available to the user on a platform dashboard to help them reach their goals.

Users are encouraged to be physically active outside the home, with the wrist monitor tracking activity as well as targeting other lifestyle challenges such as diet, alcohol consumption, stress management, medication compliance or smoking cessation, with supportive messages.

"We also wanted people to be socially active, to emotionally support each other during what can be a difficult time. So we enabled users to link up, either virtually during exercise or physically, for example by going for a walk together," says Dr Moran.

IMPROVING QUALITY AND QUANTITY OF LIFE

PATHway contributes to the EU's ambition of helping citizens better self-manage health, not only improving quality and quantity of life, but also reducing direct and indirect healthcare costs.

The team is currently analysing the data to learn more about how PATHway has affected the health indicators of users. "Aggregated data will allow us to further personalise programmes. In addition, direct data like this benefits from not relying on users' self-reporting, which is notoriously inaccurate, giving us a deeper insight into how mHealth-based systems can be effective for rehabilitation and health management," elaborates Dr Moran.

The PATHway system is now ready to be rolled out commercially with the team actively looking for partners.

PATHWAY

- Coordinated by Dublin City University in Ireland.
- Funded under H2020-HEALTH.
- cordis.europa.eu/project/id/643491
- Project website: pathway2health.eu
- bit.ly/2G9g0NQ

Online matchmaking services for personalised medicine research

Personalised treatment aims to find and implement the right treatment for the patient at the right time. To accommodate this, the PERMIDES project developed a web platform for supporting research and development in the field of personalised medicine by digitisation.

Personalised medicine is a promising emerging industry in Europe that has high growth and innovation potential. Undoubtedly, a personalised approach will decrease inefficient treatments, reduce harmful side effects, and improve the patient's health and life quality, while minimising healthcare costs. However, the constantly growing amount of patient-related data requires digital solutions to determine whether a drug will be effective, ineffective, or even harmful.

The EU-funded PERMIDES (Personalised Medicine Innovation through Digital Enterprise Solutions) platform was designed to address innovation barriers in the biopharma sector via cutting-edge IT solutions. The idea was to generate an open collaboration space consisting of workshops, a matchmaking portal and events that will help biopharma SMEs to identify suitable partners among the IT companies and set up collaboration. As project coordinator Tamara Högler explains: "The PERMIDES platform also supports the management and evaluation of applications submission for innovation projects as well as the monitoring of funded projects."

THE PLATFORM IN BRIEF

The PERMIDES platform is entirely web-based, requiring no additional plug-ins, and is accessible by any browser. It was launched in March 2017 and comprises integrated semantic algorithms to facilitate intelligent matchmaking.

Following registration, leading biopharma and IT clusters from European countries are capable of creating novel cross-sectoral collaborations between SMEs. Focusing on one specific innovation, the biopharma SME can invite registered IT SMEs as well as additional partners to cooperate. The virtual collaboration space consists of a communication area, which allows both SMEs to leave messages for each other.

To create awareness about the project and the upcoming calls for innovation projects, the consortium implemented various health forums on the latest trends in the IT and biopharma sectors. Regional workshops also helped bring together SMEs from the biopharma and IT sectors, setting the ground for a mutual understanding of innovation barriers. Alongside press releases, advertising on the consortium member website and social networks further helped spread the call. In parallel, PERMIDES partners established synergies with both national and regional innovation funding agencies, central to ensuring sustainability of the innovation projects.

FUTURE IMPACT OF PERMIDES

"We are confident that the PERMIDES platform will boost the innovation potential of personalised medicine in the future," continues Högler. A project-conducted survey

> *We are confident that the PERMIDES platform will boost the innovation potential of personalised medicine in the future.*

emphasised the importance of interdisciplinary matchmaking to support long-term personalised medicine research and development. Already, more than 400 companies have registered on the PERMIDES platform, establishing it as a trademark service. Over 45 SMEs have initiated joint innovation projects, and 59 such projects between IT and biopharma companies have commenced. Input from SMEs underscores the benefit of technology transfer and consultancy activities offered through the collaborations.

Following the H2020 funding, the platform concept is on its way to evolve into a sustainable business concept for the benefit of personalised medicine. The renewed, more user-friendly platform is about to go online in early summer 2019.

Overall, the increasing number of elderly people is expected to impact the incidence rate of cancer, metabolic syndrome, diabetes and cardiovascular diseases. This concomitantly increases the demand for data gathering and exchange, machine learning as well as new software-based methods and advanced IT tools.

The IT tools developed by PERMIDES for collaborations for specified treatments might easily be adapted to other clinical applications. This will help generate e-health tools for supporting patient-clinician communication and enable personalised medicine for all common diseases.

PERMIDES

- Coordinated by CyberForum e.V. in Germany.
- Funded under H2020-SME.
- cordis.europa.eu/project/id/691546
- Project website: permides.eu/

HEALTH

Simple sleep diagnostics model foresees a good night's rest

One EU project aims to improve the diagnostic power of sleep studies while reducing costs and increasing accessibility. By collaborating with leading scientists and applying AI to analyse data, they are bringing personalised treatment to sleep medicine.

Medical devices to analyse sleep are typically sold as very expensive and specialised equipment. As a result, the use of sleep diagnostics in the medical field is limited to those who use the devices on a frequent basis and have enough funding to buy expensive capital equipment. The Sleep for All (Diagnostics of sleep disorders for all patient groups) project run by Nox Medical has taken a two-pronged approach to alleviating this problem: they have developed a quicker, simpler setup where patients place electrodes on themselves, and a more flexible business model.

A conventional electroencephalogram (EEG) involves electrodes being placed on the scalp. "This requires hours of work for a professional sleep technician and is typically done at a health care institute or a hospital," explains Dr Halla Helgadóttir, Nox Research's Clinical Research Manager.

"Our new setup is designed to be attached by the patient themselves, using a new placement of electrodes." A follow-up usability study revealed patients seem to have no problem with the system. "It didn't show a higher failure rate than when a patient is hooked up in the conventional

© Nox Medical

way by a professional," she adds. In order to use an EEG in this new way, the team developed a method of automatically analysing the signals.

Along with making the equipment more user-friendly, thereby saving the health care provider's time, the project also focussed on developing a business model that would permit smaller providers to access such useful technology. They are offering the tools needed for sleep diagnostics as a service.

In software marketing today, people pay for the use of software per use, be it by month, year or frequency. In Sleep for All's model, general practitioners, dentists and paediatricians, among others, can use the devices when needed and pay per use. "We want to open access to sleep diagnostics to more health professions."

This is an idea they have been exploring for a while, but EU funding has helped them step up a level. "The project contributed to a new way of analysing the flow signal. This gives the doctor more information about the patient, including a way of finding the cause of breathing problems during the night. All of which leads to more personalised treatment for the patient."

It's not just doctors and patients who can benefit. The ability to rent the equipment, and the ease with which it can be used, means researchers can choose to use more devices than they could otherwise access were they to buy them. Unsurprisingly, researchers across the EU have been very interested in this aspect of Sleep for All's system. The new EEG, self-applied setup and this disruptive business model break the bottleneck in data collection and harness the potential of machine learning in medicine.

This takes us to the other innovation the Icelandic company is delving into – the use of artificial intelligence (AI) in sleep research. Nox Research already uses AI to score sleep stages in software and is working on more algorithms. One of them is the automatic arousal detector, the subject of a paper. Nox has also presented its work at AI conferences in Europe, notably the Icelandic AI conference, the conference of the European sleep society and the Nordic AI conference.

SLEEP FOR ALL

- Coordinated by Nox Medical EHF in Iceland.
- Funded under H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/id/733461
- Project website: noxmedical.com

> *The new EEG, self-applied setup and this disruptive business model break the bottleneck in data collection and harness the potential of machine learning in medicine.*

SOCIETY

Why possessing a 'gay voice' can lead to discrimination

It's just one of many stereotypes often associated with LGBT people – that the sound of their voice immediately gives away the secret of their sexuality. But is this true? Is there such a thing as a 'gay voice'? And if so, what does this mean for society and LGBT people's place in it? One EU-funded project decided to dive in deeper to find out.

Whilst many parts of the developed world have now embraced the cause of LGBT rights and equality, stereotypes about LGBT people still abound. One of the most enduring of these stereotypes is the concept of the 'gay voice' – that how an individual sounds when speaking allows others to pinpoint their sexual orientation, known as 'auditory gaydar'.

"Even in progressive societies, stereotypes about the 'gay voice' can trigger subtle forms of discrimination as judgements are made quickly, often subconsciously," explains Marie Curie Research Fellow Dr Fabio Fasoli, principal investigator on TheGayVoice (Beyond "Straight Talking": The Consequences of Vocal Cues to Sexual Identity for Modern Prejudice) project. "Among heterosexual participants, belief in gaydar was associated with more negative attitudes towards gay men and lesbians. Additionally, 41 % of the gay men and 6 % of the lesbians we interviewed reported being noticed as LGBT because of their voices. This was consistent with our finding that heterosexuals believe that auditory gaydar is a better cue for men's sexuality than for women's."

AUDITORY GAYDAR IN ACTION

For gay men, the researchers found that when they reported being targeted by others' auditory gaydar, they most often described negative experiences of being mocked, bullied or explicitly discriminated against. Some of the gay male participants also described being self-conscious, they tended to avoid public speaking, tried to change their voices in some situations or avoided certain people.

The project team also looked at how auditory gaydar can lead to discrimination in the workplace and it was here that they discovered lesbian women may be the victims of auditory gaydar more than had been assumed.

"We actually found that the strongest and most consistent anti-LGBT discrimination arose when female job candidates sounded lesbian, not for men who sounded gay, even though there are stronger stereotypes regarding gay men and how they speak," reports Dr Fasoli. "In the workplace context, we saw that when sexual orientation was inferred from auditory gaydar rather than anything more explicit, gay- and lesbian-sounding candidates were viewed as less suitable and less employable for leadership positions."

A final study suggested that, as discrimination against a woman who sounds lesbian could be attributed either to her gender or her sexuality, such discrimination prompted by auditory gaydar may be systematically overlooked both by those who enact it and by those whom it targets.

PROMOTING WIDER UNDERSTANDING

The team strongly believes that their project contributes to the wider understanding of how LGBT people still face prejudice, even in progressive societies. "If you sound lesbian or gay and you match specific voice-related stereotypes, then the bottom line is that you're likely to face different treatment," says Prof. Peter Hegarty, who helped to oversee the project. "But being aware of the stereotypes and subconscious judgement that can result from auditory gaydar is important for diversity training, LGBT support groups and legal matters."

The team will continue their research on the topic and hope to collaborate further with the local LGBT community (who were instrumental in the success of the project), companies and policymakers. "Voice is a fundamental part of everyday communication and there's still much to explore on this topic," concludes Prof. Hegarty.

THEGAYVOICE

- Coordinated by the University of Surrey in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/700844
- Project website: facebook.com/thegayvoice

SOCIETY

Team finds Syriac dialect connected Greek and Arabic thought

An EU project examined the evolution of thinking about Syriac grammar, specifically in relation to Arabic and Greek linguistic concepts.

Syriac is a literary dialect of Aramaic, a Semitic language once widely spoken throughout the Near East and Arabia. Along with Latin and Greek, Syriac is one of the languages associated with early Christian texts.

Several Syriac writers have contributed to grammatical theory, yet their work is understudied. Modern scholars almost abandoned the topic after a brief flurry of interest during the late 19th and early 20th centuries. To date,

about 80 % of Syriac grammatical texts have not been published as critical editions.

The EU-funded CSASG (Comparative Study on Ancient Syriac Grammars) project rekindled the study of Syriac grammarians. The research detailed the interaction among Greek Syriac and Arabic linguistic theories and the Syriac authors' descriptions of their language in those terms.

SYRIAC RENAISSANCE

Researchers translated and analysed the works of three 12th to 13th century Syriac grammarians. This period was the so-called Syriac Renaissance, which witnessed a flourishing of both the language and grammatical ideas.

The first of the three was Bar Zo'bi. He wrote a Syriac grammar, a tool for classifying and interpreting language, also intended as a foundation for more advanced studies in logic. Bar Zo'bi drew heavily from the Greek linguistic tradition, specifically Aristotle, and strongly disagreed with the application of Arabic linguistic concepts to Syriac. Bar Zo'bi's student, Bar Shakko, reworked his master's ideas into a more accessible form, and addressed several aspects of syntax. Finally, Barhebaeus aimed to teach correct Syriac writing. He thought that the works of logic help develop a better understanding of grammar rather than vice versa. Barhebaeus examined syntax in detail, combining the Syriac native tradition with aspects of Arabic thought.

The emphasis on correctness reflected a time of divergence and degeneration of spoken Aramaic dialects. Grammatical mistakes had become increasingly common, and the grammarians were interested in restoring an earlier standard.

"The most important general trend for us," says CSASG researcher Dr Margherita Farina, "is the emergence of syntax as an independent component of linguistic thinking." Earlier theories of Semitic grammar regard syntax as resulting from proper reading and pronunciation of a text. Since such languages are written without vowels, reading requires the reader to place them, thereby demonstrating understanding of words' syntactical function and the ability to distinguish among words written the same but pronounced differently. "According to our historical Syriac writers," adds Dr Farina, "syntax reflects the need to correctly attribute meaning and functional roles to the parts of a sentence."

CONVERGING THEORIES

More generally, the project team found the Syriac tradition to be central to the linguistic dynamics of the medieval Middle East. The Syriac tradition served as a conduit between Greek and Arabic thought. The Syriac thinkers also inherited the Aramaic and Mesopotamian linguistic heritages. "By integrating two very different approaches to language description," explains Dr Farina, "Syriac grammar is at the core of the encounter between Mesopotamian and Greek approaches to language description."

CSASG created an open-source catalogue of Syriac grammatical manuscripts. The resource will be integrated into e-ktobe, a global database of Syriac texts.

Researchers continue working on a monograph detailing the project's results, to be published at the end of 2019. Dr Farina also plans to progressively publish the remaining unpublished Syriac texts. She will further investigate the role of the Syriac grammatical tradition within the context of medieval oriental linguistic theories.

The study sheds new light on the evolution and interaction among schools of grammatical theory, and the importance of Syriac grammarians to the subject.

CSASG

- Coordinated by the National Centre for Scientific Research in France.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/701797
- Project website: csasg.wordpress.com

Towards a safer and more robust European railway sector

The EU-funded project PLASA has made great strides in improving the customer experience and increasing the system robustness and safety levels of the European rail sector.

As part of the Shift2Rail programme, "the PLASA project aimed to enhance the European rail sector by improving planning activities of various stakeholders through precise railway simulation and by providing a methodology based on risk assessment to manage its safety," explains Ying Löschel from Deutsche Bahn AG and project coordinator.

SMART PLANNING IS KEY

In Europe, different planning tools are used to simulate railway operations. This leads to non-harmonised results with a data landscape lacking proper data interfaces between countries. There is also no implemented tool that can simulate with a high degree of detail or be used for large networks. PLASA (Smart Planning and Safety for a safer and more robust European railway sector) set out to address this by gathering knowledge on smart planning approaches, activities, and existing analyses on disruptions and interdependencies in the European railway networks.

Through their work, PLASA developed a macroscopic approach to reduce execution time by restricting the level of detail to high-level relations between significant events. Löschel points out: "This approach enables us to simulate a complete day of operation on the entire German network, with around 40 000 trains, under a minute of computation time." The tested approach seems to allow for accurate results on delays. There is room for improvements in accuracy, but the new approach appears promising and will be assessed further in another Shift2Rail project, PLASA 2.

