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SPECIAL FEATURE

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EDITORIAL

by the editorial team

HOW THE RAIL SECTOR WANTS TO BE FUTURE-PROOF, AND HOW IT MIGHT JUST DO IT

It was exactly 10 years ago that the economic crisis hit the European rail freight sector head-on. Volumes dropped heavily, and some of the sector's main weaknesses were brought to light. On the legislative front, EU Member States had just started deploying the European Rail Traffic Management System (ERTMS) – a safety system that enforces train compliance with speed restrictions and signalling statuses.

It was also around the same time that the Shift2Rail Joint Undertaking was initiated, with the objective of developing cutting-edge innovative solutions to create the 'railway systems of the future': automation, smart trains, low cost, sustainability, reliability, speed and optimum energy use were amongst the project's main targets.

In fact, seeing how defining 2008 was for the rail sector makes this year worthy of a birthday celebration of sorts. How much have Europe's trains changed over the past 10 years? Have yesterday's initiatives lived up to the hype? What do we still need to accomplish to strengthen the position of railways as a viable alternative to other transport modes, as the European Commission has wanted it to be for over 25 years?

The latest EU report on the development of the rail market dates back to December 2016. In this report, the Commission emphasised how EU legislation on rail had led to a 'more efficient and customer-responsive industry'. Safety had improved considerably, the network had grown, and passenger revenue had increased substantially.

'A real mental shift is taking place and could help the sector step up its game over the next few years.'

For more up-to-date information, a look at the work of the latest EU-funded projects supported under Shift2Rail is enlightening. From smart solutions for safer rail transport to next-generation computing and communication systems, novel technologies hint at what future railway could look like. At the same time, joint stakeholder reflection under projects like Smart-Rail show that a real mental shift is taking place and could help the sector step up its game over the next few years. It's definitely worth the trouble: if Shift2Rail's ambitions are any indication, an additional EUR 49 billion of EU GDP, 140 000 additional jobs and EUR 20 billion of additional exports could reward the sector's efforts by 2030.

Our special feature is followed by the usual thematic sections on health, society, transport, environment, agriculture & forestry, industry, ICT, space and fundamental research. The magazine closes with a list of upcoming events hosted by or involving EU-funded research projects.

We look forward to receiving your feedback. You can send questions or suggestions to:
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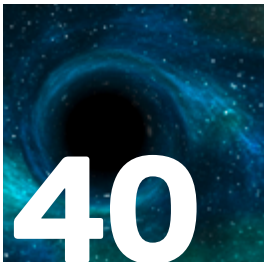

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SPECIAL FEATURE

LAYING THE TRACKS FOR A TRULY 21ST CENTURY EUROPEAN RAILWAY

SMART SOLUTIONS FOR SAFER RAIL NETWORKS

A sensory washer deployed at critical rail fastenings sends infrastructure management real-time information on the condition of the track. This simple concept could significantly reduce the risk of derailment, improve operational safety and efficiencies and empower maintenance workers.

© Mikbiz, Shutterstock

Various measurements taken at critical fastenings are fed in real-time to a cloud-based server, where maintenance professionals can remotely monitor the condition and stability of the rail network. "Remote monitoring increases passenger safety and reduces the need to send maintenance workers into dangerous situations," says GRAILS-SWE (Greater RAIL Safety using the Smart Washer Ecosystem) project manager John Evans from Smart Component Technologies in the UK. "Less signal point failure also means fewer delays."

The GRAILS-SWE project, funded through the EU's SME Instrument, enabled Smart Component Technologies to assess the potential of expanding into Europe. "We are at the point where we are ready to carry out live deployments across the UK and are looking to scale up," explains Evans. "The SME Instrument enabled us to carry out market analyses of four large European markets that we believe have similar potential – Germany, France, Spain and Sweden. The results have been largely positive, because not a lot of people are doing what we are doing."

Installing sensory washers at critical infrastructure points also has potential across other sectors. "The oil and gas industry for example could use real-time monitoring to ensure that flange bolting on critical and hard to access oil & gas process equipment remains secure and correctly tightened," says Evans. "When failures occur people can die, and offshore maintenance can cost massive sums of money in addition to loss of output."

Real-time tracking

The sensory washer concept addresses a critical industry need. After two train derailments in the UK led to loss of life, investigations discovered that many mechanical installations at crossing points designed to stop this from happening were either loose, damaged / broken or missing. Proper installation and maintenance of points that enable trains to be guided from one track to another was not being carried out in a systematic manner.

Smart Component Technologies developed the sensory washer to address behavioural as well technological weakness evident in rail network maintenance. "We felt that if people can remotely control the heating of their homes, how hard can it be to know if track bolts are tight enough and if any maintenance needs to be done?" says Evans.

Changing behaviour

This aspect of empowering workers is for Evans just as important as the technological benefits. "We firmly believe in empowering people at the work site and giving them the correct information and correct tools to do their job to the best of their abilities," he says. "We want to motivate the person who has to check the track at 3 a.m. in a howling gale. If in addition to actual torque / tension measurement they have a tablet that flashes a red light if a bolt is not tight enough, and a green light that confirms they have, then they know they have left the track in a compliant state, this fosters accountability and satisfaction."

This checklist concept of ensuring that the basics are done correctly has been successfully trialled in many other industry sectors including hospitals and healthcare. "This is the critical point about smart components that is often ignored," says Evans. "We are all about putting in place the structure where you cannot get to the next step until you've done what you need to do and providing an audit trail of steps completed."

Smart Component Technologies is getting closer to deployment, with SME Instrument funding representing an important stepping stone along this path. "Our next step is to demonstrate the benefits of this technology in the UK, and then we'll be ready to expand into other countries and market sectors," says Evans.

GRAILS-SWE

- ★ Coordinated by Smart Component Technologies in the United Kingdom.
- ★ Funded under H2020-SME.
- ★ http://cordis.europa.eu/project/rcn/207140
- ★ Project website: https://smartcomptech.com/

VIBRATION TECHNOLOGY OFFERS SAFER LEVEL CROSSINGS

A European SME has conducted a thorough market study on the feasibility of installing cutting-edge technology at level crossings, opening up a potentially lucrative market that could save lives.

Through EU SME Instrument funding, the Railscope (Improving Railway Safety Through Innovative Sensor System) project carried out a market analysis of Europe's railways and performed a pilot installation of cutting-edge vibration-based signalling technology along a high-speed track in Germany. This was then followed by a number of field tests.

"These tests were really important for us as an SME because they proved to industry the functionality and reliability of our technology," explains Railscope project coordinator Houssam El Moutaouakil from SENVISYS in Germany. "We are confident that we have a viable solution that could provide much-needed protection at unsecured level crossings."

Safety on the rails

Level crossings – the intersection where a railway line crosses a road or path at the same level – have long been recognised as critical safety points on any railway network. Despite this, many EU countries still operate level crossings without the assistance of modern technologies that could make these junctions significantly safer.

"In Germany for example there are around 8 000 level crossings without any signalisation at all," says El Moutaouakil. "This adds up to about 40 % of all existing level crossings in the country." Germany is far from alone in this respect. Some 33 % of crossings in France are unprotected, while in Finland this figure stands at 80 %.

Every year some 900 people are severely injured at level crossings. While many crossings are located in rural environments without much traffic, the overall cost of unprotected crossings in terms of human lives and material damage could be easily avoidable with some clever investment. A key challenge to date though has been the fact that current detection solutions often require a large amount of cabling to detect oncoming trains, which can be difficult to install and highly expensive.

Good vibrations

SENVISYS' technology aims to address these challenges by providing a secure and economical early detection system based on sensors that detect vibrations.

These sensors can detect trains from a distance of 5 km and then continuously monitored them in terms of speed, direction and position. This information can then be transmitted to level crossing signals that ensure safety for rail, road and foot passengers.

El Moutaouakil is confident that the technology can benefit rail operators in a number of ways. Since less cabling is required – only 1 % is needed compared to current solutions – installation is far easier and indeed safer for maintenance workers to perform. The vibration-based solution also offers benefits such as the detection of obstacles on the track and damage to rails.

"We applied for SME Instrument funding specifically because we wanted to have the opportunity to meet different operators and get a sense of the possibility of running pilot installations of our technology," explains El Moutaouakil. "We've estimated that removing the need for extensive cabling should save rail operators up to EUR 200 000 per installation."

Following the success of these initial tests, SENVISYS has begun the process of acquiring the necessary railway certification for the technology. "For this reason, we have started pilots with various other strategic partners," says El Moutaouakil. "We recently installed our sensors at level crossings and compared the results with a custom reference installation."

Another area of interest is the application of vibration technology for autonomous trains. The roll-out of driverless trains has been hampered to an extent by the lack of sensors to reliably record obstructions or damage to the track. In this sense, SENVISYS could be one of the enabling technologies that help to bring European rail transport fully into the 21st century.

Railscope

- Coordinated by SENVISYS in Germany.
- Funded under H2020-SMEINST.
- https://cordis.europa.eu/project/rcn/211306

INTERVIEW

NEXT-GEN RAILWAY SLEEPERS CAN PRODUCE ELECTRICITY

You may think that they've been around forever and you wouldn't be wrong. Railway sleepers, the rectangular blocks that can be seen under railroad tracks, have not evolved much over the years. An Italian SME is looking to shake things up with a tailor-made, sustainable sleeper technology.

Traditionally, railway sleepers have been made of wood or, later, concrete. But whilst these both proved their worth, they are not without shortcomings. Not only are they a major source of noise and vibrations, but they also require expensive maintenance. Ballast pulverisation, lateral displacement and lifespan are other major problems that Greenrail (Greenrail, innovative and sustainable railway sleepers: the greener solution for railway sector) set out to overcome.

The Greenrail solution, which has been patented in over 55 countries, innovates with an inner core made of prestressed concrete and an outer layer made from a mix of recycled plastic and rubber from End-of-life tyres (ELT). The solution, which integrates various sensors and can produce electricity or collect solar energy, is already attracting customers across the world.

★ Why do you feel like there is a need for new railway sleepers?

Giovanni de Lisi: Since 1900, we have observed a lack of innovation in the railway infrastructure sector. The concrete sleepers have been the standard for 100 years but they present several technical disadvantages, such as high noise and vibration levels deriving from the railway traffic, elevated maintenance costs, high ballast pulverisation and major exposure to atmospheric agents. There is a need for a change, a sustainable innovation, in order to follow the circular economy principles. This is exactly what Greenrail does: we offer a new product with better technical, environmental and economic performance, with the potential to become the future standard solution.

★ How does your technology compare to alternatives in terms of sustainability and cost?

The Greenrail sleeper has a unique composition which allows for reusing plastic and rubber waste, making an enormous contribution to resolving the waste management issue. It also brings technical improvements, such as better electrical insulation, the reduction of vibration, noise and ballast pulverisation, and a longer lifespan. All of these technical advantages allow for reducing the maintenance costs by around 2 to 2.5 times compared to concrete sleepers.

★ What kind of sensors can your sleepers integrate and to what end?

Greenrail sleepers can integrate into their structure elements such as piezo electric modules, solar panels and smart sensors to harvest energy and to communicate diagnostic data. The Greenrail Piezo is able to produce electricity, while Greenrail Solar is able to produce and to harvest solar energy. Furthermore, thanks to the integration of smart sensors, Greenrail LinkBox is able to communicate diagnostic data in order to improve the safety of the infrastructure. All of these smart Greenrail sleepers enable a move from a passive to an active infrastructure.

★ **Can you tell us more about your railway sleeper and how it works?**

Greenrail sleepers consist of an inner core in pre-stressed, reinforced concrete, and an outer shell obtained from a mix of rubber collected from end-of-life tyres and recycled plastics. Such a unique composition allows us to reuse up to 35 tons of these materials for each kilometre of railway line.

★ **Looking back at the initial project objectives, would you say that the project was a success? How so?**

The Greenrail project is on the right track. Since its beginning in October 2016, we have achieved many objectives and milestones initially foreseen in the project. We have produced the first stock of Greenrail basic sleepers and have also constructed a pilot test stretch. Greenrail has obtained Italian certification, and we are involved in R&D activities for smart Greenrail sleepers. Furthermore, the company has finalised its first commercial contract with an American company for a value of EUR 75 million. Last month we also signed an important partnership with INDRA.

★ **What are your next plans with regards to commercialisation?**

After the contact with the USA-based company, requests and inquiries started pouring in from all over the world. Currently, we have open negotiations with numerous entities worldwide, in Europe, the Middle East and Central Asia. Our product is tailor-made, which means it can be designed and produced according to various technical specifications. Hence, our technology is adaptable to every kind of railway, in every part of the world, making our market global.

★ **Do you intend to apply for phase 3 funding? To what end?**

We are evaluating the opportunity presented by SME Instrument phase 3 funding. But right now we are still focusing on the current project and commercial activities.


© Giovanni de Lisi.

GIOVANNI DE LISI

"The company has finalised its first commercial contract with an American company for a value of EUR 75 million."

Greenrail
★ Coordinated by Greenrail in Italy.
★ Funded under H2020-SME.
★ https://cordis.europa.eu/project/rcn/205879
★ Project website: http://www.greenrailgroup.com/en/home/

SAFE4RAIL PUTS CONVERGENCE AT THE HEART OF THE NEXT-GENERATION TCMS

For train manufacturers, the dream of a single, easily upgradable platform to control all train systems is still beyond reach. The integrated platform being developed under the SAFE4RAIL project could make it a reality by 2022.

TCMS – Train Control and Management System – is often nicknamed 'brain of the train'. Yet, ironically enough, TCMS is far behind the standards of smart technology. Existing solutions are complex and costly, and vary considerably from one train manufacturer to another. The truth is that, whilst electronic hardware and software keep evolving at an ever-increasing pace, TCMS is a niche market, and this makes the uptake of novel technology much slower.

"We're looking at a very fragmented market with high system complexity. Combine this with the long development time necessary to come up with 'service-proven' solutions, and you can easily understand why railway transportation systems are suffering from a limited adoption of novel technological advancements," says Arjan Geven from Austrian company TTTech.

In 2018, most trains are still very much made of a huge spider web of systems and applications barely talking to each other. Historically, each individual subsystem in a train has used its own electronic architecture to make the certification process easier (the same goes for computation where each application runs on its own computer with very limited interoperability). Whilst signals are being progressively integrated into a variety of bus protocols and communication systems, compliance with national regulations and the cost of deployment remain the priority, at the expense of maintainability and upgradability.

The SAFE4RAIL (SAFE architecture for Robust distributed Application Integration in roLling stock) project, which Geven is coordinating on behalf of an 11-partner consortium, aims to resolve this issue with a focus on

"We want to develop these prototypes within the two years following SAFE4RAIL, and then perform interoperability tests."

convergence. "Our objective is to remove the need for all those custom island solutions and integrate the train functions in one common platform," he explains.

This common platform is called an Integrated Modular Platform or IMP. It consists of two main parts: computation software and a communication platform, both open and interoperable. The consortium's ultimate goal is to make the IMP a cornerstone of the next-generation TCMS, able to host the most critical applications of the train to the highest certification requirements.

Besides the IMP itself, SAFE4RAIL also develops specific technologies supporting the virtualisation of the testing process. "Testing on the track and with real hardware is complex and expensive," Geven says. "One must transport all the equipment to a physical location, rent the facilities, mount expensive test equipment, and so on. Our set of communication emulators makes it possible to connect virtual and real components together, enabling Hardware-in-the-loop (HIL) and Software-in-the-loop (SIL) testing with both real and simulated hardware components and applications. The technology can connect different test sites together and simulates their physical presence in the same place."

SAFE4RAIL is also developing a test bench for train-to-ground communication, to help in the testing of train-mounted and ground equipment and make sure that implementations of different manufacturers are interoperable. Such tests are currently being conducted in close cooperation with four manufacturers.

With the project still having four months to go before its completion, it is still difficult to predict its future success. As Geven points out, the value of the IMP directly reflects the number of stakeholders who support it. "Since it is the joint interest of the manufacturers to save costs, they have united in CONNECTA, which is SAFE4RAIL's sister project. The strong collaboration between CONNECTA and SAFE4RAIL is a key enabler for this uptake."

Once SAFE4RAIL is completed – and provided that it fulfils its objective of developing the IMP blueprints – the next step will consist in implementing the solution in hardware and software prototypes and demonstrators. "We want to develop these prototypes within the two years following SAFE4RAIL, and then perform interoperability tests. These prototypes can then be further developed into products within the following two to five years and be commercialised by 2022-2024," Geven concludes.


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SAFE4RAIL

- Coordinated by TTTECH in Austria.
- Funded under H2020-TRANSPORT.
- https://cordis.europa.eu/project/rcn/206227
- Project website: https://safe4rail.eu

PROJECT PUTS RAIL COMMUNICATION NETWORKS ON RIGHT TRACK

EU-funded researchers have developed and analysed scenarios of what future rail communication networks might look like. Their methodology will now be freely available to rail and telecom operators to make their own evaluations.

The two-year MISTRAL (Communication Systems for Next-generation Railways) project has made important contributions to the SHIFT2RAIL Joint Undertaking, a collaboration between the Commission and industry to accelerate research and development. The project's findings can now be taken up by industry partners within the JU, enabling them to achieve a better understanding of future network scenarios and their implications for both rail operators and passengers.

"One of the advantages of being a small research-focused project is that we can ask difficult questions," says MISTRAL project coordinator Dr Maurizio Spirito from the Istituto Superiore Mario Boella (ISMB) in Italy. "What we don't have

are confidential industry costs and figures. By using our methodology though, rail operators can input their exact equipment costs, expected revenues, rail capacity and passenger numbers to achieve an accurate picture of what transitioning to a new communication network will mean."

Preparing for transition

Train to wayside communication describes a crucial element of rail traffic management, involving contact between the moving train and fixed infrastructure such as signals and stations. Such communication is vital for ensuring safety and operational efficiency. The communication network used for this purpose at the moment – called GSM-R – is relatively old and tends to be owned and managed by the rail operators themselves.

"This is where we are today," says Spirito. "We might talk about 4G or even 5G networks for our cell phones, but the rail sector is still using this old technology. Transitioning to a new communication model is necessary because GSM-R maintenance support and spare parts will run out by 2030."

This is a tricky proposition. While the European Commission and others would like to open rail communication networks up to the market, many rail operators that have invested in their network are concerned about safety and security. There is some reluctance on the side of industry to transition towards new technologies that have not been proven or tested in critical environments.

Future rail networks

"This is the challenge that we are addressing," says Spirito. "Within the framework of the Shift2Rail Joint Undertaking, we were asked to evaluate future scenarios where GSM-R is replaced with new technology. We have looked at what this technology would be; what services would be provided; and what the service model would be."