INVESTIGATING SAFETY

Defining a possible improved management process on the safety of the railway system using a risk assessment was a PLASA priority. This would "support managers who make critical safety decisions in day-to-day operations and in the design phase," stresses Löschel. Project work also looked at the functionalities of the system and human behaviour to better represent real-life scenarios.

PLASA developed a decision model that was applied to three use cases. The results were promising and demonstrated the relevance and added value of the approach. They also showed how it can be applied to a wide range of railway applications.

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The PLASA project aimed to enhance the European rail sector by improving planning activities of various stakeholders through precise railway simulation and by providing a methodology based on risk assessment to manage its safety.

OVERCOMING HURDLES

Löschel highlights: "There were difficulties in gathering safety input data and statistics, as railway operators consider this information to be confidential." She further notes that "the common safety indicators collected by the European Union Agency for Railways are interesting and useful, but they are not detailed enough."

To overcome this issue, some hypotheses have been assumed to compensate for the lack of data. They do not, however, call into question the principle of the approach. Therefore, they should be re-examined and challenged at a later stage to ensure the results produced for the use cases are reliable.

MOVING FORWARD

The work carried out in PLASA will be continued in PLASA 2. The project will extend the simulation tool developed in the PLASA project to handle a wider range of scenarios. The next stage aims to combine the advantages of assessing possibilities for merging the PLASA macroscopic modelling approach with a classical microscopic railway simulation. It will also outline the requirements for a smart planning tool that could be utilised to aid decision-making in intraday planning.

The French national railways will also continue the safety work of PLASA. A decision-support tool implementing the model developed within the project will be designed for one of the use cases, and the quantification of human reliability will be further investigated.

PLASA

- Coordinated by Deutsche Bahn AG in Germany.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/id/730814
- Project website: shift2rail.org

TRANSPORT AND MOBILITY

Study sheds light on impact of inflight VR and AR

To generate ancillary revenue and boost passenger satisfaction, airlines are looking to offer augmented reality (AR) and virtual reality (VR) experiences to customers. An EU initiative explored the challenges posed by immersive technologies high in the sky.

Immersive technologies provide entertainment and relaxation, offer new ways to promote and sell products during flights, and can reduce the stress passengers have during tight transfer times.

REMOVING VR AND AR COMFORT, COMMUNICATION AND SAFETY OBSTACLES

There are several hurdles to overcome before successfully introducing immersive technologies. Communication with cabin crew can be impacted potentially affecting service efficiency and potentially passenger safety. Even on the ground, AR and VR can lead to discomfort. This effect may worsen during flight. To address these issues, the EU-funded IMCA (Immersive Cabin) project "developed and evaluated an immersive experience by taking into account human factors such as health and well-being, safety, aircraft integration, and commercial and legal aspects," says project coordinator Antoine de Reus.

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"The opportunities presented by VR and AR, like the intuitive and fast means of informing passengers about their flights and destinations, and the novel and improved ways to entertain passengers while flying, are all new," he adds. Airlines are embarking on the very first experiments with immersive technologies.

The project began by evaluating the potential of using several technologies for VR and AR applications during flight. The team selected three such devices currently available on the market.

To achieve its aims, IMCA developed a methodology to identify and evaluate potential human factor issues involving immersive experiences and cabin safety concerns. It offers practical support by providing a checklist for identifying potential issues and an overview of tools and methodologies to assess passenger state. The latter helps to choose the right measurement tools for answering evaluation questions.

Lastly, project partners tested the methodology by examining the effects of passengers using VR headsets for safety, and on-board service, experience and comfort. The experiment took place in a motion-based cabin simulator with 40 volunteers and crew. They were exposed to various flight scenarios, ranging from a calm flight to a flight with rapid decompression. This type of empirical test in itself is unique and a world first. The data collected really helped to get insight into the effects of on-board use of VR.

"IMCA has shed light on the true benefits of using VR and AR aboard flights, and the problems that need to be tackled in the future concerning passenger health and well-being, flight safety and security, legal issues and cultural etiquette, as well as aircraft system architecture and integration."

WILL SERVICE ON AIRCRAFT USING VR AND AR LIVE UP TO ITS PROMISE?

Findings show that while VR has added value for passengers, it also affects communication with the crew and possibly impacts on-board safety. De Reus stresses: "When developing VR apps, it's important to take these matters into account, bearing in mind that while a VR headset can be informative and relaxing, it shouldn't be at the expense of crew interaction and safety."

"We're still years away before VR and AR are adopted as mainstream, so responsibly introducing them in an aircraft cabin is in itself beyond state of the art," concludes de Reus. "IMCA has shed light on the true benefits of using VR and AR aboard flights, and the problems that need to be tackled in the future concerning passenger health and well-being, flight safety and security, legal issues and cultural etiquette, as well as aircraft system architecture and integration."

IMCA

- Coordinated by the Netherlands Aerospace Centre in the Netherlands.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/id/717185

Autonomous inspection trolley for better train track maintenance

Combining novel technologies from robotics, electric cars, precise positioning and advanced measurement, has resulted in an autonomous device capable of spotting faults along train tracks, accurately, quickly and cost-effectively.

For 2015, the EU Agency for Railways (ERA) reported 4169 broken rails around Europe amongst 215720 km of track. Broken rails are the chief cause of derailments resulting in major disruption to services and sometimes even loss of life.

The repair cost to Member States is estimated at around EUR 2 billion annually, not including service delays and cancellation costs. With a rise in train traffic, train speeds and load carried, the need to improve rail infrastructure is becoming pronounced.

The EU-supported AutoScan (Rail inspection by autonomous systems) system comprises an autonomous rail trolley, pre-programmed to travel over tracks using mounted sensors to scan for defects. When a flaw is found, the trolley returns to the location for a robotic arm to perform a detailed rail head inspection, enabling network operators to make an accurate assessment and schedule repair work.

© AutoScan consortium

THE ROLLING CONTACT FATIGUE (RCF) SCANNER

Currently, to maintain rail track integrity, operators run dedicated inspection trains to take rough track measurements. Handheld inspection devices can then be deployed and operated manually to more accurately locate and measure flaws.

The AutoScan system comprises an autonomous inspection trolley with a payload area that can carry and integrate various inspection systems. Currently, the trolley uses electromagnetic acoustic transducers (EMATs) to detect instances of rolling contact fatigue. Once flaws are detected, this 'first-pass' information is augmented by a robotic electromagnetic inspection from different angles, logging size, shape and position, offering a detailed topographical view of the defect.

To use the system, operators programme details of the track section to be inspected into the RCF Scanner. The self-powered trolley is then brought to the track at a suitable starting point (e.g. a level crossing) and set in motion.

Findings are uploaded during inspection to the cloud-based track maintenance management system, providing information for operators which will determine follow-up actions, such as repairs and/or the setting of speed restrictions.

"Unlike manual inspection, much larger track sections can be inspected, simultaneously. Compared to inspection trains, there is also the cost effectiveness and ease of deployment. Ultimately, the interval between inspections and repair is reduced drastically, benefiting both rail companies and passengers," says project coordinator Dr Frederik Vermeulen.

The project consortium has validated the technology's capability both in the lab and on the track. Interested parties can request a pilot be set up locally to validate that the technology works for their setting.

TOWARDS GREENER TRANSPORT

By enabling more frequent track inspections – and so increasing fault detection and intervention – AutoScan significantly reduces train infrastructure lifecycle costs. The project team have calculated that overall inspection costs will be reduced by at least 15 %. Additionally, as inspectors no longer need to walk track side, safety for personnel is increased.

With rail offering the potential to be Europe's most energy-efficient transport mode, these benefits contribute to the EU's drive towards greener transport options, which can only be achieved if rail travel is reliable, cost-effective and safe.

The AutoScan product is designed and delivered as a modular concept. "To date, the separate modules have been available to the market in a variety of guises, but the full integrated system showcases the combined capability of the technology. We think it could take two to four years for it to catch on with the market," says Dr Vermeulen.

"Unlike manual inspection, much larger track sections can be inspected, simultaneously. Compared to inspection trains, there is also the cost effectiveness and ease of deployment. Ultimately, the interval between inspections and repair is reduced drastically, benefiting both rail companies and passengers."

Towards this end, the team have already developed tailor-made solutions based on the AutoScan technology, with research partners having already obtained funding for further improvements.

AUTOSCAN

- Coordinated by I-moss NV in Belgium.
- Funded under H2020-Industrial Leadership and H2020-Societal Challenges.
- cordis.europa.eu/project/id/720506
- Project website: autoscanproject.eu

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LIFE AFTER...

Catching up with Greenrail: Smart sleeper technology promises a railway revolution

Our special feature last May (2018) was on innovative EU-funded projects working to upgrade Europe's railway network for the 21st century. As part of that special feature, we spoke to Giovanni De Lisi from Greenrail SRL, an Italian SME that has patented its tailor-made sustainable sleeper technology in 80 countries. We catch up with him to find out more about how their ambitious targets for further expansion have gone over the last year.

Railway sleepers have traditionally been made of wood or, as is more common in the modern age, concrete. However, they haven't changed much since the 19th century and they're a major source of noise and vibrations felt by the train traveller. They also require expensive maintenance, so finding a new solution is a crucial element of modernising European railways. Greenrail (sustainability, safety and saving in the railroad sleeper of tomorrow) found the solution – an inner core made of pre-stressed concrete and an outer layer made of a mixture of recycled plastic and rubber, with the additional integration of various sensors and the ability to produce electricity or collect solar energy.

NEGOTIATIONS CONTINUE

In our previous interview, we were told that Greenrail were in extensive talks with entities around the world about their adoption of the new railway sleepers. De Lisi remains optimistic and, if we can say, rather coy about the progress of those discussions. "In the past few months we've focused our attention on finishing the R&D, the testing and certification phase for our sleepers and the conclusion of the SME Instrument Phase 2 project," he tells us. "But at the same time, we're still in talks with numerous entities, including European ones."

However, railway infrastructure is a very specific industry in which negotiations can take a considerable amount of time. "This is why we're engaging with a few potential clients simultaneously and we are sure that most of them will be concluded successfully in the near future," he adds.

In part, the advanced negotiations with these potentially interested clients in adopting the Greenrail solution is one of the reasons Greenrail have not gone for Phase 3 funding. "We've also focused all of our attention on the industrialisation of the technology – but we certainly don't exclude the possibility of going for Phase 3 in future," De Lisi says.

A SUCCESSFUL INSTALLATION IN EMILIA ROMAGNA

Amongst the many successes and highlights of the past year for Greenrail was Greenrail's presentation of the first smart railway tracks in Italy, in the Emilia Romagna region. "Here we showcased not only the Greenrail basic sleeper but also our smart sleepers – Solar, LinkBox and Piezo," explains De Lisi. "They've been installed on Ferrovie Emilia Romagna's (FER) track and have undergone various field tests that I'm happy to say proved their ability to significantly reduce noise and vibration levels, as well as show their capacity to harvest solar energy." The sleepers' predictive maintenance and real-time diagnosis data was also a big success.

Even as it seems that they're seemingly on the verge of a major market breakthrough, De Lisi admits that EU funding was certainly a milestone in the company's development. "Thanks to the SME Instrument, we completed the final designing, production and testing phases of our sleepers and increased our international recognition, and now we feel we're truly ready to enter the market."

> *"Thanks to the SME Instrument, we completed the final designing, production and testing phases of our sleepers and increased our international recognition, and now we feel we're truly ready to enter the market."*
>
> **Giovanni De Lisi**
> Project coordinator of Greenrail

GREENRAIL

- Coordinated by Greenrail SRL in Italy.
- Funded under H2020-SME and H2020-TRANSPORT.
- cordis.europa.eu/project/id/662376
- Project website: greenrailgroup.com

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CLIMATE CHANGE AND ENVIRONMENT

New observation network could be the key to understanding climate change mechanisms

Better monitoring of the Earth's middle atmosphere, particularly the stratosphere, can improve medium-range weather forecasting and understanding of events that affect weather patterns and climate change.

The ambitious EU-funded ARISE2 (Atmospheric dynamics Research InfraStructure in Europe) project integrates and extends existing infrasound and airglow monitoring stations, along with lidars, radars and satellites to improve the modelling of activity in the middle atmosphere.

Lying above meteorological balloons and below satellites, the middle-atmosphere – including the troposphere from the ground to a height of 6-10 kilometres, up to the ionosphere 75-1 000 kilometres above the Earth – has been difficult to measure.

"In the past, the stratosphere was not very well understood. People were told it was a cold and quiet area where nothing happened," says project coordinator Dr Elisabeth Blanc, research director at the French Alternative Energies and Atomic Energy Commission (CEA) in Paris. Thanks to improved observations of middle-atmosphere events under ARISE, "we understand now that this is very significant."

"The main objective was to measure the dynamics of the atmosphere – everything that was moving – over very broad scales in time from sub-seconds to decades, and space from local to global," she explains.

This includes planetary and gravity waves, solar tides, thunderstorm-related disturbances from standard lightning to convection waves, mountain waves, stratospheric warming events and other phenomena such as volcanic eruptions and meteorites. "There was no project doing that till now," she notes.

MULTI-ARRAY INFRASOUND, LIDAR AND AIRGLOW NETWORK

The project uses the international infrasound monitoring system developed for the verification of the Comprehensive Nuclear Test-Ban Treaty (CTBT) – a global network with some 50 stations operational today. "When completed it will have 60 stations, and it's fantastic for observation – we see everything that's happening in the atmosphere," Dr Blanc says.

The CTBT system's mini-arrays make it possible to measure the directions of arrival of atmospheric disturbances and even the elevation angle, which was not previously possible.

ARISE2 also integrates: national European infrasound stations; the lidar (Light Detecting and Ranging) stations of the Network for the Detection of Atmospheric Composition Change which measure stratospheric dynamics; the Arctic Lidar Observatory for Middle Atmosphere Research; and multi-instrument stations in Trondheim, Norway and Kiruna, Sweden not previously involved in the first ARISE project (2012-2014).

Additional instruments such as infrasound mini-arrays, radars, wind radiometers and ionospheric sounders were installed at lidar sites at the Observatory of Haute-Provence, France, for the middle latitudes, and at Maïdo, Reunion Island in the tropics, in order to extend coverage.

"High-resolution measurements from this infrastructure revealed significant differences between observations and models, especially during stratospheric disturbances and wave activity," Dr Blanc notes, adding that the enhanced data will lead to a new generation of whole-atmosphere weather forecast models and climate models.

> *"In the past, the stratosphere was not very well understood. People were told it was a cold and quiet area where nothing happened."*

EXTENDING OBSERVATION TIMES

Currently 24 datasets based on 13 different atmospheric observation technologies are available via the ARISE portal. But the project has also extended observation times.

For example, two Scandinavian lidars associated with a meteor radar provided high-resolution measurements day and night of wind and temperature in the 20-100 kilometre altitude range over an unbroken period.

A new database of Sudden Stratospheric Warming Events was also set up. Such impressive events occur when the polar vortex suddenly weakens or goes into reverse and were found to have substantial impact on Northern Hemisphere winter temperatures.

During one such event in 2016, temperature differences of up to 40 degrees Kelvin were observed in the stratosphere compared to models. "This is huge! We did not know that before," Dr Blanc says.

ARISE2

- Coordinated by the Alternative Energies and Atomic Energy Commission in France.
- Funded under H2020-INFRA.
- cordis.europa.eu/project/id/653980
- Project website: arise-project.eu
- bit.ly/2H27Cjr

Boosted computing increases European weather forecasting accuracy

The biggest challenge for state-of-the-art numerical weather prediction arises from the need to simulate complex physical phenomena within tight production schedules. Software and hardware shortcomings are holding back weather and climate modelling.

Current extreme-scale application software of weather and climate services isn't very efficient on existing central processing unit (CPU)-type processors. It has about 5 % peak performance, mostly due to a lack of arithmetic intensity. The software also isn't able to adapt to rapidly evolving options for new processor hardware mainly because of a lack of flexibility in mapping specific computational problems onto heterogeneous computing units. This problem is further exacerbated by other drivers for hardware development that aren't necessarily ideal for weather and climate simulations.

BOOSTING PERFORMANCE AND ENERGY-EFFICIENCY OF WEATHER AND CLIMATE MODELLING

The EU-funded ESCAPE (Energy-efficient SCalable Algorithms for weather Prediction at Exascale) project aimed to "restore this imbalance through actions that fundamentally reform Earth system modelling," says coordinator Dr Peter Bauer. The project developed a holistic understanding of energy efficiency for extreme-scale applications using heterogeneous architectures accelerators and special compute units.

The project team developed and tested the concept of fundamental algorithmic building blocks called dwarfs. Dwarfs represent functional units in the forecasting model. They developed new algorithms specifically designed for better energy efficiency and improved portability. "Assessing numerical methods and algorithms for dwarfs rather than entire models reduces the complexity of the code," explains Dr Bauer. "It enables high-performance computing (HPC) centres, research groups and hardware vendors to focus on specific aspects of performance for which code restructuring and adaptation to novel processor architectures is more straightforward."

Project partners then adapted and optimised the resulting dwarfs in terms of computing performance for different hardware architectures. For spectral transforms on CPUs, they achieved efficiency gains of up to 40 %. Code optimisation for graphics processing units (GPUs) delivered speed-up factors of about 10-50 on a single node, and again by a factor of 2-3 when deployed on multiple GPUs.

> *By modifying numerical algorithms and using new programming models, substantial improvements to both weather and climate predictions will be possible and affordable, leading to reliable and timely forecasted warnings.*

The ESCAPE team also focused on domain-specific languages (DSLs). When adapted to GPUs with a DSL, a dwarf calculating the advection of air showed a speed improvement of a factor of 2 compared to the manually adapted version. They investigated a range of numerical methods exploiting multi-grid solvers and different types of spatial discretisation and time stepping.

IMPROVEMENTS IN PREDICTIVE SKILLS FOR WEATHER AND CLIMATE

ESCAPE will impact European excellence for employing exascale HPC in helping to facilitate one of the largest societal impact areas: high-resolution weather forecasting. More precise forecasts in both time and space are critical for travel, health, work and safety. "The weather's impact on society via forecasting and preparation has been reduced thanks to ESCAPE's predictive skill advances," Dr Bauer says.

"By modifying numerical algorithms and using new programming models, substantial improvements to both weather and climate predictions will be possible and affordable, leading to reliable and timely forecasted warnings," concludes Dr Bauer. "ESCAPE represents a huge step forward in weather and climate modelling." The project directly benefits all European Centre for Medium-Range Weather Forecasts (ECMWF) members and cooperating countries. It will support both the Copernicus Atmosphere Monitoring Service and the Copernicus Climate Change Service that rely on ECMWF's Integrated Forecasting System.

ESCAPE

- Coordinated by the European Centre for Medium-Range Weather Forecasts in the United Kingdom.
- Funded under H2020-FET.
- cordis.europa.eu/project/id/671627
- Project website: hpc-escape.eu

CLIMATE CHANGE AND ENVIRONMENT

Tropical lichens reveal extent of biodiversity

A new study of lichens found on an African mountainside reveal a treasure trove of genetic diversity.

A lichen is not a single organism, but instead comprises a stable symbiotic association between a fungus and algae and/or cyanobacteria. While some temperate lichens have been intensively studied, almost nothing is currently known about most tropical taxa, and knowledge of African lichens is particularly sparse.

As part of the Marie Skłodowska-Curie Individual Fellowships grant, the EU-funded Horizon 2020 Tropical lichens (Symbionts and changing environment: Lichen diversity and photobiont associations in tropical mountain ecosystems) project produced the first modern account of symbiont diversity in lichens of tropical mountains. "We studied both fungal and cyanobacterial symbionts with DNA methods and focused the sampling on cyanobacterial lichens which live in the moist montane forests of Taita Hills, Kenya," says project coordinator Prof. Jouko Rikkinen.

These forests represent a global biodiversity hot spot, but little information existed on their lichen biota. Researchers therefore surveyed remnant forest patches along a steep natural climatic gradient on the slope of a high tropical volcano to determine the effects of environmental change on lichen symbiotic organisms.

UNPRECEDENTED DIVERSITY

Scientists found high fungal diversity in all the cyanolichen groups analysed. In some genera, over half of the identified species appear to be previously unknown and now await formal description. "The results highlight that the species concepts and nomenclature of many lichen lineages in tropical Africa need to be revised," Prof. Rikkinen explains.

Some of the new species may be local endemics that have a very limited range and only exist in special microhabitats. Such organisms are under serious risk of extinction due to continuing human disturbance. Prof. Rikkinen comments: "The genetic diversity of cyanobacterial symbionts was unprecedented and hardly any genotypes had been previously reported from lichens sampled from other parts of the world."

Researchers focused on cyanolichens because "in addition to their contribution to primary production through photosynthesis, they can have an even more significant impact on the nitrogen cycle due to their nitrogen-fixing cyanobacterial symbionts," states Prof. Rikkinen. Epiphytic lichens and bryophytes growing on tree trunks and branches also play an important role in water capture in cloud forests, acting as 'water towers' for surrounding dry lowlands.

DRAMATIC SCIENTIFIC ADVANCES

The project demonstrated how the application of modern DNA techniques has revolutionised lichen systematics and ecology. "The type of information gained through the Tropical lichens project was totally out of reach only some years ago and is rapidly leading to profound changes in our understanding of the extent and ecological significance of genetic diversity in lichen-symbiotic organisms," states Prof. Rikkinen.

Tropical lichens advanced scientific understanding of the diversity of biological associations that are generally labelled under the term lichen symbiosis. It also produced the fungal universal barcode marker (the internal transcribed spacer) and several cyanobacterial marker sequences from hundreds of lichen specimens, which together with the voucher specimens provide a stable and accessible basis for future research.

The work conducted by the project thus represents an important step forward in the study of lichen symbiont diversity in the tropics, and especially in Africa. Prof. Rikkinen concludes: "The data collected has direct implications on environmental conservation and strongly underlines the crucial importance of preserving the remaining moist montane forests as a refuge for unique and in many cases still largely unknown biological diversity."

TROPICAL LICHENS

- Coordinated by the University of Helsinki in Finland.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/705777

> *"The data collected has direct implications on environmental conservation and strongly underlines the crucial importance of preserving the remaining moist montane forests as a refuge for unique and in many cases still largely unknown biological diversity."*

SPECIAL FEATURE

DEFINING EUROPE'S ROLE IN A COMPLEX INTERNATIONAL ORDER

Editorial

"Who do I call if I want to call Europe?" – Henry Kissinger

The last decade has certainly not lacked for foreign policy challenges for the EU. On a global scale, these have included a more assertive Russia, a rising China that is becoming evermore confident in pursuing its interests, a United States that has begun a series of trade conflicts that many argue threaten the world's economic prosperity. Closer to its doorstep, the EU has also had to grapple with the Arab Spring that resulted in bloody civil wars in Syria and Libya that are still ongoing, as well as a major migration crisis. Meanwhile, an armed conflict continues to simmer in eastern Ukraine and finally, the Balkans and 'Eastern Partnership' regions still present important challenges as many countries here aim for closer integration with – and even one day accession to – the EU.

Whilst one of the world's three unrivalled economic and trade powers (alongside the US and China), the EU arguably does not punch its weight in the complex game of international diplomacy. This is mainly because foreign policy remains a core competence of the EU Member States but alas, the EU is not completely toothless in this domain. Since 1999, Member States have committed themselves to a Common Foreign and Security Policy (CFSP), with the aim of strengthening the EU's external ability to act through the development of civilian and military capabilities in conflict prevention and crisis management.

Then the Lisbon Treaty created the role of High Representative of the Union for Foreign Affairs and Security Policy, as well as the European External Action Service (EEAS) that acts as the EU's foreign and diplomatic service. In 2016, the EEAS launched its Global Strategy which sets out the EU's core interests and principles for engaging in the wider world, as well as giving the EU a collective sense of direction.

But are these capabilities and strategies enough or does the EU need to be granted further foreign policy powers? Here, you inevitably begin the argument over further European integration. Integrationists would argue that European nation-states, even the largest ones, are no longer quite large enough and that only a more powerful EU will guarantee Europe's place at the top table. On the other side of the debate, others passionately argue that effective foreign policy must remain the prerequisite of independent sovereign states.

In light of these two viewpoints, EU-funded researchers under the Horizon 2020 programme have much to say on this topic and this month, our special feature highlights eight projects that have been analysing the EU's external priorities and making recommendations on how the EU's future global role could and should evolve. As experts but not diplomats or politicians themselves, we've found that these projects have many 'out-of-the-box' viewpoints on how the EU could become a stronger international actor.

The EU-CIVCAP and EUNPACK projects explore the EU's conflict prevention and crisis response capabilities whilst our other featured projects showcase the EU's ongoing relationships and policy challenges with specific countries/regions: Russia, Turkey, the Middle East, the Caribbean and Latin America, and finally the Eastern Partnership countries.

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

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SPECIAL FEATURE

DEFINING EUROPE'S ROLE IN A COMPLEX INTERNATIONAL ORDER

Behind the scenes of Russia's foreign policy-making

There is much we don't know about how foreign policy is being shaped in Russia. Is Vladimir Putin as almighty as some believe him to be? Do international relations academics have an influence on government decisions? The RuKNOW project tried to find out.

Relations between the EU and Russia are at one of their lowest points in history. While patching things up will be a gargantuan task, it undoubtedly starts with clarifying the main principles and drivers guiding Russian policies towards the EU. In an effort to understand academia's role in this regard, Dr Katarzyna Kaczmarska from Aberystwyth University spent the past two years investigating the relationship between scholars and policy-makers in Russia.

Besides building bridges with Russian academics active in international affairs, her RuKNOW (Knowledge on International Relations in Russia) project, undertaken with the support of the Marie Curie programme, sheds new light on foreign policy-making in Russia and could help the EU in its efforts to strengthen pluralism in the Russian political debate.

What did we know about relations between Russian academia and government prior to your project? Does the latter exert much control over the former's research?

Dr Katarzyna Kaczmarska: Our understanding of relations between academia and government in the sphere of foreign policy-making in Russia was quite limited. Mezhdunarodniki – a group of high-profile foreign policy experts that includes but is not limited to academics – have often been presented as following the official line or as the 'guardians' of the regime. Yet, we knew little about their motivation for regime support. Pundits said it was because of either genuine persuasion or opportunism.

Meanwhile, academic and policy discourses have been described as mutually constitutive or co-evolving. The view that International Relations (IR) scholarship in Russia resembled 'policy-based evidence-making' rather than 'evidence-based policy-making' dominated.

Why was it important to verify these claims?

Russia's foreign policy-making remains difficult to disentangle. It is rarely subject to public debate, especially since the outbreak

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of the Russia-Ukraine conflict in 2014. Meanwhile, the academic discipline of IR in Russia has been flourishing for the last two decades. This raises the question of what academics' role as foreign policy advisers is or might be.

By exploring the relationship between scholars and the policy world, we can better understand how foreign policy is made in Russia. It allows for nuancing both the oversimplified picture of Vladimir Putin taking all the decisions and the presumption that all Russian experts in the area of international politics follow the official line.

How did you proceed?

The most important aspect for me was to engage with Russian scholars and understand their perspective on the relationship between academia and policy-making. By focusing on the problems and issues they raised, I intended to mitigate the potential foreigner's bias and minimise the practice of 'othering' Russia.

Over two years, I interviewed scholars while providing expertise for think-tanks. Since critical discussion has largely moved to the virtual space, I also studied opinions shared publicly by individual scholars on social media platforms, and I monitored online debates held by various academic associations and groups.

In order to better understand the context in which scholars work, I also examined the academic research governance system and monitored Nauka, a journal covering academia-related themes. This was complemented by an analysis of academic texts published in the IR field in Russia.

What would you say were your most important and/or surprising findings?

I have identified two concurrent trends in the relationship between the academic community and the policy-making world. On the one hand, authorities expect Russian universities to move up in international rankings and partake in the global education and publishing market. On the other hand, the academic community feels like professional expertise in IR is not valued by policy-makers.

I have found a full spectrum of views on scholarly engagement with the policy world. Some scholars see foreign policy-making as limited to state officials and openly excluding societal actors such as think-tanks, experts and academics. Some scholars point at how academics are often required to justify already existing policies or step in to fill policy slogans with content, and how they are not invited to participate in the process of policy formulation. Another group of scholars consciously withdraws from participation. Finally, less sceptical academics recognise that IR scholars usually share the ambition of having some leverage in the realm of foreign policy. In this group, the willingness to have impact goes hand-in-hand with the awareness of existing obstacles.

Several factors discourage scholars from active participation in the public debate. For instance, the state increasingly interferes with academic institutions and individual scholars. Some academics feel uncomfortable participating in TV or radio debates as they are unsure whether their presence could end up legitimising certain messages without giving them a proper opportunity to air their own views.

The unwillingness to contribute to the policy-making process stands in stark contrast to the relatively rich institutional setting for knowledge exchange between the expert community and the government.

How do you see EU/Russia relations evolving in the future?

The last decade showed a gradual worsening of Russia-EU relations. Both actors' official rhetoric of partnership and cooperation allowed for many problematic aspects to be swept under the carpet. Unfortunately, none of the reasons that contributed to this state of affairs seems to be disappearing, starting from the conflict in Ukraine and ending with Russia's unofficial support for far-right parties in Europe.

Both sides are disappointed in each other. Russian authorities have become more and more united in perceiving the EU as a competitor rather than a partner. In the EU, frustration related to actual and perceived threats to cybersecurity originating from Russia is growing. I believe that the evolution of the domestic situation in both the EU and Russia will be the most important factor in the future development of Russia-EU ties.

Dr Katarzyna Kaczmarska
Aberystwyth University

I believe that the evolution of the domestic situation in both the EU and Russia will be the most important factor in the future development of Russia-EU ties.

How can your project and its results inform future policy-making in Europe and, ultimately, influence EU/Russia relations?

My project shows that even under tightening control over the foreign policy process, there are societal actors in Russia who want to have a say and are willing to voice some criticism. The EU should take this factor into consideration and encourage dialogue and academic cooperation between European and Russian scholars and students. This, over the long term, could contribute to strengthening pluralism in Russian political debate.

My project also shows that it is important to promote the so-called track-two diplomacy, which allows experts to exchange their views and gain better understanding of how the other side represents the world, what obstacles exist in the process of knowledge production, and how this knowledge can or cannot be translated into policy-making.