The project began by looking at communication services, for both rail operators and passengers. At the moment, GSM-R only supports rail operations; commercial mobile networks are sometimes available on trains for passengers, but coverage is patchy. "We thought about whether there might be no distinction in the future between rail and passenger services," says Spirito. "For passengers, these services might include ticketing systems, route planning and entertainment. For railways, the network would have to deliver safety-critical services, but also perhaps real-time monitoring of the train and the track."

Next, the project looked at the type of technology needed to deliver next-generation services. Spirito and his team found that 4G (the current mobile network) as currently defined would not support mission-critical services but noted that there might be opportunities to evolve the current system to support such services.

The project team also examined the possibility of conceiving networks not as assets owned and run by rail operators, but rather as services provided by telecom operators. "In one scenario, network mobile operators would own the communication infrastructure; the technology would still be 4G mission-critical; and services would be provided to rail operators through agreement," explains Spirito. The project, due for completion in October 2018, will now assess the sustainability of various service models.

MISTRAL

★ Coordinated by ISMB in Italy.
★ Funded under H2020-TRANSPORT.
★ https://cordis.europa.eu/project/rcn/205962
★ Project website: http://mistral-s2r-project.eu/

THE RECIPE FOR A FREIGHT SHIFT FROM ROAD TO RAIL

Congestion and environment-related concerns have made the shifting of transportation from road to rail a priority for the EU. But is it even achievable? The Smart-Rail project brought together stakeholders from across Europe to identify the way forward.

Although it is still one of the main options for transporting goods across Europe, rail freight remains far behind its road counterpart in terms of market share. At first glance, it's easily understandable: road freight is reputed for its flexibility, cost effectiveness and continued innovation, whilst the rail sector pales in comparison. It's a complex system, involving a great number of different public and private stakeholders performing daily operations. They have no choice but to sit at the same table before any change in the rail system can be made.

The point of the Smart-Rail (Smart Supply Chain Oriented Rail Freight Services) project was to help the sector catch up to its main competitor. It aimed to find out the reasons why potential customers opt for road instead of rail, contribute to a mental shift in the sector, strengthen cooperation between stakeholders and establish 'living labs' to test and improve innovation measures in real-life situations.

"We focused on the identification of cost-effective solutions to deal with the rail sector's complexity and to actively address the requirements of new markets," says Ming Chen, scientific coordinator of Smart-Rail on behalf of TNO. "We believe that many things can be done as long as the user-oriented and cooperative mindset of the involved stakeholders is achieved."

The first step consisted in gaining a better understanding of why these 'new markets' are not using rail as a primary mode of transportation. Delays due to a lack of coordination between stakeholders within and beyond the rail sector, long lead times, high logistical costs for the user, low flexibility and the lack of real-time information on order status were amongst the main reasons.

With this in mind, the consortium introduced innovative measures and developed working business models for cooperation between stakeholders. They also developed an architecture for the exchange of information. The project's three 'living labs' set these in motion by respectively: validating and modifying a novel concept for wagonload trains in an important international corridor; creating an operational logistical control tower including rail; and developing several pilots for better data management, planning of international train paths, and alternatives in case of service disruptions.


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"These actions will lead to an improvement in the rail services in the short and medium term," says Chen. "Yet, there is a concern for the long term: radical innovations are currently taking place in the automotive sector that will have significant impacts on the competitiveness of rail. For instance, unmanned trucking would imply a radical cost reduction of around 50 % for road freight, which could in some cases make road transportation competitive even for bulk transportation."

Whilst Chen says that the rail sector could have seen this problem coming already for quite some time, he deems the absence of reaction to be a 'denial phase'. "We observed a strong focus of rail operation and R&I on keeping current freight on rail instead of establishing a shift of freight from road to rail."

Policy-making is also addressed by the consortium. Whilst investment in R&I for road transport automation is notably targeting the reduction of congestion, a major shift from rail freight to road resulting from a lack of political support would indeed be counterproductive. "This would lead to major societal costs and ineffective use of investments. Therefore R&I agendas and corresponding budgets should be balanced. Equally, regulation should not be a barrier to the uptake of innovation allowing for a more flexible rail system."

Whilst Smart-Rail, one of the lighthouse projects of Shift2Rail, has already been completed, the knowledge obtained on the development of the required rail and logistical information platforms is being transferred to other ongoing projects. Chen says he's confident that the sector will keep heading in the right direction.

Smart-Rail

- Coordinated by TNO in the Netherlands.
- Funded under H2020-TRANSPORT.
- https://cordis.europa.eu/project/rcn/193372
- Project website: http://smartrail-project.eu/

DIGITAL RAIL NETWORK MAPPING ACHIEVES EFFICIENCIES

EU-funded researchers have been able to gather accurate geographical data through the use of drones, remote sensing and 360-degree cameras to deliver digital 3D models of railway lines. This will assist rail and infrastructure companies in assessing tracks throughout their lifecycle.

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"Our technology tags assets and relevant information useful for the design, operation and maintenance of tracks."

The EU-funded Skylynx (Upgrading Railways from the Air) project has underlined the benefits of digitalising Europe's rail network. By more cost-effectively targeting the maintenance of assets along the line, the need to put workers in harm's way is reduced, allowing operators to allocate staff to more valuable tasks. The deployment of assets can also be more efficiently planned.

"Rail operators have in the past visualised the rail corridor using paper and technical drawings," explains project coordinator Jorge Lopez-Sanchez from SigmaRail in Spain. "What we propose instead is something like a Google Maps app for railways. Pictures are taken by drone, with 3D 'street views' achieved through 3D cameras. Our Sigma-Q technology also tags assets and relevant information that will be useful for the design, operation and maintenance of tracks."

Europe's secret success

A key aim of the project has been to facilitate the efficient deployment of the European Railway Traffic Management System (ERTMS), a relatively unheralded European success story, according to Lopez-Sanchez. "Before ERTMS, each European country had its own signalling system," he explains. "This meant that if you wanted to send a train from London to Amsterdam for example, you either had to change trains or equip trains with multiple signalling equipment, which is expensive or slow. This is how the idea to create one single system across Europe came about."

ERTMS is now Europe's de facto standard signalling system, and for new lines being constructed in Europe, there is no alternative. ERTMS has also become a global success, and is being deployed in countries including Saudi Arabia, Australia and Mexico.

The deployment of ERTMS however remains a challenge. Europe's legacy of multiple automatic train protection systems has slowed progress and required huge political effort in order to agree on a system that is suitable for all EU members. Lopez-Sanchez also points out the technical challenges in creating a system that is truly functional across all EU Member States, as well as deploying advanced systems along old rail lines.

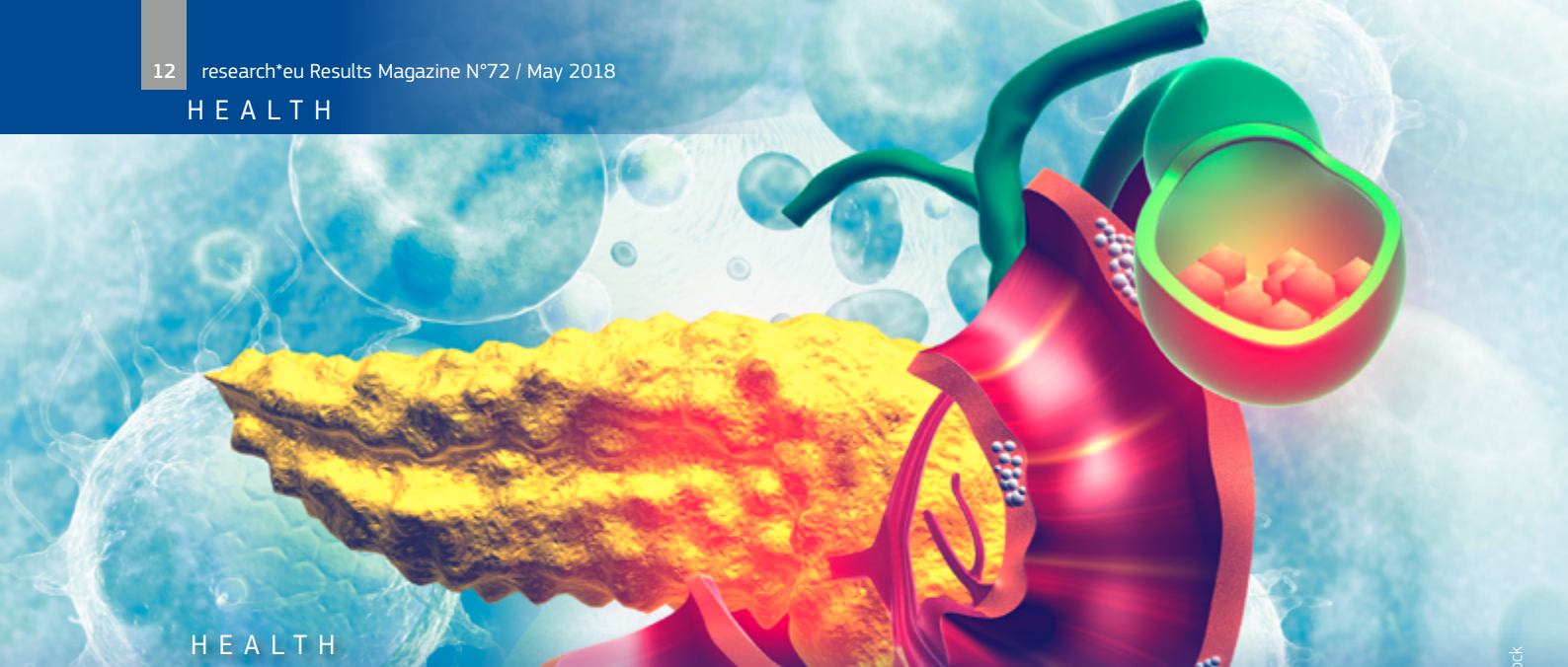
Digitalising rail networks

Gathering data on the state of these lines is therefore crucial. "Deploying advanced signalling systems such as ERTMS requires operators to know the exact location of safety-related rail assets such as signals and danger points," explains Lopez-Sanchez. "You can imagine that a system designed to carry thousands of people at a speed of up to 350 km/h requires a high degree of accuracy."

This was the starting point of the Skylynx project; applying cutting-edge technology to develop the digital models of rail corridors. "The benefits for industry are huge," says Lopez-Sanchez. "Workers for example will not be required to gather data from the tracks, since this task can be accomplished using drones. This will significantly improve safety. Rail companies will be able to quickly identify lines in need of maintenance, saving time and money. At the end of the day, operational efficiencies will translate into lower costs for the general public."

Skylynx

★ Coordinated by SigmaRail in Spain.
★ Funded under H2020-SMEINST.
★ https://cordis.europa.eu/project/rcn/208033
★ Project website: http://www.sigma-rail.com/



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HEALTH

NEW BIOMATERIALS ENABLE THE ENGINEERING OF PANCREATIC ISLETS FROM SINGLE CELLS

The NEXT project has successfully engineered a new approach to pancreatic islet transplantation using biomimetic nanomaterials, providing hope to type-1 diabetes patients across the world.

The prospect of lifetime drug administration or insulin infusion is, to say the least, demoralising. And it gets worse for those diabetic patients who don't respond to insulin administration or don't experience symptoms of hypoglycaemia: They are left with either organ or cadaveric pancreatic islet transplantation options, both suffering from a shortage of donors and limited lifespan.

It doesn't mean that there is no hope. Pancreatic islet transplantation is widely recognised as the most suitable alternative to whole organ transplantation and, should it become more efficient, it could one day be the procedure of choice for many patients worldwide.

As Prof. Matteo Santin, Director of the Centre for Regenerative Medicine and Devices (CRMD) at the University of Brighton, explains, the current islet transplantation method suffers from major limitations: lack of donor availability, unreliable selection process, uneasy transportation and strong immune/host response towards the donor's islet.

Overcoming these limitations is precisely why Prof. Santin kicked-started research on NEXT (Nano Engineering for Cross Tolerance: new approach for bioengineered, vascularised, chimeric islet transplantation in non-immunosuppressed hosts) – a new approach to bioengineered islet transplantation using nanotechnology – in October 2013. "The NEXT project is the result of the interdisciplinary work done by clinicians, material scientists and biotechnologists that leverages the latest finding in biomimetic nanomaterials," he explains.

The project's biomaterials developed at the CRMD are one of its most important breakthroughs: they can drive the formation of pseudo-islets through the assembly of pancreatic beta cells and vascular endothelial cells. In previous approaches, biomaterials were solely used to encapsulate isolated pancreatic islets. This resulted in limited protection of the islets from the host response, and poor integration with surrounding host tissue. NEXT solves both problems at the same time.

"Unlike the disordered cell aggregates formed with other methods, our biomaterial makes the biochip respond to hyperglycaemic stimuli with an enhanced production of insulin. Also, it offers an anchorage point for the coupling of the biochip with immunosuppressant proteins," Prof. Santin explains. Thanks to such coupling, specific biochemical pathways of the immune/host response that would lead to pancreatic islet death under the current treatment can be inhibited, making the use of immunosuppressant drugs known to cause adverse effects for the patient unnecessary.

Initially, the project team aimed to deliver an immunosuppressant peptide directly integrated into their biomaterial. As the results were unsatisfying, a recombinant protein was produced instead, but its relatively large size makes it unfit for integration into the biochip. Prof. Santin points out that the protein still needs to be scaled up to industrially-feasible amounts, and the procedure optimised in dedicated *in vivo* models.

"The optimisation will need to ascertain the optimal size and number of biochips to reverse diabetes conditions in the chosen animal models and to be expanded to xenogeneic protocols proving that the technology can perform when immune-protected biochips made from other animal species are transplanted. This was not achieved by the partners because of time constraints," he says.

In the meantime, the partners were able to develop novel methodologies and equipment enabling the successful clinical transplantation of the tissue-engineered biochips: an *in vitro* model of fibrosis by AvantiCells Science to test pancreatic islets for their propensity to be encapsulated in an unwanted fibrous capsule; a battery-sourced bioreactor by Cellon that can be easily accommodated in ambulances; a comprehensive set of recombinant immunosuppressant proteins; as well as a novel toolkit for DNA modular assembly now marketed as Doulix by Explora.

If all goes as planned, NEXT technology could also expand the current clinical procedure of pancreatic islet transplantation to the use of animal tissues and not only cadaveric specimens. The technology will enable the establishment of cell banks to be used for the production of immunoprotected biochips, thus solving the problem of donor shortage and immune reactions upon transplantation.

NEXT

- ★ Coordinated by the University of Brighton in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ https://cordis.europa.eu/project/rcn/110189

ADVANCES IN CLINICAL TRIAL DESIGN FOR RARE DISEASES

In Europe alone, an estimated 30 million people suffer from a rare disease that, by definition, affects less than five out of a population of 10 000. The ASTERIX project addressed the limitations of clinical trials for such diseases, aiming to speed up the implementation of novel therapies.

Currently there are more than 6 000 rare diseases known for their chronic and debilitating effects. From the multitude of new drugs under development with an orphan designation, only a small fraction has reached the market. This highlights the need to revisit the methodology for the design of clinical trials for rare diseases, in light of the inevitable sample size restrictions.

Randomised controlled trials are the gold standard for testing the efficacy, safety and benefit-to-risk ratio of new treatments. The existing statistical methodology is mostly tailored to large population studies. In the case of rare diseases, increasing trial recruitment numbers is not possible and is further hampered by the sparse geographic distribution of patients. Furthermore, the small number of patients limits the treatments that can be studied for the same disease.

Since the classical statistical methodology can overlook treatment effects in small groups, there is an imminent need for adapting innovative methodologies to suit clinical trials of rare diseases. To improve clinical trial design in small populations, the EU-funded ASTERIX (Advances in Small Trials dEsign for Regulatory Innovation and eXcellence) project proposed a comprehensive set of directions for improvement. These included methods to combine observational and clinical data, adapt efficient statistical methods to small groups, design innovative endpoints and address the level of evidence needed. The ultimate goal was to provide innovative statistical design methodologies to achieve more reliable clinical development of treatments for rare diseases.

A unique approach in clinical trial design

The consortium aimed to produce a consistent framework for reliable and efficient trials in rare diseases. Filling the gap between theoretical development and real-life implementation was a key objective of ASTERIX. As such, partners focused on end-users by testing the acceptability of methods with both regulators and patients. This was the only way to facilitate the uptake of recommendations in routine practice.

"Unique in our project was that patients were directly involved in the process and their input was taken into account in directions of the projects, such as developing novel endpoints," project coordinator Professor Kit Roes explains. The idea was further to illustrate the impact of making treatment available sooner and propose improvements for regulatory purposes. Towards this goal, researchers evaluated methods against actual drug development programmes implemented for new medicines for rare diseases.

The methodological advances were achieved by looking afresh at traditional concepts such as randomisation, as well as by developing a new methodology. This included the integration of evidence from multiple endpoints, efficient

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multi-armed trials to investigate multiple treatments simultaneously and the use of prior information to increase the level of evidence.

The next era in rare disease trials

Undoubtedly, methodological progress will aid the design and analysis of clinical trials, leading to more reliable studies. ASTERIX followed an integrated approach of existing and novel methodology that will improve statistical power of clinical trial design in small populations. Implementation will undoubtedly increase the reliability of clinical trial results, and thus speed up availability of truly valuable treatments to the patients in need.

"Validation of methods from a regulatory perspective will ease the uptake of new methodologies by decision makers and thus the degree of uncertainty on the outcome of licensing," continues Prof. Roes. More predictive licensing decisions means that companies may invest and commercialise novel therapies faster, offering access to high quality treatment at affordable prices to patients that suffer from rare diseases.

Prof. Roes' view of the future is "to stimulate a search and implementation for treatments for these devastating and largely ignored diseases." The ASTERIX deliverables undoubtedly bring us a step closer to more effective clinical research studies.