RUKNOW

- Coordinated by Aberystwyth University in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/705989
- Project website: ruknow.com/project

From conflict prevention to sustainable peace

The EU-CIVCAP project has investigated the EU's civilian capabilities for peacebuilding, pointing at improvements over the past two decades as well as problems that have yet to be overcome.

Born in 1999, the Common Security and Defence Policy made the EU an international actor of conflict resolution in its own right. But it essentially focused on the development of military capabilities. In fact, up until recently, there has been very little attention paid to the EU's civilian capabilities for peacebuilding; and only limited attempts at clarifying the EU's role across the different phases of conflict and policy areas.

The EU-CIVCAP (Preventing and responding to conflict: developing EU CIVilian CAPabilities for a sustainable peace) consortium aimed to fill these gaps. They took a strategic and holistic approach to the development of peacebuilding capability – the ability to combine key conflict prevention and peacebuilding resources to achieve the EU's external goals – and developed a dedicated assessment framework.

ASSESSING EU PEACEBUILDING EFFORTS

"We adopted a comprehensive 'conflict cycle' approach by assessing EU peacebuilding activities through the entire conflict lifecycle. This approach allowed us to incorporate a wide range of EU policies while addressing four cross-cutting challenges: filling the early warning-response gap; combining short-term versus long-term approaches to peacebuilding; enhancing civil-military coordination in conflict prevention and peacebuilding; and ensuring local ownership," says project coordinator Professor Ana E. Juncos.

Amongst the most positive developments in EU peacebuilding over the past two decades, Prof. Juncos and her team point at the significant civilian capabilities, tools and instruments at the EU's disposal. They underline that Member States have also developed a range of dual-use technologies (for civilian and military missions), with some of them – such as satellite systems and remotely piloted air systems (RPAS) – being used to meet the EU's objectives in conflict prevention and peacebuilding.

CHALLENGES TO OVERCOME

But several problems remain, as Prof. Juncos points out: "Systems to recruit and deploy civilian personnel vary widely across Member States and many of them have shortcomings. More efforts also need to go into the standardisation and improvement of civilian personnel training. Besides, we found that those formulating and implementing EU policies do not always take advantage of ICT and Big Data. And even when they do, cooperation and coordination between Member States remains limited."

Among the project's main points of concern are the lack of implementation of a fully integrated approach to conflicts and crises, the fact that conflict prevention is not always prioritised or integrated into decision-making, as well as problems related to gender equality. "Finally, despite a commitment to promoting local ownership, EU-CIVCAP found that EU capacity building activities have often taken place without local involvement. This also undermines the sustainability and legitimacy of those initiatives," Prof. Juncos explains.

DETAILED RECOMMENDATIONS

Drawing on the critical assessment of the EU's peacebuilding efforts outlined above, EU-CIVCAP has identified and documented empirically-grounded lessons, best practices and policy recommendations to better address key challenges in EU conflict prevention and peacebuilding.

The project also compared the EU's track record with that of other international actors such as the UN, OSCE, NATO and individual EU Member States. It found that civilian crisis management within the EU's framework remains relatively modest compared to, for instance, civilian UN peacekeeping or the UN's political and peacebuilding missions.

Whilst significant advances have been made over the past two decades, Prof. Juncos points at the lack of prioritisation of conflict prevention, lack of locally-owned programmes, institutional complexity and fragmentation at the EU level as the main obstacles towards an effective and integrated approach. "Ultimately, the question remains of whether the EU can find the political will – in Brussels and among its Member States – to make the reforms suggested by this research and to become a more prominent global power in this field," Prof. Juncos concludes.

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EU-CIVCAP

- Coordinated by the University of Bristol in the United Kingdom.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/653227
- Project website: eu-civcap.net
- bit.ly/2UInr5w

The EU-Turkey relationship: How to overcome the 'perennial dance' of conflictual cooperation

The FEUTURE consortium has been aiming to understand the ins and outs of the highly complex, constantly-evolving relationship between the EU and Turkey. The knowledge they gathered allowed them to infer the most likely scenario for the future of this important relationship.

The EU and Turkey have always wavered between accession negotiations and the cold wind blown by the likes of political instability, human rights-related issues, economic disputes and disagreements on foreign policy. The past four years have offered a condensed version of these problems: in 2015 and 2016, migration crises had pushed both sides to revitalise accession negotiations and get closer than ever to solving the longstanding Cyprus dispute. From thereon, the deterioration process started again and culminated with the latest European Parliament resolution to suspend the accession procedure in March 2019.

"Researching EU-Turkey relations has always been and remains challenging to this day, because we are looking at a 'moving target'," explains Dr Funda Tekin, Project Director of FEUTURE (The Future of EU-Turkey Relations. Mapping Dynamics and Testing Scenarios) on behalf of the University of Cologne. "Additionally, realities might change not only fast but also in an extreme manner. This means that so-called wild cards (unknown-unknowns; improbable but deeply disruptive events) can materialise and completely change the future of the relationship."

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DEVISING THE COMPASS OF EU-TURKEY RELATIONS

Dr Tekin and her team brought together 15 partners from the EU, Turkey and neighbouring regions and provided secure spaces for open discussion on critical and vital issues. Together, project partners aimed to generate an understanding of all factors driving the EU-Turkey relationship. They considered the fluctuating nature of the relationship to devise a 'compass' based on three idea-type scenarios (EU membership, cooperation and conflict), mapped the dynamics of EU-Turkey relations in terms of underlying historical narratives and thematic key drivers, and considered wildcards (improbable but highly disruptive events) in building the project's future relationship scenario.

Considering the six thematic dimensions of politics, economy, security, energy, migration and identity, the consortium arrived at what they labelled the 'conflictual cooperation' scenario.

"Notwithstanding conflictual dynamics in terms of politics and identity constructions, the EU and Turkey have no choice but to cooperate. The intricate interdependence in the economic, energy, migration and security domains is such that cooperation, while at times conflictual, will remain a necessity moving forward and will determine the lower-most limits below which the relationship simply cannot fall. In other words, the EU-Turkey relationship will most likely continue to oscillate between the upper and lower most limits, in a perennial dance of conflictual cooperation," explains Professor Nathalie Tocci, FEUTURE's Scientific Coordinator.

A 'DYNAMIC ASSOCIATION' FOR BETTER RELATIONS

Whether this scenario is unavoidable is another question, one that the consortium also tried to answer. Together, they tried to find out how the EU could maximise the scope of cooperation and mitigate the prospects of conflict, whilst at the same time embedding such cooperation in a rules-based framework.

"Our proposal is that of a dynamic association, one which while still considering the sky as the limit – and therefore not advocating a once-and-for-all suspension of the accession process – both seeks to maximise cooperation and strives to embed such cooperation in a rules-based framework," says Prof. Tocci. "A modernised customs union upon which further building blocks of cooperation could be added across the energy, migration and security domains is, we believe, the most beneficial and realistic way forward."

The consortium has already discussed its policy recommendations with officials and stakeholders in both Ankara and Brussels and has also had the opportunity to present them in the capitals of individual EU Member States.

FEUTURE

- Coordinated by the University of Cologne in Germany.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/id/692976
- Project website: feuture.eu
- bit.ly/2YZFJ1e

Improving EU crisis response for more effective conflict prevention

To increase the EU's conflict sensitivity and efficiency, the project critically examined the EU's crisis response. By including a bottom-up perspective, the analysis broke with the dominant line which has prioritised the EU side of the equation.

As a global actor, the EU has recently prioritised a streamlined crisis management approach. However, implementation has received relatively little scholarly attention. The EU-funded EUNPACK (Good intentions, mixed results – A conflict sensitive unpacking of the EU comprehensive approach to conflict and crisis mechanisms) project sought to redress this imbalance by unpacking EU crisis response mechanisms, providing insights on how they are received and perceived on the ground by local beneficiaries. Project Coordinator, Research Professor Morten Bøås

(Norwegian Institute of International Affairs), explains it all to CORDIS.

How did you go about the research for the project?

Prof. Bøås: EUNPACK studied seven crises at various points in the 'crisis cycle', located in three regions where the EU operated crisis responses: the Enlargement Area (Kosovo, Serbia), the Neighbourhood Area (Ukraine, Libya) and the 'Extended Neighbourhood' (Mali, Afghanistan, Iraq). We combined in-depth interviews with Brussels policymakers, especially within the EEAS, with stakeholder interviews and surveys in the case countries. While desk research did tell us about the EU's crisis response toolbox, it was the ethnographic fieldwork that gave us real insights.

Can you explain the phrase 'crisis cycle' and how this underpinned your work?

We distinguished between three phases. Firstly, the 'pre-crisis phase', which could be characterised by early warning and conflict prevention. Secondly, the 'crisis phase', where rapid reaction and aid are possible measures. Lastly is the 'post-crisis phase', with state-building, peace-building and human security as options. These helped us understand restraints and opportunities to effective response and to evaluate if EU actions met needs. For example, we found that the EU's crisis-phase response often continued into the post-crisis phase, limiting its contribution to conflict resolution and its ability to break the crisis cycle.

What sort of crises did the research look at, and why those specifically?

The crises we looked at are caused by human behaviour, are inherently political and are closely connected to conflict. They often threaten the livelihoods of millions of people and are not isolated incidents that spontaneously erupt. They are manifestations of longer processes of social change and discontent. Understanding how external actors can contribute to solutions is crucial, but equally important is learning lessons about the avoidance of unintended consequences. Examples include the protracted humanitarian and political crises that have characterised Afghanistan, Iraq, Libya and Mali, all EUNPACK case study countries.

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Professor Morten Bøås
Project coordinator of EUNPACK
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> *The EUNPACK team is proud that the results of our research have enabled us to present policy recommendations, fine-tuned to make the EU's crisis response mechanisms more conflict and content sensitive, and thereby more efficient and sustainable.*

What are the key results so far from the project?

Over the past 20 years, the EU has considerably improved its capacity for crisis response. However, we identified four main challenges still to be addressed. Firstly, there is a gap between the EU's intentions and its implementation. Secondly, there is dissonance between EU policy implementation and how this is perceived locally. Thirdly, the EU doesn't really succeed in building sufficient local ownership, limiting its ability to address underlying issues. Consequently, local people are often unaware of specific EU efforts and their implications. Lastly, responses are increasingly interest-driven and based on short-term objectives, such as halting migration and fighting terrorism. These often do not align with local priorities and could make problems worse in the long term. Designing operations based on local needs and cooperation is therefore vital.

How does the project contribute to the EU's aims and so impact the lives of its citizens?

We have provided decision makers in Brussels with perspectives from an essential group often lost in discourse but in whose name they work. We hope policymakers recognise that it is in their interests to understand what people in Afghanistan, Kosovo and Mali think; that academic scholars continue to examine local perceptions; and that people in Europe and beyond gain further insights into the consequences of EU policymaking. Equally, we hope to have given the people on the ground in case study countries a better grasp of what the EU does and what it wants. The EUNPACK team is proud that the results of our research have enabled us to present policy recommendations, fine-tuned to make the EU's crisis response mechanisms more conflict and content sensitive, and thereby more efficient and sustainable.

How do you intend to take the work forward?

As well as journal publishing, we are working on an edited volume of the EUNPACK research. We hope to continue research on the EU, putting local partners at centre stage. We are proud of this approach which enabled us to conduct systematic research in difficult, tense and dangerous environments.

EUNPACK

- Coordinated by the Norwegian Institute of International Affairs in Norway.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/id/693337
- Project website: eunpack.eu
- bit.ly/2WQkyga

Researchers investigate ways to make the MENA region's forecasted future come to pass

If events over the past 10 years are any indication, the future of the Middle East and North Africa (MENA) region looks dark and gloomy. But research under the MENARA project is there to remind us that brighter future scenarios can come to life with enough political will.

The MENARA (Middle East and North Africa Regional Architecture: Mapping Geopolitical Shifts, Regional Order and Domestic Transformations) project has spent the past three years analysing the drivers of change for regional order in the MENA region and the implications of this change for Europe. The recently-completed project outlines potential scenarios for 2025 and 2050 and identified opportunities to break with the past.

Dr Eduard Soler i Lecha, senior researcher at CIDOB and scientific coordinator of MENARA, discusses the opportunities presented by the project's findings.

Experts couldn't predict recent events such as the Arab Spring and the growth of ISIS. What do you think are the main factors that led to such a level of unpredictability?

MENARA depicts a situation in which regional conflicts proliferate and intersect, where different local, regional and global actors have a say and forge liquid alliances among them. Sudden one-off events can radically change the geopolitical landscape, so it is key to be attentive to those developments, to measure their impact and, if possible, to try and anticipate them.

Whilst we may not be able to predict when a particular military action or a protest will occur and assess its impact, we can nonetheless identify some trends that are and will continue to shape the region. I'll give you an example: Environmental degradation, combined with demographic growth and bad governance – particularly when it comes to corruption – sets the conditions for popular unrest and destabilisation.

What was MENARA's approach to identifying these trends?

We needed to look simultaneously at three levels of analysis. At the domestic level, we need to understand how state-society relations evolve and which forces are driving conflict or cohesion. At the regional level, we want to understand the dynamics of regional conflicts and the priorities of the main regional powers. We also look at the processes that contribute to further fragmentation of the region – for instance the Maghreb is increasingly pivoting towards Africa – but also all the elements that contribute

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to maintaining or increasing the interconnectedness between different sub-regions and regional conflicts – see for instance the phenomenon of foreign fighters.

Finally, we look at the global level. We have researched the role and strategies of global powers, the impact of a challenged global order in this particular region, how the region is embedded in global trends (energy, militarisation or climate change are very clear examples), but also how it risks becoming peripheral if its states and societies keep focusing on short-term risks instead of tackling long-term challenges, such as digitalisation.

We believe that to understand where the region stands right now and how it may evolve, we need to integrate the three levels of analysis.

What would you say are the project's most important findings, especially with regards to likeliest future scenarios?

When thinking about the likeliest scenario, the usual approach is to project current trends, and the result is quite worrying. This would imply increased levels of fragmentation and conflict, the greater effects of global rivalries and global trends such as climate change instead.

But the role of foresight techniques is to explain that there are alternative futures. MENARA depicts this worrying scenario, but we also look at potential game-changers and spaces of opportunities. The fact that they may be less probable does not mean that they are impossible.

The realisation that decarbonisation is unstoppable, for instance, could trigger the need to rethink economic, social and political models. Africa could be viewed as an opportunity, women's empowerment is a reality and a hope all across the region, and we can also think of processes in which societies would transcend sectarian divides or international, regional and local actors to push an agenda of reconciliation.

How can the EU best push these alternative scenarios?

The first step is to understand that the future of the region will have a major impact on Europe, and vice versa. If the EU could overcome its current crises and divisions, it would be able to play a more constructive role. Unlike the US or China, Europe can't disengage from the region because of its geographic proximity and social bonds.

Dr Eduard Soler i Lecha
Scientific coordinator of MENARA
© Eduard Soler

> *MENARA depicts a situation in which regional conflicts proliferate and intersect, where different local, regional and global actors have a say and forge liquid alliances among them.*

The second step relates to the identification of risks and vulnerabilities to go beyond a containment approach. Finally, the EU should understand that opportunities exist and can be seized. Foresight techniques could be of great help, particularly when they are combined with a good knowledge of social and political dynamics in the region.

I believe that MENARA has some key messages that should be taken into account. For instance, we say that interpreting the region through the lenses of a sectarian divide is not only inaccurate but could lead to wrong and counterproductive policy prescriptions. We are also pointing at the need for the EU to better integrate the concerns of the populations.

Based on our findings, authoritarianism is not seen as a solution but rather as a risk. This means that the EU should never renounce defending human rights and working with civil society, especially since it is the only major player who seems willing to do so.

It should also work with states and societies to better tackle issues related to environmental degradation and technological transformations, as well as support the dynamics that could lead the region towards a more promising future: youth, women and dialogue are three elements that came to the fore in our research.

Looking back, do you think the project's approach could have helped the EU to better deal with important changes in the region over recent years? How so?

I think so. Unlike policymakers, researchers are not hostages of institutional inertia, it is relatively easier for us to think long term and we may be more flexible in terms of contacting a variety of actors across the region.

When I look back, I regret that most EU leaders only realised that the region mattered in 2015. Four years after

the Arab Spring. Why 2015? Because they suffered the consequences of instability in the form of refugees or terrorist attacks and realised that this could destabilise their own governments and the European project itself.

To make things worse, the reaction was then – and to some extent continues to be – to focus on short-term threats. This is how stabilisation became the mantra and some forces in the region and beyond tried to assimilate it with the frustration of change and the need for authoritarianism. Instead of planting the seeds of future discontent and conflict, we need to plant the seeds of reconciliation, transformation and hope.

MENARA

- Coordinated by CIDOB in Spain.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/id/693244
- Project website: menaraproject.eu
- bit.ly/2IobStr

Joint efforts show the way towards a more effective Eastern Partnership

Building upon lessons learned from failed attempts to bring Eastern Partnership (EaP) countries closer to democracy, the EU-STRAT project shows the path to more successful EU support in the Neighbourhood.

Launched in 2004, the European Neighbourhood Policy (ENP) aimed to 'bring the EU and its neighbours closer, to their mutual benefit and interest'. In the case of EaP countries, it essentially meant supporting economic growth and the transition towards democracy.

Fifteen years later, the ENP's vision has yet to materialise. The ENP was revised in 2015 and, one year later, the EU allocated research funding for the Horizon 2020 EU-STRAT (The EU and Eastern Partnership Countries: An Inside-Out Analysis and Strategic Assessment) project.

"Instead of becoming more democratic, most EaP countries have transformed into rather stable hybrid regimes. EU-STRAT addresses precisely the question of why the ENP did not bring about the expected results, looking from the 'inside out' – from the perspectives of the countries themselves," says project coordinator Prof. Dr Tanja A. Börzel, and Director of the Centre for European Integration at Freie Universität Berlin, Germany.

The project brought together six universities, three think-tanks, one civil society organisation and one consultancy not only from within EU Member States, but also from Belarus, Moldova and Ukraine. Together they focused on domestic dynamics in target countries as well as regional interdependencies.

SUPPORTING CHANGE IN EAP COUNTRIES

"It quickly became clear that the perspective of EU accession cannot be a panacea for failed reforms," says Prof. Antoaneta Dimitrova, co-coordinator of the project on behalf of Leiden University. "With this in mind, we developed recommendations on how the EU can support political and economic change in EaP countries. Assessing why reforms are taking so long or simply fail in some countries but not others is crucial in this regard. Therefore, we developed a conceptual framework to understand how social orders differ among EaP countries and why the 'one-size-fits-all' approach of the EU does not work."

Project findings notably point at how the EU has underestimated the role that state capture, personal relationships, patronage networks and rent-creation have been playing in EaP countries. They state that EU policy success depends on the type of social order and dominant coalitions of domestic elites, and that it is also affected by the partner country's place in bilateral, regional and global interdependencies. "Besides, soft power, narratives and messages from Russia or the EU which target citizens and local non-governmental actors have an impact on the perceptions of citizens and their beliefs regarding the future cooperation with the EU," Prof. Börzel explains.

COMPETING WITH OTHER POWERS

Perhaps one of the most important contributions of the project in this regard consists in its quantitative analyses of the way the EU and Russia were presented on television news in the region. These helped the team to understand whether citizens comprehend the effects of EU policies and crucial engagement tools such as Association Agreements.

To be more effective, EU-STRAT claims that the EU will need strategies and instruments tailored to domestic conditions, whilst considering interdependencies with other countries. Other actors like Russia, Turkey and China compete with the EU in shaping economic and political development in EaP countries. Besides, the EU will have to address 'clientelistic' rent-seeking networks, as well as communicate more effectively.

"We hope that our findings and policy recommendations will contribute to a better understanding of the EU's Eastern Neighbourhood. But one of our most important goals was to build a lasting network of researchers and practitioners from EU Member States and EaP countries, and we have certainly succeeded in this regard," Prof. Börzel concludes.

EU-STRAT

- Coordinated by the Free University of Berlin in Germany.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/id/693382
- Project website: eu-strat.eu
- bit.ly/2U3HPti

A social, cultural and scientific boost to EU-LAC relations

In the face of deadlocked free trade agreement negotiations with Mercosur, the cultural, scientific and social dimensions of EU-LAC relations have acquired increased significance. The EULAC Focus project has been looking into ways to strengthen these bonds.

The 1990s didn't only see a return to democracy in much of the Latin American and Caribbean region (LAC): they were also marked by attempts to forge a stronger EU-LAC relationship. Decades later, bi-regional relations have only evolved in areas that were initially not considered central. The EULAC Focus (Giving focus to the Cultural, Scientific and Social Dimension of EU – CELAC Relations) project believed that the time had come to review them.

EULAC Focus started from a thorough analysis of the institutional set-up for those relations, in order to deepen existing knowledge on the concepts and visions underpinning this partnership. To do that, the team has been retracing the history of EU-LAC relations since they were first officialised in 1994.

COMPENSATING 'DEPTH' WITH 'BREADTH'

"This should have led to an ambitious trade agreement between the EU and Mercosur, but this didn't work out," explains Prof. Ramon Torrent, EULAC Focus coordinator. "So in 1999, President Chirac (of France) and Prime Minister Aznar (of Spain) suggested the organisation of 'summits' between the two regional leaderships: Maybe the idea was that 'breadth' (a very wide agenda of exchanges) would compensate for the lack of 'depth' (economic content), but this has clearly not worked either: progress in the very wide cultural, scientific and social dimensions has not compensated at all for the absence of an economic agreement with Mercosur, which

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was the main objective in 1994 and has still not been finalised."

EULAC Focus therefore concentrates on these three dimensions. It aims to: provide an overview of the regional agenda in these domains; critically examine past and current initiatives; identify lessons learned and impact; point at opportunities to reinvigorate the bi-regional agenda; and identify likely scenarios for future EU-LAC relations.

To devise such scenarios, the project built upon two relevant assessments: one issued by the European Commission in 2017, and one issued by the IBD-Atlantic Council in 2016 for LAC. These two reports proposed five scenarios for each region, resulting in a total of 25 'bi-regional' potential combinations. "Out of this list, four bi-regional scenarios were selected for being plausible, structurally different, internally coherent and useful for drawing policy recommendations and making decisions," Prof. Torrent explains.

WHAT FUTURE FOR EU-LAC RELATIONS?

So, what does the future of this relationship look like exactly? "If we are looking at this problem from a purely empirical point of view, being lucid and looking at the facts, it's very difficult to be optimistic. Both the EU and LAC suffer very serious internal difficulties, and the process of bi-regional summits is currently paralysed," he says.

It doesn't mean, however, that it isn't possible to do better. Prof. Torrent believes that both sides might need to become 'ambitiously modest', that is, being aware of the difficulties and the relative scarcity of means while at the same time looking for an ambitious outcome.

> *"Four bi-regional scenarios were selected for being plausible, structurally different, internally coherent and useful for drawing policy recommendations and making decisions."*

To help both regions in this endeavour, the EULAC Focus consortium intends to devise an action plan and a set of recommendations whilst considering the EU's nature as a political entity with competences of attribution.

"The EU cannot do everything, and most of what it can do is 'inner-looking'. This means we must change the way we approach things and, instead of discussing the cultural, scientific and social dimensions of EU-CELAC relations, we should think – with an ambitiously modest attitude – about how to give an EU-LAC dimension to the EU's cultural, scientific and social policies," concludes Prof. Torrent.

EULAC FOCUS

- Coordinated by the University of Barcelona in Spain.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/id/693781
- Project website: eulac-focus.net

A new automated system makes home-brew much simpler and quicker

An EU-funded project removes the hassle from making craft beer. A new machine takes care of everything.

For some years, global beer consumption has been declining. The trend reflects a general increase in health consciousness, as well as concerns about additives in mass-produced beer.

Home-made and craft beers omit such additives. So, during the last 10 years, these beers have reversed the trend, rising from 2 % of the US market to 20 % today.

Consumers want control over ingredients, yet making beer at home is inconvenient. The process requires considerable space, because of the many utensils and tools required, plus it is messy and time-consuming. All work associated with brewing beer at home will typically take around two full days.

The EU-funded BrewiePro (The first fully automated brewing machine for the bar and restaurant industry) project developed and is looking to commercialise a new version of an existing automated home-brewing system. The update is intended for the bar and restaurant sector which represents about one third of the European beer market. During the completed first phase of the project, the team determined the sector's requirements, refined the product accordingly and prepared a detailed plan for the next phase.

SPECIALISED DEMAND

The study confirmed sector demand in a systematic way. For example, for bars and restaurants, consistent quality is very important, as is price. Additionally, for establishments operating in saturated markets, the ability to brew their own beer allows differentiation from competitors. As expected, BrewiePro was shown to be very competitive as it met all these criteria. "The customer feedback helped us prepare a strong application for Phase Two funding," says project leader Marcell Pál.

The original Brewie machine provides automated home brewing. It enables anyone to brew their own beer more easily, and with a much smaller footprint, compared to conventional home brewing. The updated version brings that to the bar and restaurant sector.

Both machines follow the same steps as traditional beer brewing. The brewing part of beer-making is essentially like making tea, in that the user adds taste ingredients to hot water. Beer-making is more complicated, involving: mashing of the malt grain, sparging (draining and rinsing the mashed malt), boiling, hopping (adding hops), cooling and cleaning. The machines do everything the user would do manually, but they control the process.

Automated brewing still takes several hours, but only requires 15-30 minutes of the user's attention, depending on which options they choose. Using Brewie's native software, users may select from several pre-programmed recipes. The user can provide their own ingredients or the pre-packaged options the company supplies.

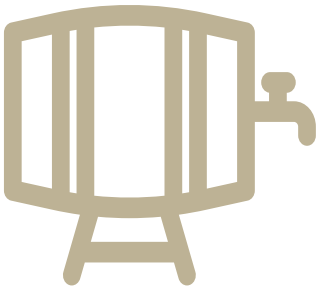
IMPROVED AUTOMATION

For the original machine, once the brewed liquid (called ready wort) has finished brewing, the user pours it into a separate tank for fermentation. Fermentation is the process by which yeast converts sugar to carbon dioxide and alcohol. Fermentation begins after about 12 hours, and takes up to a week to complete. Afterwards, fermented beer is poured into either bottles or kegs, and reaches its final flavour characteristics after another few weeks.

The next version of the product will automate fermentation and storage steps as well. Users will be able to draft their own beer directly from the BrewiePro machine.

Fermentation begins after

12 hours,



and takes **up to a week** to complete

BrewiePro will market its system worldwide. The greatest demand is expected from the American market, followed by Britain, and then traditionally beer-loving European cultures. "The resulting beer is equal in quality to craft beers costing the bar EUR 8, or more, per bottle," claims Pál. "But ours will cost EUR 1 per bottle or less."

In the future, local beers may be even more local than consumers imagine.

BREWIEPRO

- Coordinated by Newity KFT in Hungary.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership.
- cordis.europa.eu/project/id/828286
- Project website: brewie.org
- bit.ly/2NIB0Ml

FOOD AND NATURAL RESOURCES

Humane plug-and-play rodent control

The global rat population is estimated to be 60 billion or a staggering eight rats for every human. The EU project PiedPiper has developed a revolutionary pest control system to counter the emergence of the anticoagulant-resistant super rat phenomenon.

A first of its kind, the PiedPiper (PiedPiper®: smart pest control) initiative developed a novel pest control solution that doesn't rely on ingestion by the rodent. This device incorporates an aerosol that delivers a metred dose that can kill the rodent in one application.

COMPARISON WITH OTHER CURRENT RODENT SOLUTIONS

The toxin passes through the skin, and a quick, humane death results within 48 hours – compared to weeks with

currently available multi-feed anticoagulants. As a result, future populations of rodents will not develop resistance to the new toxin. "Our low-cost formulation is based on cholecalciferol, lethal to rodents but safe for humans and other species. Proven 100 % effective in independent trials, it leaves no environmental residues," outlines project coordinator Steve Goode, managing director of Biotronics Ltd.

"Whilst our technology is complex, its application and use are very simple – plug and play, set and forget," emphasises Goode. Costs of running the units are significantly lower than snap traps or electrocution systems, as these units have to be rebaited and reset after each kill, increasing CO_2 footprint. Compared to anticoagulants, PiedPiper chemicals do not leave residues for 40 years – indeed the main toxin leaves no residue whatsoever.

OVERWHELMING CONFIRMATION OF VIABILITY AND TECHNOLOGY DEMAND

Project researchers produced a feasibility study looking at the PiedPiper technology and how it fits in with the current and future market requirements of rodent pest control. The main conclusion was that anticoagulants are time-limited in European and Australian/New Zealand markets. There is also pressure in the United States (US) to reduce the dependency on anticoagulant products as they no longer provide reliable or effective control.

An intellectual property (IP) audit concluded that Biotronics Ltd has current IP in Australia, the first country to approve the transdermal rodenticide technology, and

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now major regions will follow. "We also did an evaluation of what the US market would be worth with our patent based on figures from our proposed distributor – the independent valuation came out at GBP 16 million or EUR 18 million," states Goode.

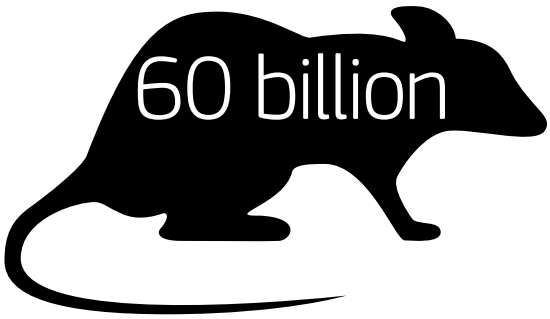
As extra confirmation of the potential demand for PiedPiper technology, the Predator Free New Zealand project is aiming to eradicate all invasive species from the country by 2050. "We therefore see enormous potential in the PiedPiper system and have formed Biotronics Australasia to exploit this opportunity," explains Goode.

NEXT STEPS – RODENT CONTROL OF THE FUTURE

PiedPiper technology has been confirmed as patentable by an independent patent audit. The next steps will be to commercialise the technology in the EU, Australasia and the US. Project members are in discussion with a number of large pest control companies to partner with Biotronics to exploit this technology in an estimated EUR 20 billion-plus international market. "We will be applying for an SMEI Phase 2 grant in 2019 from our new EU-based company in Ireland," adds Goode.

The PiedPiper rodent control technology can also be adapted to control populations of other pests. Goode concludes with his vision for future rodent control: "Wildlife protection is high on our agenda as current rodent control chemicals do not take into account different species. We will soon have a system to identify the species and decide if it is a target or a conservation species. Appropriate treatment can then be applied."