ASTERIX

- Coordinated by University Medical Center Utrecht in the Netherlands.
- Funded under FP7-HEALTH.
- http://cordis.europa.eu/project/rcn/110076
- Project website: http://www.asterix-fp7.eu/

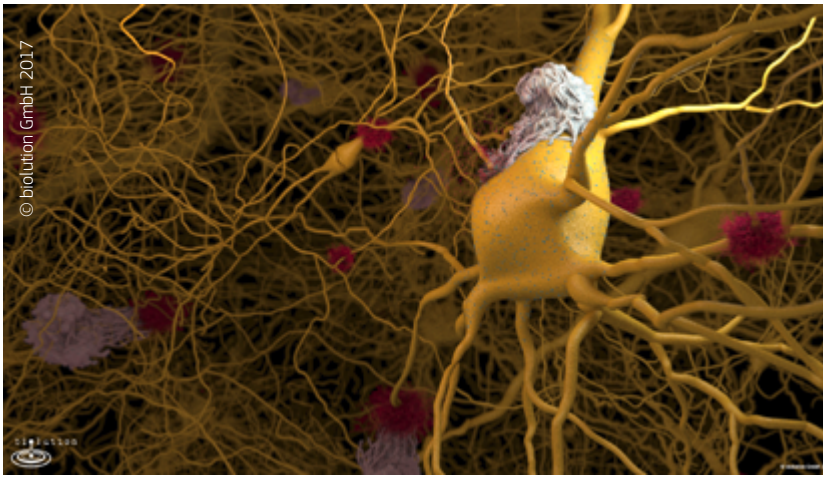
AN ACTIVE IMMUNOTHERAPY AGAINST NEURODEGENERATIVE DISORDERS

Parkinson's disease (PD) and Multiple system atrophy (MSA) are two neurodegenerative disorders and, so far, only treatment of the symptoms is available. European scientists have developed vaccines to reduce the severity of the diseases and improve patient function.

PD and MSA, also known as alpha-synucleinopathies, are two debilitating neurodegenerative disorders associated with a progressive decline in motor functions, autonomic disorders as well as behavioural changes. MSA progresses very rapidly with patients die within 10 years of disease onset.

Emerging evidence indicates that neurodegeneration in PD and MSA is associated with the formation of Lewy bodies in brain neurons and glial cells. Lewy bodies are primarily composed of aggregates of the protein alpha-synuclein, whose main function is to facilitate the release of neurotransmitters required for neuronal transmission.

Given the role of alpha-synuclein in disease pathophysiology, scientists in the EU-funded SYMPATH (Reach α-synuclein-dependent neurodegeneration: clinical development of therapeutic AFFITOPE-based active immunotherapy for Parkinson's disease and multiple system atrophy) project tested a novel Specific active immunotherapy (SAIT) approach to target it. "Directing the immune system towards neurodegenerative diseases constitutes an innovative approach that potentially has the capacity for reducing disease progression," explains project coordinator Dr Galabova.



An innovative α-synuclein-specific active immunotherapy

The SYMPATH project tested an innovative methodology based on the novel AFFITOPE® technology, which relies on short peptides mimicking parts of the native sequence or structure of alpha-synuclein. "PD01A and PD03A were designed to elicit antibodies neutralising the toxic form of alpha-synuclein but sparing compensatory beta-synuclein, thereby adding to their safety," continues Dr Galabova.

Pre-clinical evaluation demonstrated the disease-modifying activity of these SAIT candidates in various models. Treated animals exhibited lower cerebral levels of aggregated protein, less severe neuropathological alterations and improvements in functional deficits. As a result, the next step was to forward the SAIT for clinical production and testing in patients.

Successful completion of two phase I clinical trials in early PD and MSA patients demonstrated the safety profile of the PD01A and PD03A AFFITOPEs. For the future, researchers envisage "selection of the most suitable candidate based on defined criteria, and furthermore, bringing this compound into the next step of clinical development."

The collection of data and biological material from patients suffering from

PD and MSA, who received α-synuclein specific immunotherapeutic intervention, will be instrumental in the design of the next clinical study. The latter will focus on defining the precise dosage and schedule for SAIT treatment in PD and MSA patients.

The future of neurodegeneration treatment

With the ageing population rapidly increasing, there is great concern regarding the provision of healthcare for the elderly. Therefore, innovative treatments are urgently needed to address age-related diseases like neurodegeneration and cancer. At the same time, it is necessary to identify patients as early as possible and initiate treatment before damage becomes irreversible.

Towards this goal, part of the SYMPATH project was devoted to the identification of biomarkers with diagnostic and prognostic value. The team developed an alpha-synuclein detection assay to diagnose protein aggregation in plasma and cerebrospinal fluid, and assist in the assessment of therapy response in the future.

Considering the millions of alpha-synucleinopathies sufferers worldwide who receive only palliative symptomatic treatment, there is an imminent need for causative treatment approaches. Strategies targeting alpha-synuclein might be a possibility for addressing this unmet medical need.

SYMPATH

- Coordinated by AFFIRIS AG in Austria.
- Funded under FP7-HEALTH.
- http://cordis.europa.eu/project/rcn/109923
- Project website: http://sympath-project.eu/
- https://bit.ly/2HsQDGV

A TOOLBOX OF ADVANCED TECHNOLOGIES FOR NEXT GENERATION VACCINES

Winter always brings its fair share of headlines about new viral outbreaks, urging the young, old and vulnerable to head for a flu vaccine. With the future continuing struggle against diseases, EU researchers developed new immunisation technologies and included investigations into the different responses to vaccines in these special populations.

To prevent and possibly eliminate emerging and unresolved infectious diseases such as influenza and tuberculosis, there is a need to harness the potential of the human immune system. The EU-funded ADITEC (Advanced immunization technologies) project has enabled the achievement of this ambitious goal by adopting a multidisciplinary, systems biology approach to develop the necessary powerful immunisation technologies.

Adaptation to a dynamic pool of diseases and environments

Prof. Donata Medaglini, the project's scientific coordinator, explains how scientists from 42 partner institutions in 13 different European countries and the USA joined forces to achieve this. "Specific results, such as novel immunisation technologies, adjuvants, vectors and delivery systems, optimised formulations and vaccination methods for different age groups, all came together in a toolbox of advanced technologies enabling the best possible insight into fighting diseases."

ADITEC has also made the new technologies broadly available. The ADITEC biobank that stores samples from trials is available, not only to the ADITEC partners, but also to the whole scientific community. Prof. Medaglini points out that "this has evolved into a new collaborative ecosystem where the European scientific and industrial sector acts as an enterprise that is able to lead innovation globally."

Unique scale and scope of clinical trials

Tested head to head in animal models and combined in prime-boost strategies, the researchers investigated the technologies' mechanism of action in pre-clinical and clinical studies. The project has completed 12 clinical studies with over 700 subjects and is contributing to international regulation and standards for the harnessed novel technologies.

The sheer volume combined with the nature of the trials has created a high impact in the vaccination sector. "With synergies created and cross-fertilisation of research areas that have increased competitiveness in the industry, ADITEC has created a European Vaccine Enterprise," points out Dr Rino Rappuoli, project coordinator.

From common diseases to the neglected

There is a large unmet need for better vaccines against influenza and in pre-clinical and clinical studies, different routine vaccines including live-attenuated as well as those with and without adjuvants were tested. This enabled the study of different immune responses with varying formulations and in different age groups – from the infant to the elderly.

Successful completion of the first systems biology study of adjuvanted influenza vaccines in early childhood has led to a more intensive trial, again in infants. The results have been published in Proceedings of the National Academy of Sciences of the United States of America and by Frontiers in Immunology.

Shigella sonnei is a neglected pathogen despite causing more than half a million deaths from dysentery every year.

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A novel vaccine against *S. sonnei*, based on Generalised Module of Membrane Antigens technology, was successfully tested in a phase I trial and progressed to a phase II trial in an endemic population of Africa with ADITEC. Further clinical development is now supported by an external grant from the Bill and Melinda Gates Foundation.

The backbone of European competitiveness in the vaccines industry

For a sustainable vaccines sector in Europe, there has to be a foundation of solid, structured training. The project organised professional-level programmes for over 100 students as well as 210 PhD/postdoctoral researchers. ADITEC's philosophy of collaboration also provides the synergy for a platform of excellence to attract further funding for long-term vaccine development.

Further proof of the future success of the ADITEC approach comes in the form of seven patents, over 265 publications to date in international peer-reviewed journals and 10 Memoranda of Understanding with EU and United States organisations active in the vaccines field as reported in the in-depth analysis of the ADITEC Scientific and Socio-economic Impact report.

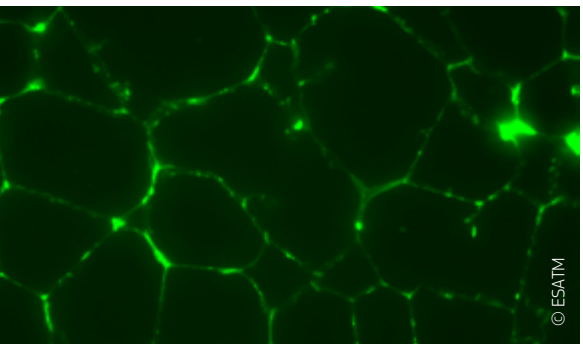
Dr Rino Rappuoli sums up the resounding success of the project by looking to the future. "By combining different types of scientific cultures and ethos, the ADITEC project has contributed, and will continue to contribute to supporting increased European competitiveness. From this perspective, this project represents a very successful experiment of a public-private partnership that could become a model for future initiatives."

ADITEC

- Coordinated by the Sclavo Vaccine Association in Italy.
- Funded under FP7-HEALTH.
- http://cordis.europa.eu/project/rcn/100067
- Project website: http://www.aditecproject.eu/

FIGHTING OBESITY AND THE METABOLIC DISEASES IT CAUSES

With a focus on adipose tissue, researchers with the EU-funded ESATM project are working to improve metabolic health in children and young adults.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Adipose tissue (AT) is a multifunctional organ that, beyond its traditional role as a lipid storage site, also plays a key role in keeping us healthy. However, excess AT can cause obesity and, later, metabolic diseases.

With the aim of improving metabolic health in children and young adults, the EU-funded ESATM (Embryonic stem cell origin of the adipose tissue macrophages) project studied the mechanisms needed to maintain healthy AT. "By 2030, it is estimated that 38% of the world's adult population could be overweight, and a further 20% obese," says ESATM Project Coordinator Tamás Röszer. "Clearly, obesity is a significant health problem and a major medical challenge that society needs to address today."

Addressing a big problem

The accumulation of excess fat in AT causes lipid-storing fat cells (so-called adipocytes) to stop functioning correctly, which results in the onset of obesity. Obesity, in turn, increases the prevalence of a range of chronic metabolic diseases, such as insulin resistance (IR) and type 2 diabetes mellitus (T2DM).

"To put this problem into perspective, consider that 8% of the world's population suffers from diabetes mellitus, and more than 90% of all newly diagnosed diabetic patients have T2DM," says Röszer. "This means that T2DM is one of the fastest growing non-communicable diseases today and is expected to be the seventh leading global cause of death within the next decade."

Interesting homeostasis findings

ESATM researchers studied the embryonic and adult development of AT-associated immune cells, specifically so-called AT-associated macrophages (ATMs). Although initially they expected to find that ATM stability was dependent only on circulating blood cells, what they discovered was that, in fact, the opposite was true.

Based on studies conducted on mice and amphibia, researchers found that most ATMs develop from embryonic progenitors. ATMs can later be replenished by the self-renewal of ATMs, controlled by hormonal signals. "Interestingly, we demonstrated that ATM homeostasis is maintained not only by circulating blood monocytes, as was initially believed, but also by ATM self-renewal," says Röszer.

According to Röszer, under homeostatic conditions, ATMs are able to self-renew by entering the cell cycle, with newly generated ATMs remaining non-inflammatory or acting against inflammation in the AT. "Intermittent fasting increases a hormonal signal, which increases ATM self-renewal, hence rejuvenating ATMs and improving AT health," says Röszer. "Taken together, these findings suggest that AT has a well-tuned endogenous turnover mechanism for ATMs, which start to develop at birth and, being rather vulnerable, may affect adulthood metabolism."

With this information in hand, researchers are now turning their attention to studying the signals that happen after birth and that can determine ATM quality in later life. "In this next stage of research, we hope to understand how these early life signals can determine how metabolism will function in adulthood," concludes Röszer. "Knowing this could help us restore healthy ATMs in individuals suffering from obesity, IR and T2DM."

ESATM

- Coordinated by Ulm University in Germany.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/195137
- Project website: https://www.uni-ulm.de/en/nawi/cme/research/roeszer-lab/

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SOCIETY

NINETEENTH CENTURY BRITISH AND ITALIAN WORKING CLASSES MAY HAVE HAD MORE IN COMMON THAN PREVIOUSLY THOUGHT

Popular literature called 'chapbooks' were read by ordinary people throughout Europe from the 17th to the 19th century. But records of these have been largely neglected, so researchers from the EU-funded CHAP project are now bringing a range of these publications into the light for the first time.

Although the elite social classes of Europe during the 17th and 19th centuries regularly exchanged ideas, literature and knowledge amongst each other, ordinary working people lacked the opportunities of the rich, and it therefore seemed likely that they would be largely isolated from the influence of other European countries. Surprisingly though, it appears that the poorer classes throughout Europe had more in common than previously thought.

Cheap, printed books of between 12 and 24 pages called 'chapbooks' were sold all over Western Europe during this period. They were translated from one original language into various other European languages, and acted as a 'gateway' between local communities and the cultures of other countries.

"They were a large element in the introduction of those people, particularly in rural areas, to the wider world and to networks of national and international communication," said Dr Niall Ó Cíosáin, coordinator of the CHAP (The transnational mobility of cheap print: British chapbooks in Italy, 1800-1850) project, from the National University of Ireland, Galway. "Ordinary British and Italian people were reading some of the same texts in the middle of the 19th century."

Chapbooks and broadsides

Chapbooks were entertaining, often containing jokes, riddles, songs, practical advice, almanacs, stories of bandits and murderers or the lives of saints, prophecies and tales inspired by medieval romances.

For more factual accounts of current affairs, people read broadsides, another type of popular literature that was often translated from other languages. A broadside was a single-sheet printed production, usually even cheaper than a chapbook, which was stuck to a wall for people to read. They commonly contained ballads, proclamations and edicts, reports of trials, death sentences, and news.

The chapbooks and broadsides were sold by travelling pedlars that moved from village to village selling clothing, small hardware, medicines and other goods in addition to the books.

Forgotten aspect of print culture

To study the chapbooks, the EU-funded researchers travelled between Britain, Ireland and Italy to consult material in the archives and to measure the impact of the English-language texts on the popular Italian chapbooks of the time. 152 texts in Italian were gathered altogether. Many of these texts had never been catalogued or organised before and were almost inaccessible for the researchers.

A key result of this project has been to resurrect the chapbooks and the broadsides, offering a new insight into the life of the working classes in Europe at that time.

"This project has recovered and brought to light a forgotten aspect of the common transnational print culture of the 19th century," said Dr Ó Cíosáin.

The project is analysing, recording and organising the chapbooks and broadsides into an easily accessible website, which will be accompanied by a series of articles focusing on the role of translation in the evolution of cheap ephemeral print in 19th century Italy.

"The aim is to produce an online library of 19th century chapbooks in Italian that derive from other languages or that correspond to texts in other languages," said Dr Ó Cíosáin. "This will encourage, promote and facilitate research on the cross-cultural dimension of cheap printed materials from the 17th to 19th centuries."

CHAP

- ★ Coordinated by the National University of Ireland Galway in Ireland.
- ★ Funded under H2020-MSCA-IF.
- ★ https://cordis.europa.eu/project/rcn/195896
- ★ Project website: https://cheapprinttranslation.nuigalway.ie/

GENOMICS SHEDS LIGHT ON THE BIRTH OF AGRICULTURE

Changing from hunter gatherer to a settled farming lifestyle occurred over a period of 7 000 years and started in the Near East, spreading to northern Europe. New genomic evidence has revealed the demographic and migratory processes behind this arguably most revolutionary change in human history.

Around 10 000 years before present (yBP), the migration of human communities across south and central Europe from the Near East introduced farming and animal breeding to Europe, replacing the pre-existing hunter gatherer (HG) way of life with limited interbreeding. By contrast, widespread adoption of farming practices in northern Europe came about mainly as a result of cultural contact, again with restricted gene flow.

The EU-funded NeoGenHeritage (Neotithic transition in the Iberian Peninsula: reviewing an old question from new technological and computational genome wide approaches) project selected the Iberian Peninsula at the western fringe of Europe to study the dynamics and demographic changes of this Neolithic transition. Researchers used this data with the prehistoric routes of migrations that swept across Spain and Portugal and then northwards through Andorra.

Combining cutting-edge technologies in ancient DNA remains and human population genomics, NeoGenHeritage researchers generated whole nuclear genome data from prehistoric remains. The next step was to analyse these genomes in the context of ancient and modern population genomics. As Professor Guido Barbujani, project coordinator, explains, "This approach enabled us to investigate the genetic affinities of ancient north and south Iberian populations in the context of worldwide human genomes."

Bridging the information gaps with state-of-the-art genomic data

Before NeoGenHeritage research, data was scant – only one complete Mesolithic genome from around 8 000 yBP and some early and mid-Neolithic remains existed. "Limitations with this data are that most of the samples come from northern and central Spain, which prevents comparison of the Atlantic and Mediterranean areas that, as archaeologist tell us, may have different demographics," Prof. Barbujani points out. A further problem was that previously analysis was hampered by a shortage of genetic markers.


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NeoGenHeritage therefore designed a sampling strategy to recover contemporary human remains from the Neolithic transition in the Mediterranean and Atlantic areas. Analysis of these complete genomes can detect otherwise elusive differences between the ancient individuals from these two shorelines.

Stepping through the DNA changes along the migration routes

Analyses based on genome-wide data support a mixture of cultural and demographic diffusion in both the north and south of the Iberian Peninsula. Genomes of all the post-Neolithic samples have two major components typical of west HGs in Europe and early farmers from the Near East.

However, after running tests for genetic admixture, a biogeographical ancestry analysis, some differences were discernible between the HG populations from the Atlantic and the Mediterranean areas. The samples from the Atlantic side had more in common with the Mesolithic HG from northern Spain.

"The simplest explanation for this finding is that the Atlantic and Mediterranean populations of Iberia were already differentiated in pre-Neolithic times," Prof. Barbujani comments. "Another reason may be localised admixture between incoming farmers and the pre-existing HG gene pool."

Analysis for future elucidation

Prof. Barbujani describes work that is anticipated to explore and elucidate the complex, dynamic genetic processes at work during the Neolithic Revolution. "Continued analysis is going to involve simulation of different levels of genomic diversity with varying evolutionary scenarios and comparison with observed real-life data."

Another option the team would like to pursue is to integrate a similar study on Cheddar Man whose 10 000-year-old remains rose to fame as the first modern Briton with blue eyes, dark to black skin and dark curly hair. This would enable a better understanding of the relationships among European Mesolithic communities.