The global rat population is estimated to be



that is 8 rats for every human

PIEDPIPER

- Coordinated by Biotronics Ltd in the United Kingdom.
- Funded under H2020-ENVIRONMENT and H2020-SME.
- cordis.europa.eu/project/id/807536
- Project website: rattrap.eu

INDUSTRIAL TECHNOLOGIES

Dirt-cheap but strong-as-steel light metal joints

EU-funded scientists unveiled an innovative method of joining dissimilar metals, exploiting the excellent alloying properties of copper. This will highly benefit industries requiring the use of light, strong materials to manufacture efficient and durable components.

Balancing weight and strength has always been a challenge in the design of safer, higher-performance, cheaper and more environmentally friendly products for the manufacturing sector. Research results and successful industrial case studies have shown that reduced weight and improved performance can only be met if material properties and geometry are ideally adapted to the requirements, the load profile, and the function of the product.

Producing the desired shapes calls for innovative manufacturing strategies especially for materials that are difficult to handle. Joining metal alloys by electromagnetic pulse welding is a promising innovative technology that can meet this demand. "The process can be used for welding similar and dissimilar material combinations including multiple ones that are difficult to join using conventional welding processes," notes Verena Psyk, coordinator of the EU-funded project JOIN-EM (JOINing of copper to aluminium by ElectroMagnetic fields).

Just as the name suggests, electromagnetic pulse welding uses electromagnetic forces for joining work pieces. The joint is formed without heat, depending more on the impact of the joining parts. The process needs no fluxes or shielding gases and produces no harmful smoke, fumes or slag. This reduces the overall negative impact on the environment. "Although this joining technique resembles more popular ones like explosive welding or cladding techniques, it is significantly less safety-critical. Thus, it can be more easily implemented in the industry," adds Psyk.

WORKING PRINCIPLE

Electromagnetic pulse welding involves the use of a so-called pulse generator that mainly consists of a capacitor bank. When the required energy amount is stored in the capacitors, it is instantaneously released into a coil. The discharge current induces a strong transient magnetic field. The pulsed magnetic field generated induces an opposite current in the work piece.

The interaction between the two currents and the magnetic field generate Lorentz forces that accelerate the work piece to very high velocities during a very short period of time. After overcoming the initial gap in between, the work piece impacts with the target work piece at a very high velocity. The quality of this collision depends on the impact velocity and the collision angle. If these collision parameters are within a process window, then a welded joint is generated, which frequently features a wavy interface.

OPTIMISING USE OF A FINITE RESOURCE

Due to its excellent thermal and electrical conductivity, copper spans a wide range of applications, especially heating and cooling equipment and electrical devices. However, it is a heavy metal and its intense application contradicts modern lightweight approaches. Given its rising demand and the current level of known reserves, copper will become more expensive and difficult to obtain, creating an additional cost issue for manufacturers.

> *"The process can be used for welding similar and dissimilar material combinations, including multiple ones that are difficult to join using conventional welding processes."*

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JOIN-EM aimed to decrease the consumption of copper by partially substituting it with aluminium. "Our new joining solution helps implement improved lightweight designs of copper-aluminium hybrid parts with further cost reduction and better performance. Joining operations will be performed faster and more efficiently, resulting in longer-lifetime and higher-quality joints. Put together, all these will decrease energy consumption and greenhouse gas emissions – an increasingly significant requirement for several industries," explains Psyk.

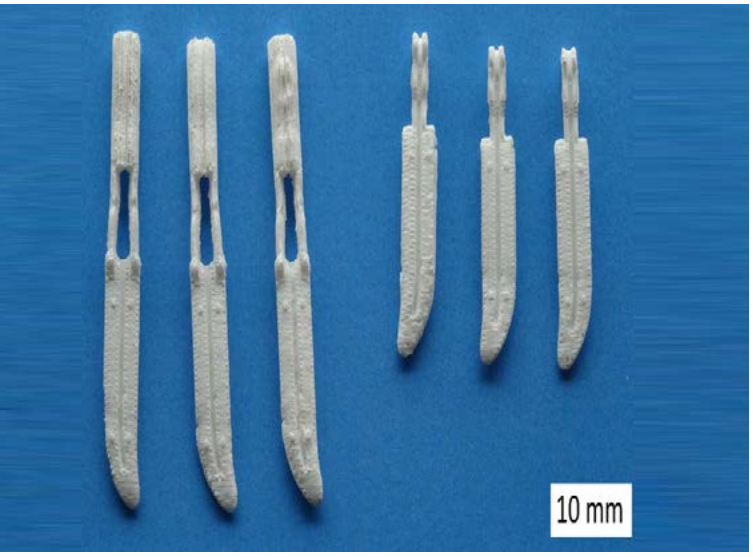
Project partners demonstrated the success of their new joining process in three full demonstrators – a refrigerant circuit, a flat condenser and a pouch cell. They are also now exploring the possibility of applying their process to other multi-material joints including copper-steel and aluminium-steel alloys.

JOIN-EM

- Coordinated by the Fraunhofer Society in Germany.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/677660
- Project website: join-em.eu
- bit.ly/2TmFGxt

Ceramic additive manufacturing enters a new dimension

Ceramic additive manufacturing (AM) promises so-far impossible geometry for a wide range of components – from individualised jewellery to surgical instruments.



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The EU-funded CerAMfacturing (Development of ceramic and multi material components by additive manufacturing methods for personalized medical products) project has developed a completely new approach for ceramic multi-material AM. "Enabling series production of customised and multifunctional components for manifold applications, it's possible to obtain property combinations that were previously incompatible, like electrical conductive/electrical insulating dense/porous or two-coloured components," explains Dr Tassilo Moritz from the Fraunhofer Institute for Ceramic Technologies and Systems IKTS and project coordinator.

DIFFERENT PRODUCTION PROCESSES FOR A WIDE PRODUCT RANGE

Researchers developed three tailored polymeric systems AM methods for manufacturing of multifunctional ceramic components: fused filament fabrication (FFF), thermoplastic 3D printing (T3DP), and lithography-based ceramic manufacturing, now known as vat photo polymerisation (VPP).

All the processes have their specific uses and applications. With FFF, for example, it is possible to produce large and complex components quickly with high material efficiency. T3DP is particularly useful for a multi-material approach and applies suspension microdroplets for dot-wise manufacturing. VPP on the other hand uses layer-wise application of a light curable ceramic suspension that can be sintered to full density later.

The CerAMfacturing team developed five very different case study components: an infrared (IR) heater, a spinal implant, a partial knee implant, a surgical micro-gripper and a customised watch case.

PERSONALISED AND UNIQUE

Initially, magnetic resonance spectrography data is transferred into CAD files to produce patient-specific medical implants such as knee or spinal implants, surgical grippers and therapeutic appliances. Based on customer anatomy and needs, the team selects the desired material or material combinations as well as the appropriate AM technology to produce the case study components. In addition, new ceramic or metal particle-filled filaments, suspensions and feedstocks were developed for different AM processes.

All three newly developed AM machines for multi-material use for VPP FFF and T3DP were successfully demonstrated at a project workshop in the second half of the project duration organised by Fraunhofer IKTS and at a workshop on Hybrid Materials and Additive Manufacturing Processes (HyMaPro) after project closure together with Fraunhofer IWS. Illustrating these three machines is the project video. Three separate films have been published in the Journal of Visualized Experiments (JoVE) recently.

> *The project will act as a door opener for the hybridisation of materials and processes and will give a remarkable input to the scientific community on combining different materials by AM methods.*

SOLVING THE UNEXPECTED

The originally planned IR limb heater proved to be too large for manufacture by the three AM routes and was substituted by a much smaller IR heater with an enclosed meandric heating structure. For another problem, due to the incompatible thermal expansion coefficient of the initial material combination, a new partnership of stainless steel/zirconia was selected.

THE FUTURE FOR CERAMIC AM

"Personalisation is high on the agenda," points out Dr Moritz. "The CerAMfacturing project helped show a wider community the opportunities of AM techniques for individualising or customising medical and consumer products," he continues. Individualisation of consumer products for a more sophisticated lifestyle is 'trendy', and the AM technique will safeguard such products from counterfeiting and bootlegging.

Two patent applications have been filed based on the project results. For increasing awareness of the CerAMfacturing project results as a marketing tool, 'CerAM' in combination with the three developed AM methods will be registered as brand names: CerAM FFF, CerAM T3DP and CerAM VPP. "The project will act as a door opener for the hybridisation of materials and processes and will give a remarkable input to the scientific community on combining different materials by AM methods," concludes Dr Moritz.

CERAMFACTURING

- Coordinated by the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Germany.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/678503
- Project website: ceramfacturing.eu
- bit.ly/2DYB86Z

INDUSTRIAL TECHNOLOGIES

Tough marine-sourced enzymes ready to shake up industry

A new library of ocean-sourced enzymes tough enough to perform under the harshest of industrial conditions could provide an invaluable cost-saving shortcut for a range of enzyme-dependent sectors.

"The EU-funded INMARE project has been a huge success," says project coordinator Professor Peter Golyshin from Bangor University in the UK. "We've created a massive range of resources that will help to significantly shorten and streamline the industrial enzyme discovery pipeline."

This was achieved by identifying enzymes already adapted to tough industrial processes due to the harsh marine environment from which they were extracted. Enzymes are used extensively in industry and are a crucial ingredient for sectors such as brewing, detergents and paper manufacturing where biological catalysts are needed.

Marine microorganisms – such as bacteria, fungi, sponges and algae – have long been recognised as an untapped source of enzymes, but only a tiny fraction of marine enzymes have achieved commercialisation. Prof. Golyshin is confident that the identification of these enzymes will significantly shorten – and even get rid of in some cases – the tedious, expensive and often unsuccessful process of having to test and optimise enzymes in the lab.

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CATALYST FOR BUSINESS

After four years of extensive ocean research and screening back in the lab, a total of 974 useful enzymes were cloned. "Of these, 311 were fully characterised in terms of understanding their ability to convert compounds of industrial relevance," says Prof. Golyshin. "Based on this enzyme collection, 15 ready-to-use biocatalysts for small-scale process operations were developed and tested." The project, completed at the end of March 2019, has resulted in four patent applications and one start-up company dedicated to delivering naturally optimised enzymes.

The INMARE (Industrial Applications of Marine Enzymes: Innovative screening and expression platforms to discover and use the functional protein diversity from the sea) project consisted of more than 20 partners from academia and industry from 12 countries, including leading multinational industrial partners. "Our industrial project partners are market leaders in enzyme production and in synthesis of fine chemicals," says Prof. Golyshin. "Their objective is to efficiently deliver safer pharmaceuticals, cheaper agricultural products and better bio-based products."

These companies have had priority in accessing the data collected by the project's academic partners, to identify whether they think there is further commercial potential. Following completion of the project, the consortium will make available the list of materials – enzymes, libraries, etc. – that can be further exploited by third parties.

SUSTAINABLY SOURCED SOLUTIONS

The INMARE project was launched in April 2015 with the ambitious aim of unlocking the secrets of the seas. "The ocean is the largest environment on our planet, covering

> *"The project will help to significantly shorten and streamline the industrial enzyme discovery pipeline."*

71 % of the earth's surface," notes Prof. Golyshin. "It is host to a myriad of highly diverse microorganisms. Our anticipation is that such enormous biodiversity must contain a multitude of yet unexplored enzymes and metabolites that could provide new solutions for the bioeconomy."

The project team applied new screening techniques to identify potentially promising enzymes from marine microorganisms. The previous EU-funded MAMBA project (2009-2013), which was also coordinated by Prof. Golyshin, developed new methods for screening marine microbial genomic resources for useful enzyme activity. "The outputs of INMARE have however been far more impressive," he says.

Of special interest to the INMARE team were microbes capable of surviving in tough conditions such as extreme salinity, temperature or elevated pressure. "We knew that these microbes could produce enzymes that could perform in industrial settings under harsh physical and chemical conditions, without the need for optimisation," explains Prof. Golyshin. "Optimising enzymes, making them stable and more efficient, can be a time-consuming and expensive process and is a recognised bottleneck in developing industrial applications."

The INMARE project is also very much in line with Europe's transition towards a more sustainable 'greener' economy that exploits renewable resources with minimal energy expenditure. Marine-sourced enzymes are a viable and attractive alternative to chemical catalysis linked with massive use of solvents and energy-costly reaction conditions. "Untapped microbiological resources from the sea could provide industry with an almost limitless source of safer, cheaper and greener products – so long as this resource is sensitively managed," notes Prof. Golyshin.

INMARE

- Coordinated by Bangor University in the United Kingdom.
- Funded under H2020-FOOD and H2020-ENVIRONMENT.
- cordis.europa.eu/project/id/634486
- Project website: inmare-h2020.eu

DIGITAL ECONOMY

Cutting-edge toolset creates immersive multiscreen video experiences

Broadcast content is consumed through traditional TV sets and second screens like smartphones and tablets. The industry has had limited success trying to get these platforms to complement each other.

Most European TV consumers watch programmes in a multi-display environment. Their attention is generally divided between these very different information streams. To date, broadcasters haven't been able to seamlessly integrate formats such as web-based texts, mobile apps and conventional broadcast TV.

The market arrival of immersive head-mounted displays introduces new possibilities, but also challenges. Immersive displays must fulfil radically different audience requirements compared to traditional broadcast TV and social media. In addition, they test the conventions of traditional audiovisual language.

The EU-funded ImmersiaTV (Immersive Experiences around TV, an integrated toolset for the production and distribution of immersive and interactive content across devices) project delivered a novel form of broadcast content that matches the demands of immersive displays and can be shared with tablet and traditional TV consumers. "We explored new forms of digital storytelling and broadcast production by putting omnidirectional video at the centre of content creation production and distribution," says project coordinator Sergi Fernandez. Omnidirectional video allows users to explore and navigate audiovisual scenes by freely choosing viewpoint and viewing direction. "ImmersiaTV delivers a fully inclusive experience that integrates the specificities of immersive displays within the contemporary living room."

PIONEERING TOOLSET COVERS ENTIRE AUDIOVISUAL VALUE CHAIN

Project partners designed an end-to-end toolset to create multiscreen immersive experiences that address the different phases of content creation: ideation, production, distribution and consumption. It enables content creators and distributors to generate multiscreen audiovisual experiences based on directive and omnidirectional video.

The toolset is comprised of several tools and components. A production set of capture devices and edition tools allow professional users to produce experiences that integrate omnidirectional video streams within a carefully constructed narrative structure. This is done across target devices for both offline and live productions. "ImmersiaTV facilitates enormously the task of creating multiscreen video experiences for live and offline contexts in all the different stages of content production and distribution," adds Fernandez.

A set of distribution and reception components includes two players that are able to reproduce directive and omnidirectional streams. Both players have the internal intelligence to understand the scene description format designed in ImmersiaTV. Another component is the audio sync module, a tool for supporting synchronisation among devices that can't be achieved by a network. Lastly, the session manager is a stand-alone application that maintains consistency between the reproduction times of different devices in a given session.

"We have proposed a solution that offers end users a coherent audiovisual experience across head-mounted displays, second screens and the traditional TV set, instead of having their attention divided across them," explains Fernandez. This new experience seamlessly integrates with and further augments traditional TV and second screen consumer habits. "The audience will still be able to watch TV sitting on their couch or tweet comments about it. However, the audience will also be able to use immersive displays to feel like they are inside the audiovisual stream."