To sum up the social and genetic aspects of NeoGenHeritage research results, Prof. Barbujani stresses that, "Our ancestors have always ventured into new territories, and on their way, they have met and admixed with other populations. The result is a rich patchwork of genomic components, difficult, or impossible, to trace back to a single geographic origin."

NeoGenHeritage

- Coordinated by the University of Ferrara in Italy.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/195115
- Project website: http://www.unife.it/ricerca/finanziamenti-gestione/ricerca-internazionale/progetti/neogenheritage

HOW TRAVELLING IN EUROPE CAN BOOST ACTIVE CITIZENSHIP

New research shows that the more Europe's youth visit other Member States, the more civically engaged they will become at home.

Cross-border mobility during adolescence and youth contributes significantly to young European citizens' sense of belonging and civil participation, according to the findings of a recent study.

Conducted as part of the EU-funded CATCH-EyoU (Constructing AcTive CitizensHip with European Youth: Policies, Practices, Challenges and Solutions) project, the research involved over 10 000 adolescents aged 14-19 and young adults aged 20-30 in eight Member States (Czech Republic, Germany, Estonia, Greece, Italy, Portugal, Sweden and the United Kingdom). The results were recently published in the European Journal of Developmental Psychology.

The project's international research team focused on young Europeans, typically highly educated and well-skilled, who have travelled between Member States for a limited time. The team grounded their work on the idea that cross-border mobility is associated with more positive attitudes toward, a stronger sense of identification with, and multifaceted visions of the EU.

CATCH-EyoU researchers set out to determine whether these factors positively influence participation at EU level.

The findings showed that, for both adolescents and young adults, short-term mobility has a significant direct effect on participation in EU issues through identification with the EU and its vision as a political community. Results from the questionnaires indicate the same appears to hold true as regards long-term mobility for young adults.

Staying with the young adults group, the study found a negative indirect effect of both short- and long-term mobility through vision of the EU as an economic community. The two forms of mobility also had an indirect effect on intention to vote through identification with and positive attitudes toward the EU and vision of the EU as a community of shared values.

The study found that 30 % of its young participants had in the past year been involved in social and political issues of European importance, and 67 % had plans to vote in the next EU elections.

The findings clearly evidence a positive relationship between mobility and identification as European and also between mobility and positive attitudes toward the EU. This offers strong support for policies that support mobility, so contributing to young peoples' sense of European citizenship.

Referencing the 'Erasmus Generation', CATCH-EyoU project coordinator Prof. Elvira Cicognani noted these are "young people who have seized the opportunities to go beyond national boundaries. They know what they want from Europe and they are willing to get involved in order to obtain it."

CATCH-EyoU is exploring young people's views of the EU and how their engagement from local to EU level contributes to building the EU. The initiative and its results will help to advance a modern conceptualisation of youth active citizenship and ways to integrate these perspectives in relevant policymaking.

CATCH-EyoU

- ★ Coordinated by the University of Bologna in Italy.
- ★ Funded under H2020-SOCIETY.
- ★ https://cordis.europa.eu/project/rcn/194593
- ★ Project website: http://www.catcheyou.eu/

INNOVATIVE FRAMEWORK TO STRENGTHEN RESEARCH ETHICS IN EUROPEAN SCIENCE

There's a pressing need to improve ethics principles and laws in research and innovation (R&I), and to ensure that they're in line with technological progress and societal concerns.

How can we ensure that R&I performed by universities, industry and other institutions adheres to the ethical standards that Europeans find important, such as respect for humans and animals, privacy and data protection, sustainability, equality and freedom? According to Prof. Philip Brey, this is the fundamental question raised and addressed by the EU-funded SATORI (Stakeholders Acting Together On the ethical impact assessment of Research and Innovation) project. "Science and technology have a major impact on our lives, but if the two aren't developed in an ethical way, then society suffers," says the project's coordinator.

European framework for ethics assessment of R&I

SATORI developed a framework of common basic ethical principles and joint approaches and practices that are supported and shared by all the key actors involved in the design and application of research ethics standards and principles. It presents international standards and best practices for creating and operating ethics committees. This is especially useful for organisations that currently do not have an ethics committee and find themselves needing one, which is nowadays often the case in fields other than medicine.

The framework contains the first comprehensive list of ethical guidelines for different fields of scientific R&I, and a novel ethical impact assessment methodology that uses foresight to anticipate ethical impacts of R&I. Prof. Brey explains that one of the framework's major accomplishments was development of the world's first European (CEN) ISO-compliant pre-standard for R&I ethics assessment. This pre-standard is endorsed by the European Network of Research Ethics Committees (EUREC).

Other key content includes a set of recommendations that outline how to structure ethics assessment and ethical guidance in specific types of organisations, including research funding organisations, universities, industry, national ethics committees and civil society organisations. Another set formulates ideas on how to create strong ethics assessment and guidance institutions and regulations at national and EU levels, as well as a roadmap to further develop ethics assessment in the EU.

In all, 49 reports describe the current state of play of ethics assessment and its legal regime in different scientific fields, organisations, Member States and beyond. Researchers also investigated and compared national and international legislation for ethics assessment, different value systems around the world and their implications for ethics assessment, and how ethics assessment is practised and governed at EU and international levels.

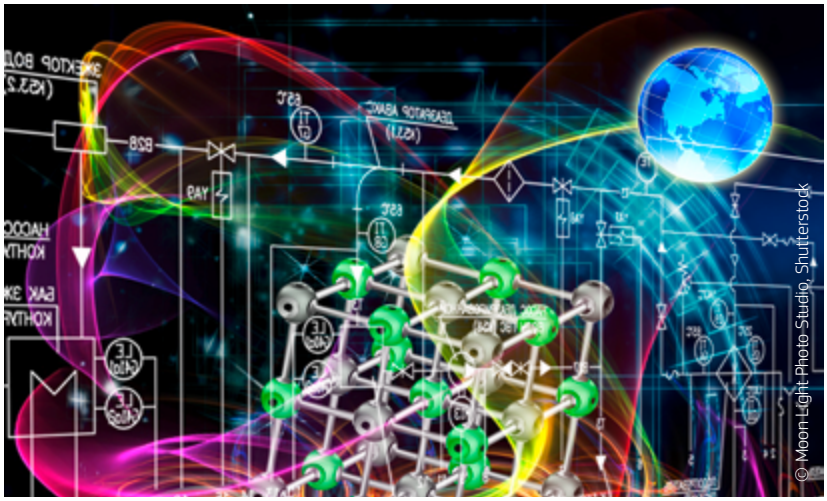
An extensive study examined how R&I has become a global enterprise, and how this globalisation brings specific ethical challenges. Team members reviewed international policies and actions to mitigate the undesirable and unethical consequences of R&I globalisation, followed by specific policy recommendations. They discussed issues like the international dimensions of scientific misconduct, the ethical treatment of indigenous knowledge in R&I, and the ethics of clinical research and trials in low- and middle-income countries. Also debated were the development of responsible supply chains, the ethics of outsourcing CO_2 emissions, and benefit sharing of low- and middle-income countries in R&I outcomes.

Towards more responsible R&I processes and outcomes

A variety of organisations are already benefiting from the framework. "Actionable methods, guidelines, approaches and recommendations were created for a broad range of R&I stakeholders, including regulators and policymakers," says Prof. Brey. "Ultimately, the framework will ensure that R&I outputs are consistent with the moral values, needs and expectations of society as a whole."

Even though the project officially ended in September 2017, an extensive strategy has been launched to secure its sustainability. Several EU-funded projects have committed to taking SATORI forward, by using, further developing or applying its results.

Lastly, the European Commission is working towards making ethics a cross-cutting priority in the next Framework Programme (FP9), and will look to SATORI to frame some of the issues. The Commission also intends to use the results to improve its ethics review of project proposals under Horizon 2020.



SATORI

- Coordinated by the University of Twente in the Netherlands.
- Funded under FP7-SIS.
- http://cordis.europa.eu/project/rcn/111019
- Project website: http://satoriproject.eu/
- https://bit.ly/2HEY5MD

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TRANSPORT

NEW TESTS FOR MORE ECO-FRIENDLY AERO ENGINES

Gas turbine performance strongly depends on the flow field inside the combustor. EU-funded scientists have advanced aero engine design by treating the combustor and turbine as one entity instead of optimising each component separately.

Modern gas turbines are increasingly designed to operate under extreme conditions of temperature and pressure. Such conditions increase thermal efficiency and decrease emissions.

Scientists initiated the EU-funded FACTOR (Full Aero-thermal Combustor-Turbine interactiOn Research) project to further study flow field interactions between the combustor chamber and the gas turbine. Detailed knowledge of this interaction is essential for design of higher-performance engine turbines with longer operating lifetimes.

Higher performance, lower emissions

The complex flow physics in combustion and turbine systems that usually consist of many highly sophisticated components has been the subject of numerous studies over the last decade. Engine manufacturers are making major efforts to master this interface as extremely hot gases, variable boundary layers, turbulence effects and inherent unsteadiness are some of the phenomena making this region highly complex.

Better understanding of the complex interaction between the coolant system and the transport and mixing of the air within aircraft turbines will enable reduction in the specific fuel consumption.

“Accurate prediction of combustor-turbine interaction will lead to a better optimised design and therefore engines of higher efficiency,” says Project Coordinator Matthieu Chevrier. “The objective of FACTOR was to provide accurate and reliable data which can be used to enhance calculation models,” he continues.

FACTOR’s goal was not only to reduce fuel consumption, but also to decrease high-pressure turbine weight by 1.5 % and, accordingly, engine cost by 3 %.

New experimental facilities

Relying on results and guidelines from previous relevant EU-funded initiatives, the project succeeded in creating new links between European combustor and turbo machinery experts. A new turbine test facility hosted by DLR in Göttingen that couples a combustor with a high-pressure turbine simulator for aerodynamic and aerothermal measurements intensified this effort.

The FACTOR test infrastructure was used to collect experimental data to enhance understanding of secondary flow transport and mixing mechanisms through the turbine. Fed by hot and cold air, this new facility also enabled researchers to further explore thermal interactions between the combustor and turbine. A complementary blow-down turbine facility hosted by Oxford University in the United Kingdom was used to supplement analysis of the DLR continuous flow test rig.

Even if test bench temperatures remained below real temperatures, the aerodynamic behaviour of the turbine was representative of the most recent engines.

“The nozzle guide vane, which is found just after the combustor chamber, has to be cooled because of the high temperature that comes from the chamber,” explains Mr Chevrier. “This temperature flow is not homogenous, but rather highly heterogeneous, and by better predicting the hot point migration through the turbine we can optimise engine efficiency.”

All measurement data have been used to create a new test database that is available for all FACTOR partners. The database contains different clocking positions that will facilitate improved understanding of how the hot point interacts with the turbine. It also includes detailed measurements in all interfaces that will be available and used for at least 10 years to better understand the fluid structure inside the turbine.

FACTOR's results should significantly contribute to designing new internal combustion engines with high air-fuel ratios. Known as lean burn, these engines combust more fuel and emit fewer emissions.

FACTOR

- Coordinated by Safran Aircraft Engines in France.
- Funded under FP7-TRANSPORT.
- https://cordis.europa.eu/project/rcn/96395
- Project website: http://www.factor-fp7.eu

FULL SPEED AHEAD FOR AN E-PROPULSION SOLUTION FOR LAND, SEA AND AIR TRANSPORT

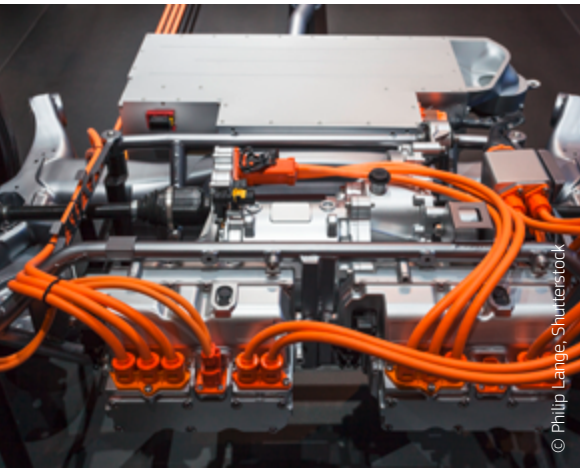
If the EU is to meet its energy and environmental targets, it will have to find efficient alternatives to fossil fuel. Taking the transport sector, electrification is proving a promising avenue, and an EU-funded project, ADEPT, is paving the way forward with its work on e-propulsion systems.

E-propulsion systems are the powertrain systems which provide electrical propulsion for fully electric cars, ships and aircraft. They typically consist of the electrical components, power electronic converters, control systems and batteries, necessary to enable movement in vehicles. If electric vehicles, offering less environmental pollution than fossil fuel powered varieties, are ever to become widely viable, these electric powertrain systems will have to be more efficient than is currently the case.

To contribute to the expertise necessary to achieve these efforts, the ADEPT (ADvanced Electric Powertrain Technology) project set out both to establish and train a multi-disciplinary research network, funded under the EU's Marie-Curie Action: Initial Training Networks grant, and to produce a virtual development environment for e-propulsion systems.

The people and the platform

The ADEPT project created a training network consisting of 12 Early Stage Researchers (ESRs) and two Experienced Researchers (ERs). Personalised training was developed for the network members through a collaboration which offered applied research methodologies, knowledge transfer, support for publications, secondments and workshops.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The training programme covered an extensive range of fields including: vehicle integration of e-propulsion; electromagnetics; thermal, mechanical and vibro-acoustic systems; as well as vehicle control applications. Reflecting on the success of the project, coordinator Professor Elena Lomonova puts some of it down to the "professionalism of the international team, their extended network and their ability to tackle very complex and challenging tasks together."

In addition to supporting the talent necessary to take e-propulsion to the next level, the project also developed a virtual platform, for predictive analysis and simulation of proposed systems, enabling engineers to trial scenarios before committing to their build. The platform is now publically available on the GitHub software platform, and as Professor Lomonova says, "It can be used by engineers and academics to reduce time needed for analysis, design and development of e-propulsion components, cutting costs while not compromising accuracy."

The transport sector's role in our energy-climate future

The EU's energy-climate policy includes energy efficiency targets for 2020. As well as ambitions for the reduction of greenhouse gas emissions, these targets also include alternatives to fossil fuels for energy provision. Taking the example of cars alone, the EU's Green Vehicles Initiative aims to support the development of new and more sustainable forms of road transport. As well as investigating performance and safety for biofuel and hydrogen-run vehicles and infrastructure, the initiative is looking to battery powered electric and hybrid innovations for alternatives to petrol and diesel.

ADEPT is uniquely placed to contribute to these efforts as the project consortium includes industrial partners currently producing powertrains, such as Siemens, MACCON and Triphase. Additionally, as Professor Lomonova points out, "Through all the novel network training activities, we've prepared a brilliant team of top-class engineers and specialists ready to make their mark within EU universities and companies, including across the automotive and wind-energy sectors."

To develop the work further, the team is currently fine-tuning the virtual platform, reducing significantly the design and development time required for the vehicle components. In this way ADEPT's approach will be better able to fit with so-called Industry 4.0 prevailing trends, which seek to make the most of advances in areas such as automation, big data and the Internet of Things (IoT).

ADEPT

- Coordinated by Eindhoven University of Technology in the Netherlands.
- Funded under FP7-PEOPLE.
- http://cordis.europa.eu/project/rcn/109583
- Project website: http://www.adept-project.eu/
- https://bit.ly/2HHU9ee

ACCELERATED, HYPER-ACCURATE FORCE MODELLING LEADS TO FAR MORE EFFICIENT AIRLINER DESIGNS

Greener airliners need to be lighter so they burn less aviation fuel. Yet aircraft must remain strong enough to withstand any forces they are likely to meet in flight. Researchers from the ALPES project have worked out how to predict those loads quickly, and with unprecedented accuracy, allowing more innovative aircraft designs to be conceptualised.


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Anybody whose holiday jet has flown through turbulence will be aware that aircraft are not flying in a benign, friendly medium. The air is awash with swirling winds, temperature gradients and weather patterns that can cause the air supporting the plane to move violently, exerting strong forces, or loads, on the aircraft's structure. Similarly, manoeuvres that the aircraft has to make – such as banking to change course, climbing or landing – exert loads on its structural components.

But to design safe aircraft, the makers of airliners need to know how strong those loads can be at their worst, so they can work out just how tough the critical parts of their aircraft must be to cope with the maximum stresses and strains they may experience in flight. Until now, however, airplane designers have not been able to accurately predict those loads because their software modelling tools have not been sophisticated enough.

Ousting the errors

That's now set to change, however, thanks to the EU-funded ALPES (Aircraft Loads Prediction for Enhanced Simulation) project in which project coordinator Jonathan Cooper, from the University of Bristol, UK, worked alongside system modellers from the Siemens Aerospace Centre of Competence in Leuven, Belgium. Their aim? To develop speedy software modelling techniques that calculate those aircraft loads with great accuracy.

To do this, the ALPES team have improved upon the current industry standard for wind-gust load modelling: the 40-year-old Doublet Lattice Method (DLM), which is prone to errors and needs correcting using extensive Computational fluid dynamics (CFD) runs or time consuming wind tunnel testing.

“New techniques we have developed in ALPES correct the DLM results based upon just a few runs in a CFD system, enabling production of gust-load predictions that are both fast and accurate,” says Cooper. He estimates they can now simulate the load effects of aerodynamic and structural factors 95% faster than the previous method. These methodologies can be enhanced by other surrogate modelling techniques.

For aircraft design engineers, having software do these heavy computations for them will be a boon: “Many hundreds of thousands of calculations need to be made to consider all of the possible load cases that might be encountered during an aircraft’s lifetime,” says Cooper.

Aircraft optimisation made easier

Having determined the loads, engineers can then compute the stresses all over the structure and optimise the size of the various structural elements, such as the wing spars and ribs, and the fuselage and control surface skin thicknesses, to cope with them. It's important that the ALPES-developed software methods do this at high speed, Cooper says, as the entire process has to be repeated several times during each sizing calculation.

The ALPES team has already used its new techniques to show some interesting load-related results on an emerging aviation concept: folding wing tips. An aircraft can gain more lift, reduce drag and boost fuel efficiency by having a longer wing span – even though higher loads are produced. But longer wings cannot fit in standard airport gates – so folding wingtips have been proposed, by Boeing for instance, with its 777X airliner design. At the gate, the hinged wingtips remain vertical, as on aircraft carrier planes, but before takeoff they would rotate down and lock flat to boost wing span.

"Our ALPES research has demonstrated that by enabling some flexibility in the hinge during flight it is possible to achieve a significant wing-tip extension this way with a limited or even minimal impact on wing weight," says Cooper.

Future applications

The results are going to make a real difference in aviation circles, predicts Cooper. “The technologies investigated are going to help towards development of environmentally friendly aircraft designs and enable faster design and certification processes for those aircraft, too,” he says.

In addition, work related to ALPES continues in AEROGUST, an EU-funded project focused strongly on further improvements to aeroelastic gust load and wind shear modelling – both for aircraft and for wind turbines.

ALPES

★ Coordinated by the University of Bristol in the United Kingdom.
★ Funded under FP7-PEOPLE.
★ http://cordis.europa.eu/project/rcn/109366

TELEMATICS TECHNOLOGY STEERING US TOWARDS SMARTER EU ROADS

If we are to have truly smart cities our transport systems will have to be more cost-effective, safer and sustainable. Perhaps most of all they will need to be more integrated, as the EU-funded project MFDS demonstrates.

The stated aim of the EU's 'smart, green and integrated transport' initiative is to build a European transport system that is 'resilient, resource-efficient, climate- and environmentally friendly, safe and seamless for the benefit of all citizens, the economy and society.'

As a contribution, the EU-funded MFDS (Multi-Functional Detective System (MFDS) – Advanced, 'Intelligent Transport System' creating smarter and safer European roads) project has developed a versatile and affordable 'Intelligent Transport System' offering several functions including wrong-way driver detection, traffic congestion detection, vehicle counting by vehicle classification and parking accounting. The core innovation of MFDS is the system's ability to perform its functions simultaneously, while remaining low-cost to buy and install, as well as running on minimum power. The project's feasibility study has demonstrated that the system will be of interest to multiple EU markets.

Over and above state-of-the-art alternatives

A standard Multi-functional detection system (MFDS) consists of six delineator posts which distribute a secure radio field across the target path, detecting and classifying objects with 100% precision. The system can be placed at car park entrances and exits or on highways, reporting vehicle details to a web portal in real time. Beyond categorisation, the innovative sensors mean that the system can detect the direction, size and speed of vehicles. This proved the most difficult aspect of MFDS, as project coordinator Mr Dennis Dorn recalls, "The challenge has been developing the novel sensors to be able to detect and classify the traffic accurately enough to pass the required standards and certifications."

The data accrued by MFDS can be viewed centrally through the web portal or redistributed securely via interfaces and the cloud, to motorists or the relevant authorities. Crucially the system can be integrated into existing guide posts or bollards, making installation of it more cost-effective and seamless.

During the recently closed Phase 1 of the project, the team developed a Feasibility Study. The subsequent market study, incorporating customer feedback, has paved the way towards the creation of a new company (S-Tec GmbH) and Phase 2. Phase 2 will identify strategic collaborators, scope legislative requirements and plan the technical and commercial groundwork to include finalising the system for multiple scenarios and markets.

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Elements of the system have already been assessed on the German Ministry of Transport test tracks. The first MFDS application selected for roll-out in late 2018 is the car park accounting (without classification) functionality. Amongst additional features, Phase 2 should see the roll-out of car park accounting classification, alongside wrong-way driving detection. As Mr Dorn explains, "Speaking with the relevant authorities has given us the idea of a multifunctional use of the system, such as including parking and traffic counting." Ultimately the target is for over 6500 units to be deployed across the EU by 2024.

Benefiting all road users

The system can work across many markets. As Mr Dorn summarises, "The system will benefit all road users, with road safety increased especially on highways, parking spaces better utilised and congestion significantly reduced, by connecting traffic management with municipal parking spaces. Everyone can also use the data to better plan the management of resources, from authorities with the deployment of staff, to lorry drivers planning the timing of their rest breaks." There are also commercial markets, for example with the offer of parking space accounting for stadiums or exhibition spaces.

To make these full benefits tangible there are a number of challenges the team are working to overcome. The system must first be further developed and tested, especially for the public market, which means stress testing the innovative sensor technology – the core of the system – to ensure reliability regardless of weather conditions. This will then lead to the production and assembly of the system.

MFDS

- ★ Coordinated by Wilhelm Schroder GMBH in Germany.
- ★ Funded under H2020-LEIT-ICT, H2020-SME & H2020-TRANSPORT.
- ★ https://cordis.europa.eu/project/rcn/211257
- ★ Project website: http://www.mfds.eu/de/

3D IMAGING UNLOCKS MYSTERIES BEYOND THE OCEAN FLOOR

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Mid-ocean ridges (MORs) represent the longest, volcanic mountain chain in the world. However, little is known about the processes that shape this most extensive mountain range on Earth.

Along MORs, plates have been moving apart from each other, and an oceanic crust has been forming thanks to magmatic processes that operate within and at the base of the crust. It is believed that there is a strong link between these magmatic processes and relatively localised volcanic, tectonic and hydrothermal processes.

However, the "characteristics of this link are largely unknown," says Dr Milena Marjanovic, a marine geophysicist who received a Marie S. Curie Individual Fellowship as principal researcher for the EU-funded 3DWISE (3D Full Waveform Inversion on seismic data at the East Pacific Rise) project. "We examined this link and tackled fundamental and enduring questions in Earth sciences that concern mechanisms behind crustal accretion, hydrothermal circulation and submarine volcanic eruption." The upper crust's poorly defined properties where the link is hosted and activity occurs are what lie at the root of the problem.

Getting to the bottom of Earth's inner layers

To map these properties, 3DWISE utilised 3D full waveform inversion (3D FWI), a cutting-edge technology developed by the oil and gas industry similar to X-ray or magnetic resonance scans used in medicine. The technology was applied to the available high-fidelity seismic data sets collected along one portion of the East Pacific Rise (EPR), a MOR located along the Pacific Ocean floor. The EPR is characterised by considerable hydrothermal activity, two documented volcanic eruptions and substantial multidisciplinary time-series measurements that are unique on Earth.

Once seawater penetrates the crust, there's insufficient knowledge about its hydrothermal pathways and how it interacts with other crustal processes. Scientists examined the nature of zero-age crust formed at the EPR from 9 °16'N to 9 °56'N using modern geophysical techniques. They imaged low-velocity irregularities and associated them with the presence of up-going and down-going hydrothermal pathways within the axial plane of the fast spreading ridge.

Project partners then compared results with the available data sets. Findings show that the interaction between the tectono-magmatic and hydrothermal processes is not straightforward because of the different timescales at which they operate. In addition, they found that the high crustal permeability and high thermal regime must coexist in time and space for developing, maintaining and driving vigorous, high-temperature hydrothermal flow.

The upper part of the crust formed at the EPR is represented by basalts (layer 2A) and dikes (2B). In velocity models, the layer 2A/2B boundary is characterised by a velocity gradient, which is attributed to change in porosity. The geologic nature of the gradient is debated. Due to limited information on the upper crustal velocities, it's unclear if this observation is due to the extrusive layer's physical thickening or because of a downward propagating, hydrothermally driven, cracking front.

Team members applied an elastic 3D FWI method to a 3D seismic data set collected at the EPR. Results indicate that the emplacement of extrusives, variation in their thickness and rate of dike subsidence are predominantly controlled by tectono-magmatic features and processes operating near the ridge axis.

Capturing groundbreaking 3D images of the ocean's upper crust

In addition, 3DWISE provided a proper 3D image of the axial magma lens that rests at about 1.5 km below the seafloor and is about 1 km wide. According to Dr Marjanovic, this is the first time a 3D high-resolution image of the oceanic crust's upper portion has been obtained.

Understanding the formation of crusts at the origin of oceanic plates will provide better insight into plate behaviour farther from the ridge axis and in subduction zones. "These zones are particularly important because they're the places where large earthquakes and devastating tsunamis began, some of which are considered the worst disasters in human history," concludes Dr Marjanovic.

3DWISE

- ★ Coordinated by the Institute of Earth Physics of Paris in France.
- ★ Funded under H2020-MSCA-IF.
- ★ http://cordis.europa.eu/project/rcn/195087
- ★ Project website: http://www.ipgp.fr/~marjanovic/3DWISE/3DWISE_MM/3DWISE.html

BALANCING CONSERVATION AND SOCIAL EQUITY

Researchers with the EU-funded TRECKQUITY project have developed a new approach for tracking the achievement of multidimensional social equity in the world's protected areas.

Due to the pressures of climate change, population growth and pollution – among others – the world is witnessing a rapid decline in biodiversity. As well-governed and effectively managed protected areas are a proven method for safeguarding both habitats and species populations, many governments are working to halt this loss of biodiversity by expanding protected areas. In fact, many have signed on to the Aichi Biodiversity Target (Aichi Target 11), which aims to conserve at least 17% of terrestrial and inland water areas and 10% of coastal and marine areas by 2020.

In line with these objectives, governments are working to expand such protected areas as the Great Barrier Reef in Australia, Banff National Park in Canada, Tablas de Daimiel in Spain and Tsavo East in Kenya. However, to be successful, these conservation efforts must be equitable, meaning they must strike a balance between protecting nature and protecting the well-being of local communities. "Protected areas should at least do no harm to local stakeholder groups, who disproportionately bear the burdens of biodiversity conservation, while many benefits accrue to other beneficiaries at broader scales," says Dr Zafra-Calvo, a researcher with the EU-funded TRECKQUITY (Social equity goals in conservation interventions: a system thinking approach to track progress at global level) project.

According to Zafra-Calvo, one of the challenges that prevents achieving this balance is the inability to assess multidimensional social equity concerns in protected areas on a global scale. That is until now.

Thanks to TRECKQUITY, conservationists now have access to an innovative approach for tracking the multiple dimensions of social equity in their conservation efforts. This includes: recognition (rights, cultural identities and traditional knowledge systems), procedures (accountability, access to justice and participation in decisions, transparency), and distribution (burdens and sharing of benefits).

"We have proposed 10 criteria of multidimensional social equity that can be easily assessed by 10 indicators using a simple survey in any protected area worldwide," explains Zafra-Calvo.

A new methodological approach

Through its work, TRECKQUITY researchers have addressed the unresolved scientific question: what is the world's progress on reaching the societal goal and policy target of achieving social equity in protected areas? "Our assessment has helped build a common understanding to facilitate the integration of current multidisciplinary approaches to assess social equity in nature conservation," adds Zafra-Calvo.

The completion of this project resulted in a completely new methodological approach and further dataset for administering the survey. "Together, these results represent the first contribution to tracking our progress on reaching social equity in conservation interventions, which is necessary to supporting critical decision making and actions," says Zafra-Calvo.

A first step

The TRECKQUITY approach is just the first step in advancing our understanding of the relationship between social equity and conserving protected areas.

"Our aim was to develop a novel approach for tracking the achievement of multidimensional social equity in protected areas on a global scale."

"Next, we can use this understanding in global decision-making processes to achieve equitably managed protected areas, such as the definition of the next biodiversity targets," says Zafra-Calvo. "Together with our approach, which can be easily implemented as a short survey by several stakeholders involved in the management of protected areas, we should take targeted management actions to urgently address social inequity in each of the world's protected areas."

However, according to Zafra-Calvo, doing this requires a combination of a TRECKQUITY-like survey with a more open-ended, long-term and multi-stakeholder approach capable of providing a more detailed description of the status of each protected area in terms of social equity.

TRECKQUITY

- ★ Coordinated by the University of Copenhagen in Denmark.
- ★ Funded under H2020-MSCA-IF.
- ★ https://cordis.europa.eu/project/rcn/197283

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A BETTER UNDERSTANDING OF THE HIGH LEVELS OF MERCURY POLLUTION IN THE ARCTIC TUNDRA

Scientists have been searching for over two decades to explain how the Arctic is contaminated with toxic mercury pollution. A new study sheds light on the likely process, while warning of its hazards to humans and the environment.

If you had to pick a region of the Earth that might be sheltered from human-induced pollution, the Arctic tundra, a vast northern ecosystem surrounding the Arctic Ocean, would be a good start. Yet, the area is contaminated with the highly toxic metal mercury known to leak from the soil into rivers and ultimately the Arctic Ocean, contaminating the aquatic life that native communities rely on for survival.

Understanding the mercury cycle

Industrialised and developing nations emit about 2 000 tonnes of mercury into the atmosphere annually. These mercury emissions come in various forms, such as oxidised mercury, known as Hg(II) and gaseous elemental mercury, or Hg(0). The former tends to remain close to the emission source, while the latter can travel worldwide.

Scientists studying the phenomenon, with contributions from the EU-funded MEROXRE (Understanding the fate of Arctic atmospheric mercury (Hg) deposition – A Hg stable isotope investigation of redox processes and Hg re-emissions) project, writing last year in the journal 'Nature' outlined how they gathering data year-round, using a lab set up on the tundra. By measuring mercury levels and conducting chemical analyses, the researchers were able to ascertain that Hg(0) represented 70 % of the mercury found in the tundra soil, with Hg(II) less than a third.

Given Hg(0)'s ability to travel widely, scientists have been perplexed as to why there should be high concentrations in the Arctic. Professor Daniel Obrist, one of the authors of the study, writing in 'The Conversation', notes that Hg(0) in sunnier and warmer places tends to induce chemical reactions resulting in the Hg(0) being repelled.

The researchers suggest that much of the mercury is absorbed from the atmosphere in the leaves of the tundra vegetation, much like carbon dioxide, during the small window of plant growth when snow melts. Given that the plant is then again covered by snow and ice for many months, the mercury is sequestered in the soil and protected from the sunlight and heat that might cause the chemical reactions resulting in it becoming airborne again.

When the plants shed leaves or die, the mercury is then deposited directly into the soil, which explains why runoff from tundra soil to the Arctic Ocean accounts for half to two thirds of the total Arctic Ocean mercury deposits. In the ocean, the mercury can be converted to organic methylmercury, which is highly toxic and can pass into the aquatic food chain.

The MEROXRE project's unique contribution was to measure stable mercury isotopes, a technique which allowed the team to identify various sources of mercury in the atmosphere, snowpack, vegetation and soils. These measurements further confirmed the dominance of Hg(0), suggesting the Arctic tundra as a possible globally significant mercury sink.


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The team's findings have largely overturned theories that mercury pollution was due to rain and snow or sea-salt-induced chemical cycling of mercury in the Arctic tundra.

Avoiding climate change triggers

High levels of mercury in the Arctic have been found in beluga whales, polar bears, seals, fish, eagles and other birds. This impacts on people, especially the local Inuit who get their food from traditional hunting and fishing practices. It is known that extended periods of exposure to high levels of mercury can result in neurological and cardiovascular problems.

While studying the potential impacts of climate change was beyond the scope of the project, the researchers point out that global warming could result in the release of sequestered mercury, currently trapped in the permafrost, discharging even more into Arctic waters.

Prof. Obrist points out that there is more work to be done to develop a better understanding of plants and soil uptake of Hg(0), and the environmental impact, in order to help regulators, policy makers and initiatives such as the Minamata Convention reduce risks.

MEROXRE

★ Coordinated by the National Center for Scientific Research in France.
★ Funded under H2020-MSCA-IF.
★ http://cordis.europa.eu/project/rcn/195407

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AGRICULTURE AND FORESTRY

EFFICIENT MOBILISATION OF WOOD FROM THE BOTTOM UP

The stakes are high for a more sustainable and efficient mobilisation of Europe's forest resources. Thanks to regional pilot projects and a platform exchanging information and best practices, partners under the SIMWOOD project hope for a snowball effect.

Europe's 117 million hectares (ha) of forest are shared across a multitude of owners, and efficiently mobilising these resources is set to become increasingly difficult in the face of climate change and growing demand for wood.

The wood market is known for its complexity and lack of transparency, and initiatives to sustainably increase wood mobilisation have so far failed to engage stakeholders throughout the whole value chain. The consequence of this lack of a common vision is revealed by modelling work carried out under the SIMWOOD (Sustainable Innovative Mobilisation of Wood) project: out of 11 model European regions representing 7.8 million ha, only 53.6 million m^3 are exploited, whilst there is a theoretical potential to harvest 17.2 million m^3 more. About 4% of this additional wood is considered easy to mobilise, whereas 26% could be made available with 'medium' effort.

"Forecasts for the sector predict a substantial increase in the demand for wood over the coming decades," says Roland Schreiber, coordinator of the project on behalf of the Bavarian Ministry of Food, Agriculture and Forestry. "'Solid' uses are growing steadily whilst novel chemical uses of wood are emerging and gaining momentum. The biggest increase in demand, however, will be for wood energy, which will play a critical role in Europe's future renewable energy supply and the achievement of climate protection objectives."

In other words, scarcity lies in wait, and only dynamic structural shifts can stabilise and secure supply.

Starting small, dreaming big

This is where SIMWOOD comes into play. Within the past four years, the project made two major contributions to the sustainable and innovative mobilisation of wood in Europe. Firstly, the project created the SIMWOOD Information System – an online platform encompassing: a knowledge base of barriers impeding wood mobilisation and measures to overcome them; maps and graphs showing wood mobilisation initiatives; an interactive tool to assess the outputs of modelling exercises; and a newsfeed on the latest trends in biomass mobilisation.

The project saw its SME partners engage into pilot projects showcasing targeted forest use and its tangible impacts on rural economies. These include: the 'Grown in Britain' marketing campaign; small woodland mobilisation projects in England and Scotland; and awareness raising initiatives among French logging companies operating on sensitive soils.

"Learning from peers in regions is already creating benefits that are expected to strengthen the forest sector. Small-scale initiatives taking into account local conditions and the specific barriers experienced by owners and contractors there can increase wood mobilisation, and the next step would be to promote and roll out the most successful initiatives on a wider scale," Schreiber explains.

In their final report, project partners state that they "consider that the lessons learnt while developing and implementing our project, and the changes and achievements evidenced by the stakeholders we worked with, will be useful to a larger community of wood mobilisation facilitators throughout Europe." The SIMWOOD Information System is expected to keep growing in order to make this wider mobilisation possible.

In the meantime, work on modelling wood mobilisation potential will be published in 2018 or 2019. "This work has shown how difficult it is to quantify this important element of the European bioeconomy and will hopefully lead to the provision of better quality and more consistent data on this subject," Schreiber says.

Most teams involved in SIMWOOD's pilot projects will continue to implement the project initiatives and roll them out on a larger scale. In England and Scotland, for instance, projects seeking to implement the conclusions of the SIMWOOD project and make its findings available to a wider group of forest stakeholders have already been kicked off.