> *"ImmersiaTV offers an excellent opportunity for broadcasters and content creators to attract younger audiences and offer enhanced services that don't distract from but complement the main content still served on a framed screen known as TV."*

"In the coming years, we expect hybrid TV applications to flourish," concludes Fernandez. "ImmersiaTV offers an excellent opportunity for broadcasters and content creators to attract younger audiences and offer enhanced services that don't distract from but complement the main content still served on a framed screen known as TV."

IMMERSIATV

- Coordinated by the i2CAT Foundation, Research and Innovation Center in Advanced Internet in Spain.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/id/688619
- Project website: immersiatv.eu

DIGITAL ECONOMY

Meeting societal challenges through cutting-edge computing

To encourage the wider use of computer modelling, simulation and optimisation (MSO) methods, the EU-funded MSO4SC project created a user-friendly e-infrastructure.

Complex challenges require complex solutions. One solution is the application of MSO methods, which has proven effective at solving such problems as predicting air pollution and climate change, improving the filtration process for drinking water, and optimising methods for intensity-modulated radiation therapy.

These highly-complex methods are typically processed using the most cutting-edge ICT tools, including high performance computing (HPC) and big data. Although useful, due to their complexity, MSO methods require the support of skilled experts – experts who are in very short supply.

To help fill this gap, the EU-funded MSO4SC (Mathematical Modelling, Simulation and Optimization for Societal Challenges with Scientific Computing) project created an e-infrastructure to optimise the use of MSO methods. "Basically, we wanted to use complex pieces of software called mathematical frameworks, in combination with HPC and cloud technology, to optimise the resources being used," says project coordinator Francisco Javier Nieto de Santos. "At the same time, we provided interfaces for using these maths frameworks that don't require the user to have a deep knowledge of the technologies."

SIMPLIFYING SIMULATIONS

To ensure that the end frameworks matched real user needs, project researchers started by conferring with relevant stakeholders – namely mathematicians and pilot application users. Within the context of EU-MATHS-IN, an important European network of applied mathematicians, researchers organised workshops and a mini-symposium to let these stakeholders test and comment on the frameworks being developed.

Within just 24 months, this process led to the improvement of three mathematical frameworks (FEniCS, Feel++ and OPM) and six applications addressing different domains (air quality prediction, design of wind turbines for clean energy, design of high field magnets, detection/treatment of neurodegenerative diseases, etc.). Each of these frameworks and applications was adapted to fit the specific needs of the project.

"We set out to do a lot of things and the pressure was very high, but we managed to focus and deliver a good e-infrastructure that can be used by people with different interests and levels of knowledge," explains Nieto de Santos. "We now have a solution that works quite well and that can be used to show good demonstrations."

All frameworks and applications can be deployed using containers and are available to be executed through the

> *"We set out to do a lot of things and the pressure was very high, but we managed to focus and deliver a good e-infrastructure that can be used by people with different interests and levels of knowledge."*

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MSO4SC Portal. According to Nieto de Santos, this portal integrated with a resource manager is the project's most important outcome. "The portal simplifies the execution of the simulations, meaning the end user just needs to take care of configuring the simulation inputs and let the orchestrator deal with the usage of resources," he says.

PIONEERS

The project's main legacy is an operational e-infrastructure for mathematicians and people who want to run applications based on mathematical simulation. However, the MSO4SC project is also notable for being one of the first to use a combination of HPC and typical cloud resources to run containerised maths-based software. "We're pioneers in the use of containers on top of HPC," adds Nieto de Santos. "I think this is an important model of how we can achieve a fully integrated European Open Science Cloud where scientists can use any type of resource transparently."

With the project now closed, researchers are working to attract more users to the portal by improving current applications, adding new features, and marketing its benefits.

MSO4SC

- Coordinated by Atos Spain SA in Spain.
- Funded under H2020-INFRA.
- cordis.europa.eu/project/id/731063
- bit.ly/2TqmP3R

DIGITAL ECONOMY

Cybersecurity system scans Internet of Things devices

An EU team designed an automated Internet of Things (IoT) security checking system. This will mean superior vulnerability detection, while allowing software developers more time to fix problems.

The IoT refers to ordinary objects – other than computers, phones and tablets – having an internet connection. Among countless others, these typically include home appliances, medical devices and utilities meters.

Although the connections are convenient, they are built using so many communications technologies, for so many purposes, that security levels vary greatly. Many connections are highly insecure and vulnerable to hacking. Such cyberattacks have already brought about severe consequences.

The EU-funded SecIoT (Cybersecurity Threat Detection for Internet of Things Connected Devices) project helped close the security gap. Experts in IoT security are relatively scarce, while demand for IoT security consultations is growing. Hence, the project team developed a plan for an automated cybersecurity expert system, intended for companies manufacturing IoT devices. The system will ultimately allow manufacturers to test their products for vulnerability and make necessary improvements.

AUTOMATED SECURITY TESTING

"Our first goal was to understand the complexity of existing IoT solutions," explains project leader Olga Pavlovsky. "Despite the fact that most IoT devices are relatively cheap, they are complex beasts constructed over several hardware and software layers." To map the complexity, researchers performed security tests on many devices. This yielded a universal methodology for vulnerability

> *"Experts will be able to devote more time to fixing vulnerabilities. This will reduce the number of issues present in devices and software that reach end users."*

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testing that was also a step towards automated vulnerability scanning.

Vulnerability scanning is where special software (security scanners) assesses the defences of a target device. This process is time-consuming but also routine, and therefore suitable for automation. SecIoT's automation allows simultaneous use of several security scanners.

EASY INTERFACE

A friendly system interface will allow both expert security and non-expert software developers to conduct vulnerability scanning. The software will suggest certain kinds of scan, which the user may accept or override. Scanning examines networks, systems, other hardware and software code that are often a primary source of vulnerability. The proposed interface will provide ease of use, while the multiple embedded security scanners will detect code vulnerabilities that a human would be unlikely to find.

The project's system will present the scanning results as an easily read report that suggests ways of fixing any security problems found. The system's simplicity will also enable developers to run vulnerability scans as often as necessary during development, instead of once at the end as usual. Security problems found early in the process are easier to resolve.

"All this means that experts will be able to devote more time to fixing vulnerabilities," says Pavlovsky. "This will reduce the number of issues present in devices and software that reach end users."

Next, the team hopes to improve the design. In particular, the system currently automates vulnerability scanning on security layers 4 to 7; layers 1 to 3 were checked manually. The team plans to automate testing across more layers. This, and other planned upgrades, will allow the software to address even more IoT security situations and detect more vulnerabilities.

Worldwide, the IoT market is expected to reach nearly USD 10 billion by 2025. Since the project is still defining the best application for the system, researchers are reluctant to make market forecasts. Nevertheless, even a small share of that market would be very lucrative for European SMEs.

SECIOT

- Coordinated by Secure Secure Ltd in the United Kingdom.
- Funded under H2020-SME.
- cordis.europa.eu/project/id/739685
- Project website: se.cr/iot

PROJECT OF THE MONTH

Innovative Spanish SME launches its highly efficient and environmentally-friendly SmartPodX

*This month we're highlighting the success of Spanish SME Submer that, with the help of Horizon 2020 SME Instrument funding, completed its R&D phase in March 2018 and after just a few months had already launched the fourth iteration of its Immersion Cooling solution, the **SmartPodX**. The SmartPodX was presented at the 2019 edition of the prestigious Open Compute Project Summit that recently took place in San José, California.*

The SmartPodX platform is the world's first liquid Immersion Cooling system that conforms to the standard 19-inch server format and also to the OCP specification for high-performance, supercomputing and hyperscale infrastructure. Submer's new Immersion Cooling solution was welcomed as a 'game-changer' by data centre experts. From a technical point-of-view, Submer's solution has made it possible to achieve previously unrivalled IT hardware densities and easily dissipate >100 kW per rack footprint. In terms of practicality, this translates into unprecedented computational capacity for data centres, HPC, hyperscalers, research centres, etc.

On top of all this, SmartPodX is environmentally-friendly, saving 50 % in electricity output when compared to competitors, and uses a proprietary dielectric fluid (SmartCoolant) that is completely biodegradable and non-toxic.

SUBMER

- Coordinated by Submer Technologies in Spain.
- Funded under H2020-SME, H2020-LEIT-ICT and H2020-ENERGY.
- cordis.europa.eu/project/id/806817
- Project website: submer.com

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"SmartPodX represents our new line of Immersion Cooling SmartPods designed to power the next generation of high-performance servers and supercomputers built to the latest OCP specifications. Our hyper-efficient SmartPodX will allow the creation of the world's first GREEN supercomputers and usher in a new wave of research and technical innovation."

Daniel Pope, CEO of Submer

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!

SPACE

Advanced solution for satellite missions

Estonian start-up company Spaceit has unveiled next-generation service for control and monitoring of satellites. The company offers an alternative approach to satellite ground communications, enabling customers to use their resources more efficiently via a modern and secure software solution.

Software is the key to developing the full potential of Space via satellites providing efficient and effective services. The value of software to space systems has greatly increased over recent decades, reflecting the growing functionality and autonomy of spacecraft and the vast amount of mission data to be collected and processed.

Under the EU-funded research and innovation programme, the SPACEIT-MCS (Development of cloud based Mission Control System for satellite missions) initiative, the SME Spaceit offers customers a complete turnkey solution. In other words, they provide all the hardware and software necessary to operate, maintain, process and archive data from satellites. They are focused on providing flawless and automated solutions to satellite missions and system integrators, as well as value-creating activities to ground communication equipment owners.

MISSION CONTROL AS A SERVICE

Recently, there has been a bold shift from dedicated data centres to cloud platforms. Following the example of other small or large companies, space companies are moving towards cloud computing due to its pronounced advantages. By utilising virtual machine technology, cloud providers can host ground system software with a significantly smaller footprint.

"Spaceit offers mission control as a service, a one-stop solution for satellite ground communications," notes Silver Lodi, co-founder of Spaceit in Estonia. Taking a low-cost, scalable approach to space, the company provides a complex solution which includes public cloud and Software-as-a-Service (SaaS) innovations like pay-as-you-go pricing and hybrid infrastructure for space operations. In addition to the flexible software and service upgrades, the customers receive pre-integrated access to a worldwide network of ground stations, professional satellite control and consultation service.

"The cloud-based mission control system is an integral part of our service. Imagine looking at your satellite telemetry from a mobile device from anywhere and at any time without worrying about software development, data backups or operational risks," notes Lodi. Some features of this new mission control system include satellite command delivery, access to telemetry by remote users, efficient data exchange between systems, payload data delivery, and accurate prediction of the satellite orbit.

OVERCOMING CHALLENGES

Spaceit is simplifying communication services for satellite operators by providing a sophisticated cloud communications platform that enables customers to customise, simplify and scale communications. Although the service can be used on all satellites, regardless of their size, the company targets small satellites that weigh less than 500 kg to enter the market.

"Currently, small satellite missions are spending up to 50 % of the mission budget on the development, upkeep and operations of mission control systems. Due to the lack of viable alternatives on the market, mission control systems are often built in-house from scratch," notes Lodi. However, these solutions often have limited scalability, a few essential features and limited security. Furthermore, they are typically limited to using a small number of ground stations – mostly one – narrowing down radio coverage.

Spaceit's platform allows users to operate multiple satellite missions simultaneously using a worldwide network of ground stations. By eliminating software development, investments into hardware and extra resources for mission control system maintenance, the operational costs

> *"Using Spaceit's service, satellite missions will receive wider radio coverage and higher reliability at a lower cost."*

are decreased by 50 %, which translates into a 30 % decrease in the overall budget of the mission.

"Using Spaceit's service, satellite missions will receive wider radio coverage and higher reliability at a lower cost. At the same time, ground stations will have an open marketplace with access to a customer base to monetise their operations," notes Lodi. With its innovative cloud platform, Spaceit aspires to become the leading provider of mission management systems for small- and medium-sized satellites in the world over the next five years.

SPACEIT-MCS

- Coordinated by Spaceit in Estonia.
- Funded under H2020-LEIT-SPACE and H2020-SME.
- cordis.europa.eu/project/id/791721
- Project website: spaceit.eu

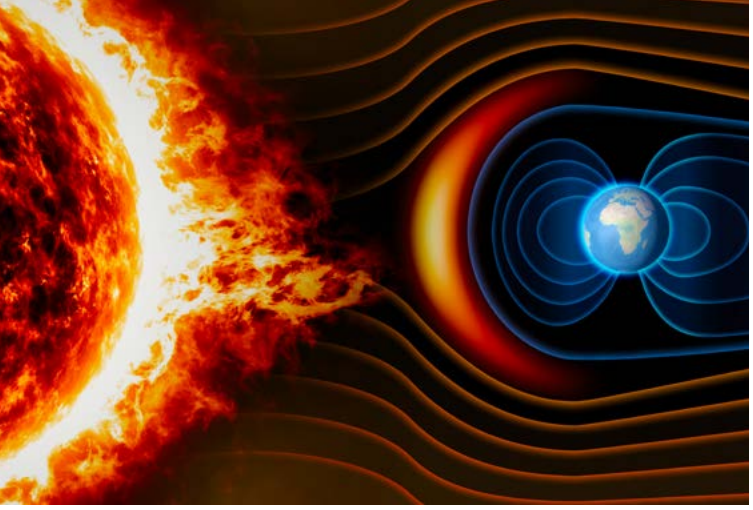
SPACE

Improved space weather forecasting protects vital infrastructure

Europe's economy depends upon space- and ground-based communication systems, which can be adversely affected by space weather. Forecasting these events is critical to effectively mitigate their negative effects.

The EU-funded Horizon 2020 PROGRESS (Prediction of Geospace Radiation Environment and solar wind parameters) project used both spacecraft and ground-based data combined with state-of-the-art data assimilation methodologies to develop accurate and reliable forecasts of space weather. The goal is accurate prediction of space weather events in terms of occurrence and severity.

Researchers successfully developed a set of European forecasting and nowcasting tools for space weather. These tools link all aspects of space weather from their



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origins on the solar surface to how they may affect the terrestrial environment and our modern technological infrastructure. "We have exploited our combined expertise to create a comprehensive set of forecasting tools, combining data-based modelling techniques with improvements to state-of-the-art physics-based models," says project coordinator Prof. Robertus von Fay-Siebenbürgen.

NEW MODELS

PROGRESS partners created a European numerical magnetohydrodynamics (MHD)-based model by coupling two individual models to enable an advanced forecast of solar wind parameters. "The first, AWSoM, analyses the magnetic field at the solar surface, using it to simulate the solar atmosphere out to 25 solar radii. From this point outwards, the second model SWIFT propagates these solar winds out to 1.5 million kilometres upstream of the Earth," explains Prof. von Fay-Siebenbürgen.

The dynamics of particles in the radiation belts depends upon their interaction with plasma waves. PROGRESS scientists constructed a new set of statistical wave models to accurately reflect the acceleration and losses of particles within the terrestrial radiation belt region.

Space weather hazards strongly affect the level of geomagnetic activity. PROGRESS has developed new models to forecast this activity using different approaches based on neural networks and NARMAX.

PROGRESS also developed a set of models (SNB3GEO) to forecast the electron fluxes encountered by satellites at geostationary orbit. These models were shown to perform better than the tools currently available.