SIMWOOD

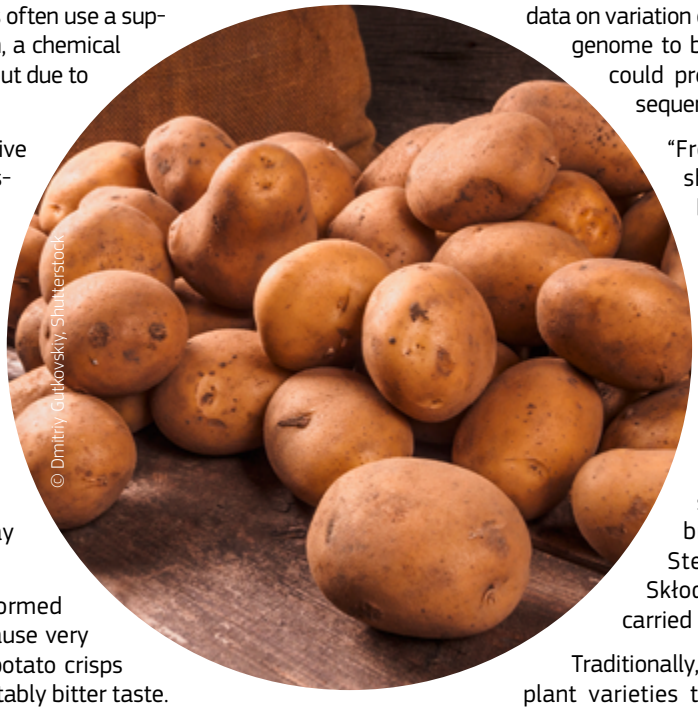
- ★ Coordinated by the Bavarian Ministry of Food, Agriculture and Forestry in Germany.
- ★ Funded under FP7-KBBE.
- ★ http://cordis.europa.eu/project/rcn/110708
- ★ Project website: http://simwood.efi.int

POTATO DNA MARKERS COULD KEEP POTATOES FRESHER FOR LONGER

EU-funded scientists have discovered genetic markers that could allow potatoes to be selected for their ability to be stored at low temperatures, keeping them fresh and avoiding the use of anti-sprouting chemicals.

Ireland is world-renowned for producing potatoes, but Irish crisp and chip manufacturers face a shortage of locally grown potatoes mainly due to long-term tuber storage problems. This means they need to import over 50 000 tonnes of potatoes each year.

Potatoes used for crisps and chips are usually stored at eight degrees – a temperature high enough to prevent starch from breaking down into glucose and fructose. To slow sprouting, potato producers often use a suppressant like chlorpropham, a chemical the EU is looking to phase out due to health concerns.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Hoping to find an alternative to chemical sprout suppressors, the EU-funded GenSPI (Genomic Selection for Potato Improvement) project has developed a genetic marker system to identify plants that display a resistance to glucose and fructose formation. Their tubers can be stored at three or four degrees, low enough to keep sprout growth at bay for very long periods.

"Glucose and fructose formed during cold storage can cause very dark fry colours, leaving potato crisps and chips with an unacceptably bitter taste. The sugars can also cause a build-up of acrylamide, a potential carcinogen," says Dan Milbourne, GenSPI project coordinator.

Slower to sweeten

GenSPI developed new genomic selection breeding methodologies which will allow potato breeders to select the varieties of potato that seem to be resistant to sweetening at low temperatures.

To do this, researchers gathered a large collection of potato plants and fried thousands of tubers – the equivalent to 10 000 bags of potato crisps – that had been held in different storage conditions. They then measured their colour once fried and drew the links between fry colour and the genetic variation of the plant.

"Because the fry colour is controlled by many genes the best approach was to scan the genome for variation at many sites to find correlations between colour and genetic variation," explains Milbourne.

Researchers then used the latest techniques in genome sequences – known as next generation sequencing – to identify over 100 000 regions across the genome where the DNA sequence varied among the plants. They combined data on variation on the potato phenotype and genome to build statistical models that could predict fry colour from DNA sequencing information.

"Glucose and fructose formed during cold storage can cause very dark fry colours, leaving potato crisps and chips with an unacceptably bitter taste."

"From the 100 000 regions showing genetic variation between the breeding lines, we were able to identify a smaller number of DNA markers that gave us a good ability to predict fry colour. This means we can develop an inexpensive DNA-based test to predict fry colour that can be applied to tens of thousands of plants in a potato breeding programme," says Stephen Byrne, the Marie Skłodowska-Curie fellow who carried out the research.

Traditionally, potato breeders inter-cross plant varieties to produce up to 100 000 seedlings, and then eliminate poorly performing plant types over a period of 10 years. Varieties that are resistant to glucose and fructose formation can only be identified at the end of this time, meaning that many potential varieties have already been eliminated from the breeding process.

GenSPI carried out its research in collaboration with a commercial potato breeding programme led by Denis Griffin. Its newly-developed technique allows resistant plants to be identified early in the 10-year breeding programme. The team hopes the project will lead to the release of one or more varieties that give an excellent fry colour even at low-temperature storage, avoiding chemical sprout suppressants. "We hope to see these varieties released in the next five years," concludes Griffin.

GenSPI

- Coordinated by Teagasc – the Agriculture and Food Development Authority in Ireland.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/195536
- Project website: https://figshare.com/collections/GenSPI/3593570/1

CROSS-LINGUISTIC DIVERSITY IN FOREST TERMINOLOGY COULD INSPIRE POLICYMAKERS

New research shows that analysis of forest semantics and its diversity across languages could have a bearing on forest policies and agendas.


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Ever since the 1992 United Nations Conference on Environment and Development (the Rio de Janeiro Earth Summit), forests have been at the forefront of international policies aimed at tackling climate change, fostering sustainable development and enhancing food security. But is the word 'forest', or 'tree cover', described in the same way, considering the need for coordinated action towards sustainable forest management?

Although some common and workable definitions have been provided by international organisations such as Food and Agriculture Organisation of the UN, with certain parameters such as crown cover, land area and tree height in terms of threshold values, it has been acknowledged that few concepts have identical lexical expression across all human languages.

A team of researchers supported by the EU-funded LACOLA (Language, cognition and landscape: Understanding cross-cultural and individual variation in geographical ontology) project described, compared and evaluated some of the semantic diversity observed in relation to forests. They outlined their findings in the journal 'Geographica Helvetica'. The paper 'Forests: The cross-linguistic perspective', coordinated by Muriel Côte, Flurina Wartmann and Ross Purves, was produced as part of a workshop funded by the Geocomputation research unit at the University of Zürich.

Based on first-hand linguistic field data from a genealogically and geographically diverse sample spanning six language families and four continents (from Avatime in Ghana to Makalera in East Timor), the researchers showed that basic linguistic categories relating to tree cover vary considerably in their principles of semantic encoding across languages. They argued that "forest is a challenging category from the point of view of intercultural translatability."

The team pointed to the diversity of terms that may be assumed to be close equivalents of forest in relation to their meaning. "While some do closely approximate the English meaning of a densely treed area of some size, others refer to untamed vegetation in a more general sense (akin to bush); yet others do not encode vegetation at all but instead evoke more abstract spatial meanings of outdoors or outside," the researchers noted.

The paper concluded that the cross-linguistic diversity in forest terminology may have consequences for current efforts aimed at standardising forest definitions and measurements. It also emphasised the need to pay great attention to categorical variation in designing and implementing forest agendas, as well as the importance of understanding local indigenous classification systems for successful communication of those agendas on the ground.

"We hope to have shown that linguistic diversity, although sometimes an obstacle to comprehension, can be a rich source of information and inspiration for scientists and policymakers alike," the researchers said.

The LACOLA project, which supported the research, also raised new questions and perspectives of inquiry in other disciplines, such as anthropology and psychology. Completed in 2016, the project highlighted the importance of understanding the variation in geographical ontology for providing clues about human cooperation in several fields, from navigation and resource management to international law.

LACOLA

- Hosted by Lund University in Sweden.
- Funded under FP7-IDEAS-ERC.
- http://cordis.europa.eu/project/rcn/97289
- Project website: http://projekt.ht.lu.se/lacola/project-home/

A SWITCH TO PLANT-BASED PROTEIN COULD HELP TACKLE CLIMATE CHANGE AND HUNGER

Agriculture – both victim and cause of climate change. New research shows moving away from animal protein towards legumes makes sense nutritionally a nd environmentally.

Agriculture is often thought of as being at the mercy of climate change, with increasing droughts and flooding resulting in lower yields, especially across the developing world. Yet the agricultural sector also contributes significantly to greenhouse gas emissions, itself exacerbating climate change. In fact, recently agriculture was identified as the second biggest emitter globally, producing around 10-13 % of emissions. A substantial amount of these emissions comes from livestock farming with the production of the gas, methane.

TRUE (Transition paths to sustainable legume based systems in Europe), an EU-funded project, has found evidence that switching diets towards plants as sources of protein as opposed to meat, is much more sustainable. In a study conducted by one of the TRUE project partners, Trinity College Dublin, researchers scored legumes by their environmental cost of production (including greenhouse gas emissions, groundwater pollution and land use), as well as according to their nutrient content.

The five to one benefit

The results clearly showed that plant protein sources (legumes) had the lowest environmental production cost, while at the same time demonstrating the highest density of nutrients. Putting this finding into context with an example for 'Trinity News', Assistant Professor in Botany at Trinity, Mike Williams, is quoted as saying, "Peas have a nutrient density to environmental footprint ratio approximately five times higher than equivalent amounts of lamb, pork, beef or chicken."

The researchers used the environmental and nutritional criteria to test a number of dietary scenarios, which has enabled them to quantify specific environmental benefits, against instances when consumption of animal protein is decreased.

This quantification means the research has a very practical value for the development of policy and ultimately consumer education. Professor Williams adds, "Such quantitative estimates of sustainable food and agriculture will hopefully allow a more informed choice for consumers when considering the main protein component of their diet."

Transition to sustainable legume consumption

The team are working ultimately to balance social, environmental and economic needs throughout the supply chain. This includes ensuring high nutritional standards, along with general health and wellbeing for people and animals, while minimising environmental impacts and optimising commercial diversity and efficiency.

In its quest to enable the success of future legume production systems, including for agri-feed and food chains, the TRUE project brings together 22 partners, representing business and society interests. It is further supported by a series of 15 farm networks and includes the development of seven innovation Case Studies looking especially at supply chains. The researchers are employing Life Cycle Analysis techniques which apply advanced mathematical analysis to fine-tune processes, as well as using modelling to design Decision Support Tools to aid the transition.

To increase the likelihood of success for these new farming, processing, manufacturing and retailing practices, the project will also make policy recommendations. Alicia Kolmans, from the Research Centre for Global Food Security and Ecosystems in Germany, is quoted as saying, "These first results of the TRUE project are an important orientation for European consumers and decision makers, considering the risks to society emerging from the global increase in animal protein consumption, including growing environmental problems and increased food insecurity due to the competition between food and feed in global fields."

TRUE

- Coordinated by the James Hutton Institute in the United Kingdom.
- Funded under H2020-SFS.
- https://cordis.europa.eu/project/rcn/210171
- Project website: https://www.true-project.eu/

"Switching diets towards plants as sources of protein as opposed to meat, is much more sustainable."

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INDUSTRY

RESOURCE AND ENERGY-EFFICIENT MANUFACTURING

Food, textile and steel production accounts for more than 50 % of CO_2 emissions and 20 % of electricity consumption in Europe's industry. An EU-funded project investigated and tested ways of making manufacturing more efficient in terms of energy and materials usage, thereby reducing its environmental impact and contribution to climate change.

The EU-funded REEMAIN (Resource and Energy Efficient Manufacturing) project combined cutting-edge knowledge with experience gained from production processes to develop and demonstrate a methodology for increasing the efficient use of energy and materials in factories. The goal was to optimise production through the seamless integration of renewable energy systems and the recovery of wasted energy.

Project partners used an integrated approach based on professional energy simulation software tools, energy and resource planning standards, and renewable energy and storage technologies. "Incorporation of renewable energy resources in the factory environment, taking into account innovative technologies to reduce overall energy demand will lead the drive towards net zero carbon factories," says project coordinator Anibal Reñones.

Integrating renewable energy technology

A life cycle approach was used to measure improved environmental performance in demonstrator factories. The team created decision-making tools, enabling factory managers to select the best strategies for reducing the use of energy and materials, minimising environmental impacts and making informed decisions about where to invest financial resources.

The consortium conducted 15 specific factory demonstration activities at a biscuit producing company, a textile manufacturer, and a foundry, respectively. These activities were based on waste heat recovery, production-product-process optimisation and the integration of renewables. Renewable energy research into solar thermal concentration resulted in improvements in performance and maintainability of the parabolic solar collectors. Electricity battery storage research led to the development of an industrial lithium battery system prototype for use in factory electricity networks.

Better energy and resource management

Results from the biscuit factory demonstrator showed that new baking ovens equipped with heat recovery mechanisms could provide important natural gas savings. In addition, cool outside air can help save an enormous amount of electricity normally used for water-cooling. "Although airside free-cooling is a well-known technology for buildings, their use in a manufacturing environment is challenging as temperature limits are very strict and may affect the final product, therefore appropriate control of this energy technology is vital," explains Reñones.

Researchers also tested the impact of organic raw materials on textile production processes and the use of carbonic acid instead of sulphuric acid for wastewater treatment. According to Reñones: "The key result was achieving higher levels of sustainability and reduction of the environmental footprint, without compromising quality and energy spent."

The foundry demonstrator showed the technical feasibility of recovering heat from the cupola furnace, a major challenge. Furthermore, high variations of temperature and the harsh environment created by the exhaust fumes puts a lot of pressure on heat exchanger materials. Great control is needed to recover as much waste heat as possible. The pouring stage was optimised by incorporating a new innovative Plasmapour technology, with the demonstrator being the second foundry in the world where this new specific system has been installed.

Everyone can benefit

REEMAIN can benefit virtually any industry, claims Reñones. "The results of the demonstration activities regarding efficiency measures should inspire others to save energy, resources and money," he says. "Our results show how it is possible to invest time and money to analyse the manufacturing processes, to conduct an energy and resources study and finally to provide and implement replacements or modifications that reduce the consumption of energy and materials. This is what we call the REEMAIN methodology."

REEMAIN

- ★ Coordinated by CARTIF in Spain.
- ★ Funded under FP7-NMP.
- ★ http://cordis.europa.eu/project/rcn/109595
- ★ Project website: http://www.reemain.eu
- ★ https://bit.ly/2H51w2l

GENERATING 'AS-IS' 3D MODELS OF EXISTING INFRASTRUCTURE

There has been a lack of viable 'as-is' 3D modelling methods for existing infrastructure. Researchers have now recently fine-tuned the first scene and object detection method; capable of automatically modelling infrastructure from arbitrary 3D points while also estimating the layout and connections of the objects in 3D.

A major challenge faced by engineers today is that of effectively mapping and labelling existing infrastructure. Currently, over two thirds of the effort is taken up with manually converting clouds of points (coordinates) to a 3D model. The end result is few constructed facilities with a complete record of as-built information, information which is not produced for the vast majority of new construction and retrofit projects. It is estimated that this has led to rework and design changes costing up to 10% of the original installation cost.

The EU-funded INFRASTRUCTUREMODELS (Infrastructuremodels – Automated As-Built Modelling of the Built Infrastructure) project was set up to improve the situation by developing a means to detect and classify common building objects from visual and spatial data, reducing the time needed to create the as-built geometric Building Information Model (BIM). The project successfully created methods that generate slab, wall, room and floor objects/assemblies in point cloud datasets, quickly generating as-is 3D models of existing buildings, and reducing costs.

Exploiting the 'architectural priors'

As-built models are virtual, 3D object-oriented models of existing structures. Their difference with an as-designed model is that their dimensions are a true reflection of what is actually built.

Traditionally, attempts to render 'as-is' 3D infrastructure models have employed a somewhat bottom-up approach as they locate significant points, then find significant lines and planes, before moving on to objects. This however does not work so well for many infrastructural elements. As the project's coordinator Dr Ioannis Brilakis explains, "Many infrastructure objects are 'boring'. Columns, beams, slabs and walls for instance have very few significant points to distinguish them from each other."

To get around this challenge the INFRASTRUCTUREMODELS project focused on the contextual information that can make such objects distinguishable; their position in space, alongside their relationship to other objects. They achieved this feat by creating a set of segmented stages that broke down a building's point clouds into floors, rooms, walls/slabs, etc. As Dr Brilakis summarises, "Buildings are complex, but they all have floors, walls, doors and other key elements that have relatively well defined and standardised relationships with each other. These architectural priors are what we are trying to exploit to reduce complexity and assist the detection process."

The team used image analysis tools to visually characterise the infrastructure, identifying and numerically mapping the elements. These representations, along with their inferred topological relationships, constitute the 'elements' used by machine learning algorithms to create meaningful infrastructure categories for the models. The models can then automatically detect element types, with their relative positions, from a range of viewpoints. By estimating their distance to the observer and their 3D position in space relative to other points, these elements can be mapped onto the 3D point clouds and rendered with colour and texture to generate accurate models. As Dr Brilakis further enlightens, "Images are very useful in determining what category each object belongs to. For instance, a white colour on a vertically-aligned long and thin cuboid increases our confidence that we are looking at a wall object. A carpet pattern on that same object would infer something different."

The main challenge faced by the team was in collecting enough data to train the algorithms, with infrastructure often ranking low amongst all Big Data sectors. With points clouds being no exception, they found very few industry partners had them available to share. Furthermore, out of those available, most did not meet the required quality standard.

The project team is confident that their 3D models will benefit building tasks such as retrofitting energy infrastructure to fix problems, increase efficiency or improve green credentials. Another prime example of likely applications is for building operations management. Additionally, the impact from shut down management of industrial plants could be minimised, if as-built models of the plants were available.

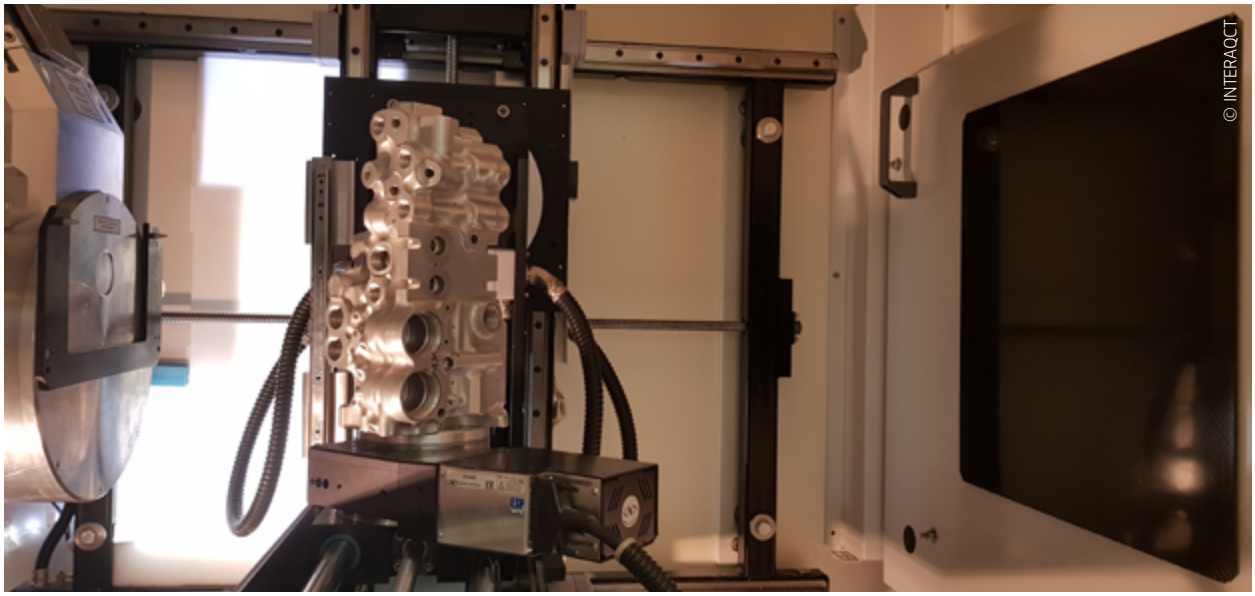
The team is currently in the process of setting up a commercialisation centre in Cambridge, UK, intended to boost the rapid development of this technology, alongside other associated advances. The aim is to bring products to market within two-three years.

INFRASTRUCTUREMODELS

- ★ Coordinated by the University of Cambridge in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ https://cordis.europa.eu/project/rcn/109137

IMPROVED X-RAY COMPUTED TOMOGRAPHY FOR QUALITY CONTROL OF ADVANCED MANUFACTURED PARTS

Innovations such as 3D printing, which enable the manufacturing of complex components, are advancing faster than the necessary quality control systems. An EU-funded project, INTERAQCT, has fine-tuned techniques for fast and accurate computer tomography (CT) model acquisition, with special emphasis on 3D printed, composite and multi-material parts, for improved reliability of measurement and defect detection.



A consequence of advanced manufacturing technologies is that some internal structures tend to be inaccessible and so quality control is necessarily destructive. This is clearly problematic for high added-value products, where customers nonetheless expect reliability and certified quality. CT has been heralded as an answer, making visible as it does internal structures and moreover combining dimensional metrology and material defect analysis. However, the technology has its limitations.

The EU-funded INTERAQCT (International Network for the Training of Early stage Researchers on Advanced Quality control by Computed Tomography) project created a research environment, harnessing a wide skillset to improve the industrial X-ray CT workflow. Amongst other successes, the 15 researchers improved verification procedures for acceptance testing of new CT equipment, enhanced a method to determine misalignments in CT systems (including software compensation, reducing measurement errors) and exploited the power of CT to minimise porosity formation in 3D printed parts.

Towards non-destructive testing

Innovative manufacturing techniques have enabled a range of desirable characteristics for high value-added components, such as high customisability (e.g. for implants) and light weight (e.g. for the aerospace industry), at lower cost and with increased efficiency. However, taking the example of 3D printing, the INTERAQCT project coordinator Professor Wim Dewulf points out, "Parts often have complex internal structures to combine high strength and stiffness, with low weight. Since these are not accessible to conventional quality inspection instruments, they can only be inspected by being opened destructively, after which the part needs to be made again, hopefully with similar quality."

CT takes X-ray images of an object from a variety of perspectives, then combines them to construct a 3D model of the object. Using X-rays means that manufacturers can also reconstruct the interior of the object. Putting this into context Professor Dewulf enthuses, "X-ray CT opens an unprecedented wealth of opportunities for non-destructive quality control, for example we can now measure the dimensions of complex internal structures, we can check whether the fibres inside a composite are correctly oriented and we can detect internal material defects, such as cracks and pores. We can even do all of these at the same time."

Contributing to the CT workflow, including improvements to the efficiency of the CT-equipment, CT-software, non-destructive testing, dimensional metrology, additive manufacturing, micro-manufacturing and composite manufacturing, necessitated a highly interdisciplinary team. The selected researchers represented a broad range of expertise encompassing physics, dimensional metrology, material sciences, precision engineering and manufacturing engineering, straddling European industry, academia and National Metrology Institutes.

Supporting the driving force of the European economy

In recent years there has been a push for a European industrial renaissance, against a backdrop of increasing outsourcing of mass production to lower wage economies. Efforts to safeguard and enhance this competitiveness will

benefit from a shift in focus from a cost-based competitive advantage to that of delivering demand-driven customised and high-quality products.

While innovative manufacturing technologies are key to this, widespread acceptance is dependent on the availability of techniques that can certify their quality. As Professor Dewulf reflects, "This remains a major challenge, since quality depends on internal structures and features that cannot be inspected by conventional means. By improving X-ray CT based quality inspection, INTERAQCT has contributed an increased acceptance of these novel manufacturing methods in industry."

Despite improvements in high-quality CT scans, they are still largely performed offline, requiring expert input when a new geometry is scanned. The INTERAQCT team are currently working to realise the readiness of industrial CT by making it fast, autonomous, robust and fully integrated. As Professor Dewulf concludes, "The vision is to integrate CT in a manufacturing environment in a way that allows 100% quality control of all parts made, and to use all CT scanning data to automatically adapt and improve the production process."

INTERAQCT

- Coordinated by Leuven Catholic University in Belgium.
- Funded under FP7–PEOPLE.
- http://cordis.europa.eu/project/rcn/109611
- Project website: https://www.interaqct.eu/

EUROPEAN MANUFACTURERS STILL STRUGGLING TO TRANSFORM THEIR BUSINESSES? SURVEY SAYS YES

New research highlights the challenges faced by European capital goods manufacturers in their transition toward service-oriented business models.

Within the fiercely competitive global market, manufacturers are under increased pressure to differentiate their businesses. A major route to achieve this involves 'servitisation', the transformation from traditional business models (BMs) to new service-oriented BMs. During this process, companies shift their focus from product-centric offerings to services and solutions. This is done in an effort to increase and provide steady revenues and to build sustainable competitive advantage.

But is this trend gaining momentum among European capital goods manufacturers? In order to analyse the uptake, a team of researchers carried out a survey as part of the EU-funded T-REX (Lifecycle Extension through Product Redesign and Repair, Renovation, Reuse, Recycle Strategies for Usage & Reusage-Oriented Business Models) project. They presented their findings in the 'International Journal of Engineering Business Management'.

The researchers argue that servitisation implies "not only a redesign of the value proposition but also companies' need to reshape their business models." They add: "However, manufacturers undertaking such a shift face numerous challenges that may lead to the so-called service paradox." When there is such a paradox, substantial investment in adding services to the existing product portfolio doesn't generate the expected higher returns.

The survey, which covered around 100 manufacturers, investigated the degree of service orientation of BMs of capital goods manufacturers that operate in the automation (e.g. system integrators, robot manufacturers), machinery (e.g. machine tools, packaging machines, textile machines) and transportation (e.g. forklifts, earth-moving machines) sectors. The respondents, operating mainly in Germany and Italy, were classified according to their size: micro and small (25%), medium (29%) and large (46%). The survey's reference framework included various aspects of the new BMs to become more service-oriented. These were value proposition, customer segments, customer relationships, service delivery channels, key resources and activities, partnerships, revenue model and cost structure.

Slow adoption of service-oriented BMs

The survey found that the adoption of service-oriented BMs was still low in the analysed sectors, particularly in the automation and machine tools industries, where revenues are still dominated by product sales, with services representing only 20%. "Although the majority of respondents believe that the importance of service business will increase in future (86% of the total), only 68% of them claim that services are already an important part of their company's business," the researchers noted. They emphasised that information systems and ICTs still have unexploited potential, especially in SMEs. The survey also concluded that customer relationships are transaction-based and that customers are perceived as an obstacle rather than an incentive to offer new service-oriented BMs.

The T-REX project worked to develop conceptual tools to implement and experiment through three industrial application cases. It created a new business platform to offer capital goods as new product-service systems. Through the three validated demonstrators in forklift trucks, machine tools and robot solutions, T-REX demonstrated that it's possible to create new service-oriented BMs. These can achieve up to 84% component reuse, a life-cycle extension in the range of 30-100%, and a reduction in maintenance service costs of 27-36%.

T-REX

- Coordinated by Tekniker in Spain.
- Funded under FP7-NMP.
- https://cordis.europa.eu/project/rcn/109189
- Project website: http://www.t-rex-fp7.eu/
- https://bit.ly/2H9XiCF

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INFORMATION AND COMMUNICATION TECHNOLOGY

LEADING-EDGE ARCHITECTURE TACKLES SAFETY AND CERTIFICATION HURDLES IN EMBEDDED SYSTEMS

In areas such as avionics, industrial control and healthcare, there is an increasing trend in the use of mixed-criticality systems, where multiple functions with different importance and certification assurance levels are combined on a shared computing platform. Key technological challenges serve as a roadblock to such systems' integration.

The foundations for this integration are mechanisms for temporal and spatial partitioning. This includes the combination of software virtualisation and hardware segregation, and the extension of partitioning mechanisms to jointly deal with important requirements such as time, energy and power budgets, reliability, safety and security.

Supporting integration of functions with different criticality on shared platforms

Platforms that encompass networked multi-core chips will also be required in many mixed-criticality systems. In addition, today's technology does not support the manufacturing of electronic devices with failure rates low enough to meet the reliability requirements of ultra-dependable systems.

To address these challenges, the EU-funded DREAMS (Distributed REal-time Architecture for Mixed criticality Systems) project "introduced a cross-domain architecture and design tools for networked complex systems that support the execution of application subsystems of different criticality levels on networked multi-core chips," says project coordinator Prof. Roman Obermaisser. The focus was on three application domains: avionics, wind power and healthcare.

Architectural style to guide mixed-criticality system development

By consolidating and extending architectural concepts from previous projects (e.g. ACROSS, ARAMIS, GENESYS, RECOMP), DREAMS introduced a new architecture style for the seamless virtualisation of networked embedded platforms. These platforms range from multi-core chips to cluster level with support for security, safety and real-time performance, as well as data, energy and system integrity. It defined a waistline architecture with domain-independent platform services. Such services can be successively refined and extended to construct more specialised platform and application services.

DREAMS' deliverables include certifiable platform services for virtualisation and segregation of resources at cluster and chip levels. Its adaptation strategies for mixed-criticality systems deal with unpredictable environment situations, resource fluctuations and the occurrence of faults, while ensuring predictability and safety. Integrated resource management was introduced for mixed-criticality systems involving monitoring, runtime control and virtualisation extensions that recognise system-wide, high-level constraints, such as end-to-end deadlines and reliability.

Project partners established a model-based methodology and prototypes of tools for mapping mixed-criticality applications to heterogeneous networked platforms, including algorithms for scheduling and allocation, analysis of timing, energy and reliability. As a foundation for modular certification, they provided modular building blocks that can be combined in a safety case for certification and increase the reuse possibilities of available evidence.

To validate the DREAMS approach, team members developed avionics, wind power and healthcare demonstrators. The demonstrators used and assessed the platform, tools and certification/development methods.

Lastly, DREAMS guided and boosted European research and technology awareness in distributed mixed-criticality and embedded computing systems. A mixed-criticality forum and a code repository were set up to provide news about events on mixed-criticality systems, projects, research results, technological building blocks and links to further information.

Cost and operational savings across the board

Prof. Obermaisser explains that the diminished need for over-provisioning of hardware resources will cut material and

maintenance costs. Simpler hardware, reduced wasteful spatial separation of components, less wiring and fewer component types will also significantly drop operational costs.

"By design, DREAMS will enable the integration of systems mixing different criticality levels at a cost much lower than the compound of individual systems," he concludes. "Results will lead to a significant reduction in development, life cycle and certification efforts, and enable mixed-criticality product lines."

A book will be published summarising the DREAMS goals, approach and achievements. Two other EU-funded projects are currently extending the DREAMS architecture for power/energy efficiency and train control and management systems.

DREAMS

- Coordinated by the University of Siegen in Germany.
- Funded under FP7-ICT.
- http://cordis.europa.eu/project/rcn/109896
- Project website: http://www.dreams-project.eu/
- https://bit.ly/2HF5ETx

PROGRAMMABLE MULTICORE OPTICAL FIBRES SET TO KEEP MOVIES AND MUSIC STREAMING INTO THE LATE 2020S

Streaming services like Netflix, Amazon Video and Spotify are making heavy bandwidth demands on today's optical communications networks. To ensure data capacity will be available in future, the SAFARI (Scalable And Flexible optical Architecture for Reconfigurable Infrastructure) project developed multicore optical fibres, compatible light amplifiers and novel programmable optical networking hardware – offering petabits-per-second speeds.

The volume of data traffic traversing the world's optical fibre networks is growing by more than 40% per year as data-hungry services like streaming audio and video become ever more popular. So that future networks have the capacity to cope with this ever-swelling traffic, and also handle emerging applications that will boost it still more – from connected cars to mobile HD video and the Internet of Things – the technologies that power long-haul optical networks are going to need a major upgrade in the mid-2020s.

Some of the key groundwork for this has now been laid by engineers working in SAFARI, an EU and Japanese collaborative project. The EU side was led by project co-coordinator Toshio Morioka from the Technical University of Denmark, whilst the Japanese side was led by project co-coordinator Dr Yutaka Miyamoto from NTT Corporation, Tokyo.

Photons torpedoed

The chief metric in need of vast improvement in laser-based Optical transport networks (OTNs) is data throughput – the number of bits of data per second they can carry encoded in laser beams. Today's individual optical fibres operate at several tens of terabits per second – but that is not going to be enough. "To support the huge capacity demands coming up in the future, far higher capacity transport networks with fibre speeds scalable to petabits per second will be needed," says Morioka.

To make this happen, the SAFARI collaborators have innovated on a number of fronts, in terms of both overall network control and light-carrying components, to produce building blocks for future OTNs that can boost their speeds from today's 10^{13} (tens of terabits) to 10^{15} (petabits) per second.

SAFARI's first innovation was to develop super-dense multicore optical fibres with 30, 32 or 37 light-carrying cores inside them rather than the single core used today. What allowed them to create this world-record number of cores, says Morioka, was working out a way to stop light from one core leaking into another and causing signal interference that would negatively impact bandwidth. "The fibres have a very high degree of crosstalk suppression," he says.

Into the matrix

When traversing large distances of 1000km or more, light travelling in this complex matrix of cores loses power and has to be boosted at regular intervals. To do this in a power-efficient way, the project team developed multicore optical fibre amplifiers, based on erbium and ytterbium, which can be spliced directly into the new multicore fibre, allowing loss-compensated transmission to be made over long distances. "We have broken core-count records, and enabled a reduction in power consumption for optical inline amplifiers, enhancing the power efficiency of future OTNs," Morioka says.

However it is not all about the waveguides: telecoms carriers also need to be able to dynamically allocate and optimise extra network resources, while maintaining quality, to meet spiking demand – like a whole nation wanting to watch the finale of 'Game of Thrones' on streaming video at once, for instance. So NTT developed programmable optical hardware that allows highly flexible, scalable and adaptive OTNs to be constructed.

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Programmable light

A SAFARI testbed was developed and built comprising of novel optics that allow for adding, blocking, passing or redirecting light beams in a fibre network under software control. This programmable network "can be adaptively controlled and managed in response to the actual traffic demands by a central entity," explains Morioka. The OTN's programmability has also been tested in experiments designed to ensure that it is suitable to meet the needs of multicore fibre transmission in the networks of the future.

With SAFARI not set for deployment until the mid-2020s there is no immediate commercialisation planned for the technology. But thanks to this successful

research project, the European and Japanese telecoms sectors will be ready when the time comes.

"SAFARI delivered world-leading technology, world-record and world-first network demonstrators and system experiments, joint intellectual property and partnerships that will last long into the future," concludes Morioka.

SAFARI
- ★ Coordinated by the Technical University of Denmark.
- ★ Funded under H2020-LEIT-ICT.
- ★ http://cordis.europa.eu/project/rcn/196615
- ★ Project website: http://www.ict-safari.eu/

TOUCHLESS SENSING: FROM SOMETHING YOU CAN FEEL TO SOMETHING THAT FEELS RIGHT

Helped by EU funding, Ultrahaptics is the first and only company in the world to develop a device which allows users to feel sensations with their bare hands while interacting in mid-air with a touchless sensing system. This frontier heralds a fundamentally new relationship with technology.


© UTOUCH

The EU-funded UTOUCH (Universal mid-air haptic feedback) project has enabled the development of ultrasonic speakers which project Invisible forces into the air, capable of being felt on human skin at a distance of up to one metre. The technology adds value to gesture-control applications, such as hand swipe recognition for control functions, providing reassurance in the user's selection.

Given that the technology can generate invisible buttons, dials and sliders that can be felt when needed, along with visible hand-tracking interfaces, the range of possible applications is almost limitless. The team were able to demonstrate some possibilities, including automative gesture control, household device controls, a holographic ATM, and transport interfaces for increased accessibility (e.g. for the visually impaired), at this year's Consumer Electronics Show, in Las Vegas.

An intuitive and simple technology based on complex mathematics

Explaining the technology, which grew out of a PhD project undertaken by the current Ultrahaptics Chief Technology Officer Tom Carter, UTOUCH project coordinator and Ultrahaptics CEO Mr Steve Cliffe explains, "We use 40 kHz ultrasonic transducers, much like those used in vehicle parking sensors and many other places. Based on the X and Y coordinates for our target reception area, we arrange the transducers accordingly so that we can project the sound at high pressure to the right place."

Motion sensor cameras are used in conjunction with the device, to continually track the position and activity of the hand. Knowing where it is and what it is attempting to do allows algorithms to inform the device about what kind of sensation to create and at which 3D coordinates. Sound waves and vibrations are then manipulated to sculpt a force onto the hand, creating the desired feeling and texture.

To get the technology to market the team could not simply make the device available to customers without integration support and so they created the Dev Kit. These are support tools comprised of development boards and software, with embedded Ultrahaptics systems, which enable a range of SMEs to code their own applications without having to undergo the Ultrahaptics evaluation programme. As Mr Cliffe recalls, "The EU support allowed us to demonstrate commercial traction, which was an essential precursor to attracting further investment."