To investigate the electron environment of the inner magnetosphere, PROGRESS uses two models. The Inner Magnetospheric Particle Transport and Acceleration Model (IMPTAM) deals with low energy electrons, while the Versatile Electron Radiation Belt (VERB) model is for high energy electrons.

> *"We built a comprehensive set of forecasting tools by combining the most accurate data-based forecast of electron fluxes at geostationary Earth orbit with the most comprehensive physics-based model of the radiation belts currently available."*

Project researchers have made significant improvements in the way IMPTAM describes electron dynamics in the inner magnetosphere. Furthermore, the nowcast model has been modified to provide forecasts of the evolution of the low energy electron environment.

Furthermore, PROGRESS has enabled the development of a new improved version of VERB VERB-3D which now provides a two-day ahead data assimilative forecast for the high energy electron environment. In addition, PROGRESS performed separate studies to couple VERB with IMPTAM and SNB3GEO to further improve VERB forecasts.

BENEFITS FOR BOTH SCIENCE AND INDUSTRY

PROGRESS will benefit scientists working in the field of space weather and space physics in general. Prof. von Fay-Siebenbürgen comments: "The new models developed by the consortium are based on our improved understanding of the dynamics of the radiation belts. The results are important for the scientific community as they give novel insight into physical processes of plasmas in the near-Earth environment."

Industry will also profit as space weather can severely disrupt activities like satellite operations, communications and aviation. This will also be beneficial for power companies who will receive prior warnings about geomagnetic storms that could damage their power grids. "All of these sectors can benefit from timely warnings of potential space weather hazards and so take steps to mitigate their effects on our technological infrastructure," Prof. von Fay-Siebenbürgen concludes.

PROGRESS

- Coordinated by the University of Sheffield in the United Kingdom.
- Funded under H2020-LEIT-SPACE.
- cordis.europa.eu/project/id/637302
- Project website: ssg.group.shef.ac.uk/progress/html/

FUNDAMENTAL RESEARCH

Understanding the powers and limitations of algorithms to solve logic formulas

In the age of ubiquitous computing, being able to identify what problems can efficiently be solved by computers is crucial. Towards this end, the UtHoTP project studied algorithms for solving logic formulas, opening up solutions to a wide range of computational problems.

The focus of the UtHoTP (Understanding the Hardness of Theorem Proving) project was to design and study efficient algorithms, where the quality of an algorithm is measured by how the running time scales as the input data size increases. As project coordinator Prof. Jakob Nordstrom puts it, "If an algorithm was a runner's performance during a race, ideally it shouldn't matter how long the race is – 100 metres or a marathon – a good algorithm runs fast for all distances."

A particularly interesting algorithmic challenge is so-called NP-complete problems. This class of problems includes some very challenging combinatorial optimisation problems which can nonetheless often be solved surprisingly well in practice. Researchers do not yet understand when and why the algorithms for these problems work as well as they often do.

The project studied the best algorithms known today and their methods of reasoning. By proving mathematical theorems, delineating their power and limitations, the team has provided a better understanding of how these algorithms work.

THE IMPORTANCE OF NP-COMPLETE PROBLEMS

Research in computational complexity theory has focused on problems at the limit of what is possible to solve. Many of these problems have an intriguing characteristic: while they are very challenging to solve, once a solution is proposed, it is easy to verify. Many tasks in science and engineering share this property, and this is why research in computational complexity theory has focused on problems with this property and attempted to understand their difficulty.

It turns out, rather surprisingly, that in order to solve any computational problem with this property, referred to as an NP-complete problem, it is enough to have efficient algorithms for solving logic formulas. This is why research in computational complexity theory has focused on this problem, known as the Boolean satisfiability problem, or SAT for short – doing so enables researchers to better understand the workings of efficient algorithms.

The UtHoTP project studied algorithms for solving the SAT problem – so-called SAT solvers – focusing, in particular, on more advanced mathematical methods of reasoning that are exponentially stronger than the methods commonly in use today. By designing and studying new algorithms, and proving mathematical theorems about them, the project shed light on their potential.

The team has also experimentally evaluated the new algorithms that they have developed, but so far only in 'idealised, lab-like conditions'. They constructed benchmark formulas, designed to highlight the strengths and weaknesses of different methods for solving the SAT problem.

This work has yielded some quite promising results, and Prof. Nordstrom says, "If these new methods could be made to work as well on formulas arising in real-life problems, then this could have a huge impact on many areas in industry that use SAT solvers, such as computer hardware and software design."

BUILDING BRIDGES BETWEEN THEORY AND PRACTICE

When theoreticians and practitioners from different areas of research study the same problems, their different perspectives can often present almost insurmountable challenges for communication – researchers from different communities do not even share a common technical language.

As Prof. Nordstrom explains, "This has been one of the barriers to designing and understanding really strong algorithms for the SAT problem. Although SAT has been intensely studied since the 1960s, there has been very little interaction between theory and practice. This is now starting to change, and I believe an important part of this is a series of international workshops that I have organised since 2014, with the help of this ERC grant."

The team is now looking to apply this approach to the practical performance of algorithms in neighbouring areas such as constraint programming and mixed integer linear programming.

UTHOTP

- Hosted by the KTH Royal Institute of Technology in Sweden.
- Funded under FP7-IDEAS-ERC.
- cordis.europa.eu/project/id/279611

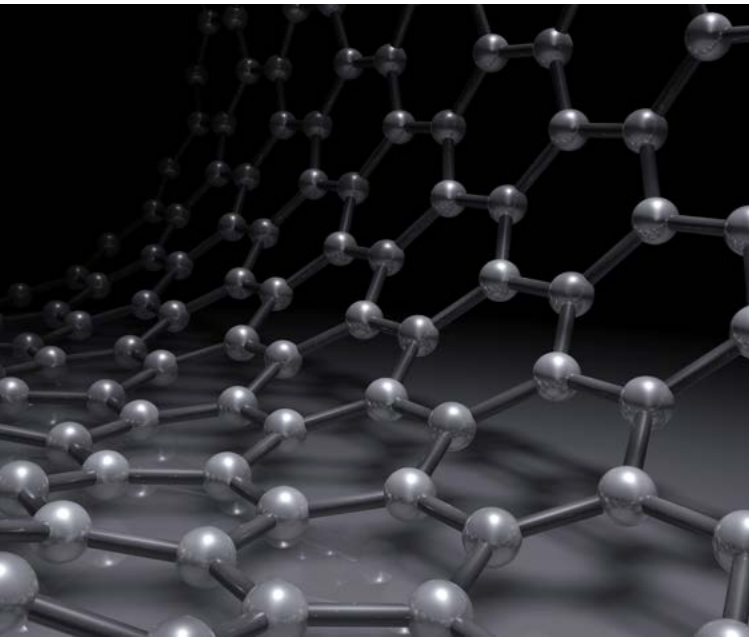
FUNDAMENTAL RESEARCH

Single-molecule circuits lead way for miniaturising electronics

As the components in our electronic devices drastically decrease in size (from 800 nanometres in 1993 to just 7 nm in 2015), the field of single-molecule electronics has become the focus of numerous experimental research initiatives – including the EU-funded MOLCLICK project.

Historically, the field of single-molecule electronics has been motivated by the possibility of extrapolating the consistent decreases to components with sizes in the order of atoms and molecules, with molecules being considered the smallest conceivable functional unit.

"Single molecules have been shown to behave like electronic components such as wires, resistors and switches," explains MOLCLICK (Molecular 'Click-tronics': Surface-based synthesis of single-molecule electronic components) project coordinator Dr Philippe Hapiot.



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"However, we are still a long way from understanding how to wire-up vast arrays of single molecules into addressable circuits in a way that would capitalise on the size advantages of using a molecular-based system in the first place."

In an attempt to bridge this gap, researchers with the EU-funded MOLCLICK project investigated whether synthetic chemistry could be used to build complex circuits on surfaces. "Our aim was to develop different methods to build molecular circuits on surfaces, to find ways to evaluate the success of our methods, and then explore how to increase our capabilities in this field," adds project researcher Dr Michael Inkpen.

A SUCCESSFUL DEMONSTRATION

MOLCLICK successfully demonstrated that synthetic chemistry can be used to wire-up single-molecule circuits. Specifically, the project developed an innovative method to reversibly form and break bonds between individual fragments that behaved like resistive circuit elements.

This was then evaluated using a scanning tunnelling microscope-based break junction (STM-BJ) method that measures the conductance of the molecules on the surface both before and after synthetic modification. STM-BJ is a technique used to wire-up individual molecules into an electronic circuit for testing, a method developed by Columbia University's Dr Latha Venkataraman, a world-leading expert in the field and one of the project's partners.

> *"Alternative technologies and materials, such as the use of circuits built from single molecules, as demonstrated in this project, are the key to the continued miniaturisation of electronic circuits in the years and decades to come."*

"With clear conductance differences being observable before and after modification, we could confirm that we were indeed building the simple molecular circuits that the project had initially designed," says Dr Inkpen. "Most importantly, we showed that our approach can be generalised by demonstrating the success of other synthetic methods and, in the process, also demonstrated the role of STM-BJ as a remarkably sensitive surface analysis tool."

THE KEY TO CONTINUED MINIATURISATION

Since the invention of the transistor in 1946, the miniaturisation of integrated electronic circuitry has always been about decreasing costs and size, while simultaneously increasing power and capability. However, due to the limitations of current technology, the path towards further miniaturisation has plateaued.

"Alternative technologies and materials, such as the use of circuits built from single molecules as demonstrated in this project, are the key to the continued miniaturisation of electronic circuits in the years and decades to come," adds Dr Hapiot.

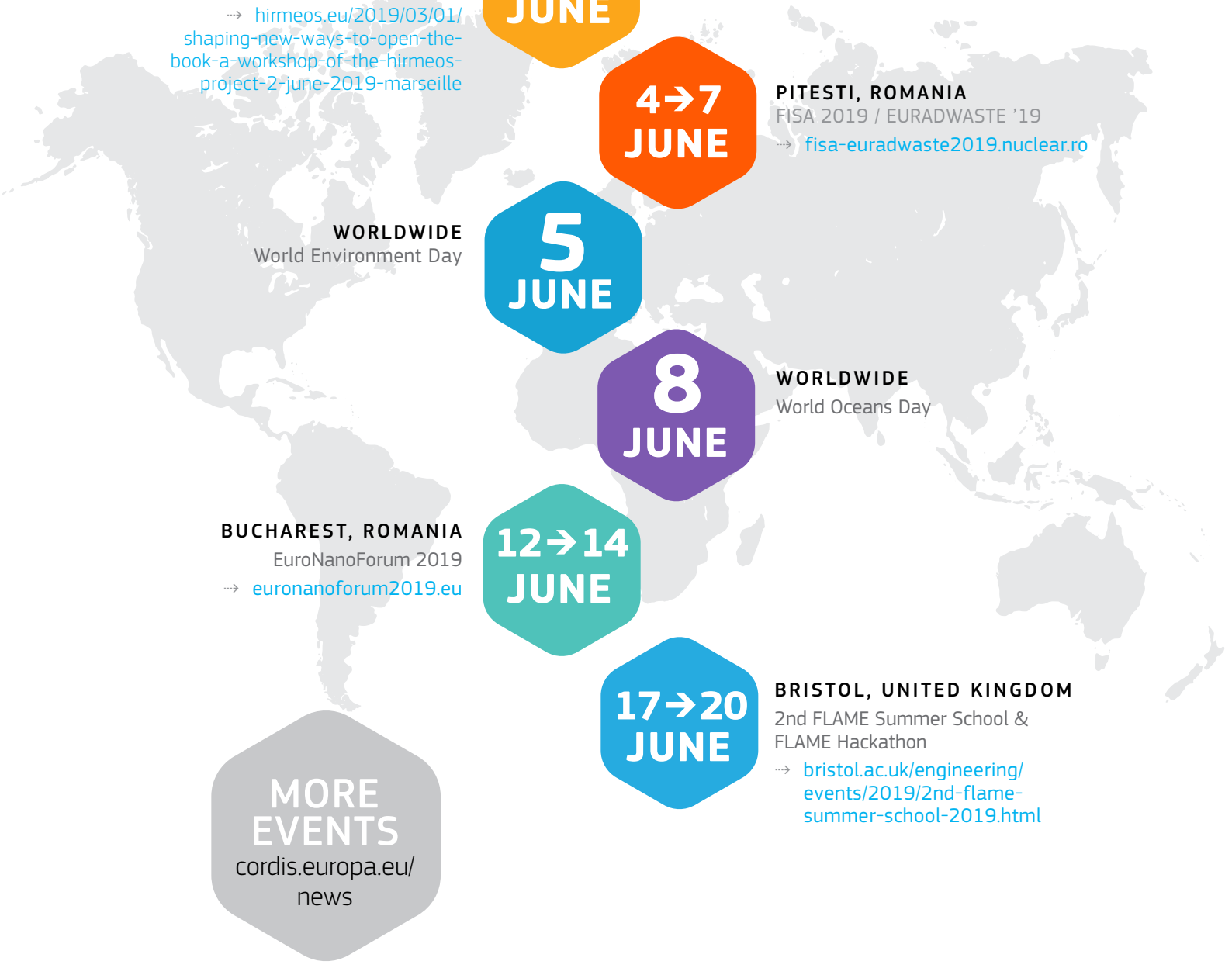
Although the MOLCLICK project is officially closed, work goes on. For example, Dr Inkpen will continue his work in single-molecule electronics and surface chemistry in his new role as Assistant Professor of Chemistry at the University of Southern California. "The lessons learned and experience gained during this project will prove invaluable to my independent research career," he says.

MOLCLICK

- Coordinated by the University of Rennes in France.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/657247

AGENDA

JUNE 2019



2 JUNE

MARSEILLE, FRANCE
HIRMEOS workshop at ELPUB annual conference
→ hirmeos.eu/2019/03/01/shaping-new-ways-to-open-the-book-a-workshop-of-the-hirmeos-project-2-june-2019-marseille

4→7 JUNE

PITESTI, ROMANIA
FISA 2019 / EURADWASTE '19
→ fisa-euradwaste2019.nuclear.ro

5 JUNE

WORLDWIDE
World Environment Day

8 JUNE

WORLDWIDE
World Oceans Day

12→14 JUNE

BUCHAREST, ROMANIA
EuroNanoForum 2019
→ euronanoforum2019.eu

17→20 JUNE

BRISTOL, UNITED KINGDOM
2nd FLAME Summer School & FLAME Hackathon
→ bristol.ac.uk/engineering/events/2019/2nd-flame-summer-school-2019.html

MORE EVENTS
cordis.europa.eu/news

18–20 JUNE

BRUSSELS, BELGIUM
EU Sustainable Energy Week (Policy Conference)

This is the major policy conference of EU Sustainable Energy Week (taking place 17-21 June) and is the biggest European conference dedicated to renewables and efficient energy use in Europe. Next to the conference, the Networking Village brings the EUSEW Community together and the EUSEW Awards celebrate outstanding projects and ideas.

→ eusew.eu/about-conference

CORDIS RESULTS PACK ON OCEAN PLASTICS

Plastic waste in our oceans has been receiving a huge amount of attention in recent years and with good reason. Not only is it devastating to the environment, it also costs millions of euros annually in clean-up efforts. One of our latest Results Packs dives deep into this highly pressing topic and explores how EU-funded research is helping to find solutions to the world's plastic epidemic.

Check out the Pack at:
cordis.europa.eu/article/id/401309

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