Completely new interfaces

The team has been exploring a range of applications. Taking the car industry as an example, mid-air haptics combined with gesture recognition for in-car controls will mean that safety is increased with drivers concentrating on the road, with the responsive technology reinforcing and acknowledging control selection.

Invisible controls providing feedback for user interfaces without the need to touch an actual display has wide-ranging safety benefits. For example, in medical environments it can reduce pathogen transmission from surfaces and equipment. As the system even functions through surgical gloves, time currently taken during surgery between procedures for cleaning equipment could be reduced. The same hygiene and reduced maintenance principle also applies to public spaces, for example for elevators controls.

The technology can also be extended to the smart home and future workspaces where heating, entertainment, lighting, along with modern workstation elements relying on touch for activation (such as keyboards and mice etc.), could be replaced by haptic feedback gestures.

Speaking about some of the somewhat unexpected successes of the technology Mr Cliffe recalls, "Brand engagement is a fast moving sector. Take film posters, people typically currently spend 3.8 seconds looking at one. By making them more interactive with touchless sensing we get that dwell rate up to 10-15 seconds, and up to 30 seconds when we integrate gaming." A demonstration of this at CES included a poster which emitted lighting – which could be felt by visitors – from a sorcerer's orb. Indeed, the development team see the next frontier residing in mixed realities, blending Artificial Intelligence, Artificial Reality and Virtual Reality, of particular value to the gaming and entertainment industries.

The team is currently further developing textures, investigating the alteration of vibrations to vary sensations of softness and roughness. As Mr Cliffe summarises, "The technology will be ubiquitous, replacing many devices and procedures, where it will enhance safety and security, increase accessibility – for example for the blind – as well as delivering more unique, immersive and enriching experiences in daily life."

UTOUCH

- Coordinated by Ultrahaptics Limited in the United Kingdom.
- Funded under H2020-LEIT-ICT & H2020-SME.
- http://cordis.europa.eu/project/rcn/198538
- Project website: https://www.ultrahaptics.com/
- https://bit.ly/2qFF6KE

NEW-GENERATION GPGPUS INCREASE ENERGY EFFICIENCY BY AN ORDER OF MAGNITUDE

By catching up with GPGPU evolutions and parting ways with von Neumann architectures, the EXAFLOW project was able to successfully develop a new processor offering high performance and great energy efficiency.

We are all familiar with Moore's Law and, to a lesser extent, Dennard scaling. Their combination dictates that every year technological advances will see the number of transistors in the same area double without increasing their overall power consumption.

However, since 2005, this pace has been increasingly difficult to sustain. Transistors still get smaller, but power consumption increases with every new generation of devices. At the end of the tunnel is the power wall, where processors will consume too much electrical power for their size and simply burn out.

Engineers circumvented the problem by using multi-core processors. In doing so they created another wall – the programmability wall. This makes the development of software that is able to gather more power from concurrent processors, notoriously difficult. So how do we break these walls, you might ask? This is the million-dollar question the EXAFLOW (Reconfigurable non-von-Neumann Accelerators) project has been trying to answer.

"Breaking the power and programmability walls are two intertwined efforts," says Prof. Yoav Etsion, coordinator of the project for the Israel Institute of Technology. "The power wall requires us to come up with new computing models and processor designs that will be more power efficient than the prevailing 70+ year-old von Neumann model; and the programmability wall requires us to ensure that these new computing models will be easy to use and to program."

To get there, Prof. Etsion's team has designed a new type of processor. This relies on the Single-instruction, multiple threads (SIMT) processing paradigm – a paradigm that emerged from graphic accelerators (GPUs) like that of NVIDIA and AMD, and later resulted in GPUs for general purpose computing (GPGPUs).

"The EXAFLOW project set out to rethink the way we design GPGPUs. We wanted to fundamentally redesign the processor itself around the programming model, and not the other way around. And indeed, our latest results show that our processor dramatically outperforms GPGPUs whilst providing about an order-of-magnitude more energy efficiency," Prof. Etsion enthuses.

The secret behind this better performance lies in the use of the 'dataflow' execution model – a 50 year-old model that had yet to be used to execute concurrent (parallel) code. Dataflows execute instructions as soon as their dependencies are met. This is in contrast to von Neumann architectures that execute instructions when they get to the top of the stream, regardless of their dependencies. The latter Prof. Etsion compares to incandescent light bulbs, as far as energy efficiency is concerned.

The functional resources, as compared to standard GPGPUs, are the same but they are wired differently to allow intermediate values to be communicated directly between functional units. This allows the compute fabric to be almost 100% utilised.

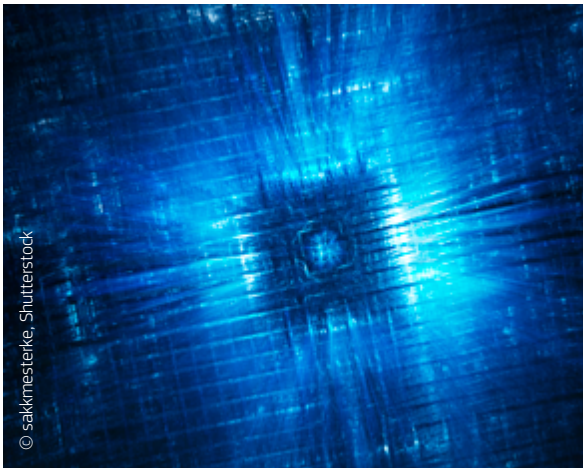
"We use two variants of dataflow ('static' and 'dynamic') at runtime, to extract instruction-level parallelism and execute concurrent threads out-of-order. Whenever an instruction from one thread is blocked on a long memory access, functional units go on to compute instructions from other threads. Finally, since intermediate values are communicated directly between functional units, we do not need a register file. This is another major energy saving," Prof. Dr Etsion explains.

By providing evidence that breaking away from the von Neumann model can offer great performance and energy consumption benefits, Prof. Dr Etsion hopes to inspire other researchers to explore new computing models that will eventually break the power and programmability walls.

He and his team are currently exploring opportunities to commercialise their processor, and will be exploring two different academic paths. "Firstly, my team is working on developing new processor architectures based on the dataflow model. And secondly, we are developing a new dataflow language for hardware design, which will make designers 10 times more productive. We hope to be able to present these in the near future," Prof. Dr Etsion concludes.

EXAFLOW

- Coordinated by Technion in Israel.
- Funded under FP7-PEOPLE.
- http://cordis.europa.eu/project/rcn/107458
- Project website: http://exaflow-project.eu/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SPACE

UPDATING THE DYNAMICAL PARADIGM FOR GALACTIC GLOBULAR CLUSTERS

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The dynamic properties of globular clusters are still relatively unknown even though they are often used by astrophysicists to gain insight into galactic properties. The EU-funded NESSY project set out to unveil some of their mysteries.

Globular clusters are collections of stars orbiting a galactic nucleus. They are traditionally considered to be simple, spherical, non-rotating and thermodynamically relaxed systems. This means the orbits of their member stars do not have a preferred orientation. For decades they have been held up as an exemplar of a so-called 'single stellar population': where stars are born together and share a simple formation history.

However, recently this traditional picture of globular clusters has been challenged by a series of discoveries about their chemical, structural and kinematic properties. Multiple stellar populations are now considered ubiquitous. The EU-funded NESSY (NEw Science from the phase space of old stellar SYstems) project, has contributed to this formulation of a more realistic dynamical paradigm for this class of stellar systems. It did so by combining analytical models and numerical simulations, alongside new-generation astronomical data.

NESSY addressed three problems facing modern astrophysics: the role of internal angular momentum and external tides on the dynamical evolution of dense stellar systems, the formation of stellar populations which are among the oldest in the universe, and the possible existence of intermediate-mass black holes.

The new-generation of astronomical data

Gaia, the European space observatory, is now measuring the positions and the velocities of thousands of stars in globular clusters in our Milky Way, with unprecedented accuracy. This new generation of data, coupled with measurements by the Hubble Space Telescope and other state-of- the-art astronomical facilities, enable theorists to explore, for the first time, the full 'phase space' of star clusters by studying both the position and velocity of their stars.

As a NESSY researcher, and recipient of a Marie Skłodowska-Curie Individual Fellowship, Dr Anna Lisa Varri says, "These compact groups of stars truly are the pocket Swiss Army Knives of astrophysics, as they have been used for countless purposes, over many decades. Yet, the study of the motions of their stars is still trapped within a narrow range of simplifying assumptions. And world-class astronomical facilities are now unleashing a flood of data on such objects, which current theory cannot match."

Among its contributions, the team has helped develop a new understanding of the role of kinematic complexity, in the form of internal rotation and velocity anisotropy (different properties, in different directions), in the long-term dynamical evolution of collisional systems such as globular clusters. NESSY also contributed to the development of a dynamical model of a Galactic cluster, 47 Tucanae, which describes its rich structure in velocity space. This reveals an unexpected degree of internal rotation.

The role of angular momentum is one aspect that can clarify the internal dynamics of collisional systems, such as globular clusters. As Dr Varri points out, despite a dearth of research into the phenomena, "An increasing number of young and old star clusters are now being observed to have evidence of rotation. Indeed, it is possible that the presence of some angular momentum may actually accelerate the dynamical evolution of such systems."

Taking the research into a new era for astrophysics

NESSY's work will be advanced through collaboration with Edinburgh University's School of Mathematics, to further investigate the role of kinematic complexity, looking at equilibrium, stability and the evolutionary properties of dense, rotating stellar systems. It is hoped this will enrich our understanding of globular star clusters and galactic nuclei. As Dr Varri explains, "Stemming from this, I will continue to study the implications of kinematic complexity on two outstanding puzzles in my field: the dynamical dimension of the multiple population phenomenon and the formation of intermediate-mass and stellar-mass black holes."

In fact, the presence of internal rotation may significantly affect the size of the parameter space in which the collisional processes that lead to the formation of black holes in clusters can take place, as well as their outcome. Thanks to NESSY's study into kinematic

complexity, researchers can now investigate the implications of these additional degrees of freedom for the formation and retention of black holes in dense stellar systems. As Dr Varri says, "This topic is particularly timely given that, thanks to the LIGO interferometer, there is now a new astrophysical window to explore black hole physics, such as gravitational waves."

NESSY

- Coordinated by the University of Edinburgh in the United Kingdom.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/195550

EUROPEAN SMES READY TO CLEAN UP OUTER SPACE

EU-funded SMEs have validated the first European system for removing space debris with nets, thanks in part to SME Instrument funding.

The ADR1EN (First European System for Active Debris Removal with Nets) project was able to not only develop and test in lab-simulated operational conditions a scaled-up demonstrator of the innovation, but also develop the necessary business and commercialisation plans to reach the market and boost growth.

"Thanks to the ADR1EN project and our inclusion in the European Space Agency (ESA) list of companies recognised for their know-how in space debris removal, we look forward to taking part in the first European mission to remove a dead satellite, e.Deorbit, programmed for 2023," says project coordinator Umberto Battista from Stam, Italy. "While robotic arms and harpoons are alternative technologies for space debris capturing, the great advantage of nets is that they are lightweight and safer as they can be launched from far away."

Safer space

The innovation works by trapping debris in a net, which can then be towed away by a chaser spaceship by a tether connected to the net. The debris is then burnt in the atmosphere or moved out of harm's way (at a safer orbit for example). The ADR1EN project brought together three highly specialised SMEs (Stam, as well as Polish firms SKA Polska and OptiNav), which were keen to take this system to the next level.

Stam, the coordinator of the project, was in charge of up-scaling the net ejector and developing the business plan; SKA Polska was responsible for the development of the net simulator and the capturing net; while OptiNav was in charge of developing the test rig and performing the full-scale free fall tests on the ground. Thales Alenia Space Italy provided a thermal-vacuum chamber and contamination test facilities, while Franco Malerba, the first Italian astronaut, acted as the project's business coach.

"We had already developed at the small scale a debris capturing system to protect space infrastructures like satellites from the increasing amount of debris orbiting Earth," explains Battista. "Having validated the system at zero-gravity, we identified the SME Instrument as an ideal funding mechanism to support the financial risks involved in addressing the remaining technical and non-technical barriers to market entry."

A global market

Following successful validation of the technology through the ADR1EN project, Battista believes there is real market potential. While around 7 200 satellites have been launched, only around 1 400 are still in operation. The rest are derelict and beginning to fragment. In fact, an estimated 750 000 pieces larger than 1 cm are now orbiting the earth, presenting a clear and present danger to expensive satellite equipment and space stations.

"The space environment might not be sustainable if no mitigation or remediation efforts are undertaken," says Battista. "Debris generation is steadily increasing, and with each collision generating even more space debris, the likelihood of further collisions is enhanced. If we launched 10 space debris removal missions a year, then it would still take about two centuries to restore the space environment to a stable level."

This is a truly global issue. More than 50 countries operate at least one satellite, while space infrastructures such as the International Space Station, the Galileo satellite constellation and the Copernicus Earth-observation satellites represent billions of euros in investment.

"We think that the ADR1EN system can help address the risk of collision by directly reducing the amount of debris," says Battista. "This will allow satellite operators to avoid extra expenses due to debris collisions and extend the life span of the equipment. There is also the possibility of exploring more down-to-Earth applications for the net technology, such as neutralising offensive drones."

ADR1EN

- Coordinated by Stam in Italy.
- Funded under H2020-SMEINST.
- http://cordis.europa.eu/project/rcn/196408
- Project website: http://www.adr1en-project.eu/
- https://bit.ly/2H7L1mh

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BIGGER PIPES IN SPACE FOR HANDLING THE DATA EXPLOSION

Earth observation is being held back by our inability to transport all the data generated down to Earth. Irish researchers have developed a new set of pipes, in the shape of a smart system of optical feeder links, to fix the data bottleneck.

Observing the planet from space could help manage disasters, track climate change and help farmers and people monitor wildlife. But the growth of Earth observation (EO) is being held back by the lack of capacity for getting the data from the satellites back to Earth. Researchers from the EU-funded RAVEN (Real Time Access To Virtual Earth Observation Network) project are aiming to fix this bottleneck by developing optical feeder links which can do this in real time.

Until not so long ago, a satellite might cost EUR 100 million to build and be about the size of a double decker bus. But the advent of smaller, cheaper cube satellites is changing all this and, in the process, lowering the entry barriers to space.

"Where before space was dominated by government bodies, now it is becoming a place to do business," says John Mackey, RAVEN project coordinator and CEO of photonics specialists mBryonics of Galway, Ireland. One example is Planet Labs, set up by ex-NASA scientists in 2010, which recently began imaging the Earth on a daily basis.

Worn-out pipes

New initiatives such as this are regularly generating petabytes of data, but the pipes for bringing the data down to Earth are beginning to show their age.

This is where RAVEN comes in. "We are creating whole new pipes for sat coms which is likely to revolutionise how satellites can be used for communication purposes," says Mr Mackey.

mBryonics has developed an intelligent architecture for optical communications in space that can link a constellation of satellites in an automated, transparent way and creates a virtualised distributed ground segment. "It minimises the number of ground stations you need and allows you to get that data down… in near real time," says Mr Mackey.

This photonics system not only can handle 10 gigabytes per second of data but is also considerably lighter and cheaper than existing solutions. "We have managed to miniaturise the whole system down with a revolutionary Size, weight and power (SWaP) and the price point is considerably less so it is suitable for small platforms and mass production," says Mr Mackey.

Optical brains

The team has developed an ArcLight™ modem – an optical software-defined network which acts as a kind of optical brain allowing satellites to communicate with each other. They have also used RAVEN funding to explore the potential of EO from High Altitude Platforms – constellations of balloons, airships or drones which fly 20 kilometres above the Earth in the stratosphere.

As well as advancing the technology, mBryonics has used the six-month duration of RAVEN to talk to key stakeholders in the satcom ecosystem about what they need from a photonics system. "H2020 is a nice door-opener when you want to have conversations with people as it gives prestige," says Mr Mackey.

The team now has a prototype adaptive optics phased array feeder system and plans to apply for RAVEN II funding to develop it further. The future looks bright for this kind of technology, they believe, and not only for EO. The coming explosion in data, driven by developments such as the launch of 5G mobile in 2020, means existing networks will be unable to cope, predicts Mr Mackey.

"When it comes to 5G, the data crunch is going to be phenomenal – Earth-based systems will be overwhelmed and satellite systems will come into their own to backhaul data as a kind of alternative routing option. The bi-directional feeder system will be key because you will need to route the data in an intelligent way," he says.

RAVEN

- Coordinated by mBryonics in Ireland.
- Funded under H2020-SMEINST.
- https://cordis.europa.eu/project/rcn/210436
- Project website: http://www.mbryonics.com/

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FUNDAMENTAL RESEARCH

EU PROJECT PIONEERS NEW WAVE MATERIAL ANALYSIS

EU-funded researchers have expanded the scope of wave modelling to accurately predict the behaviour of certain porous materials. This could facilitate the development of new high tech industrial equipment, more accurate medical diagnoses and new geological discoveries.

"The internal structure of certain materials can be highly complex," explains MUSAL (Multi-scale modelling of waves of porous media with applications to acoustic control and biomechanics) project coordinator Professor Graham Rogerson from Keele University in the UK. "A good example is a type of material known as heterogeneous porous media, which importantly contain voids. Human bone is a good example of this material occurring naturally."

Heterogeneous porous materials have also been developed synthetically in response to specific industry demands, for example as an effective insulation material against noise. "Heterogeneous media behave differently to homogeneous solids," continues Rogerson. "Understanding their remarkable effects has led to the design and development of new engineering devices. These include acoustic absorbers, ultrasonic transducers and transmitters in the aerospace and automotive industries."

Identification portrait

The two-year EU-funded MUSAL project was launched in 2015 to assess the application of elastic wave modelling on heterogeneous media, and whether this can be expanded to accurately and efficiently predict the behaviour and properties of certain materials. One key advantage is that the wave data collected can be interpreted and assessed without the need for invasive analysis. "The modelling of wave propagation in heterogeneous media could really benefit mechanical and civil engineering for example, because it offers a non-destructive means of testing materials and structures," says Rogerson.

Wave patterns represent a kind of 'identification portrait', unique to every material. The larger the frequency range that can be explored, the more accurate the 'portrait' will be. By increasing this range, the MUSAL project has opened up the possibility of detecting minute variations in a material's microstructure and developing new, more precise methods of acoustic diagnoses.

"To date, many theoretical approaches to wave propagation in heterogeneous media have been applicable in only a few limited cases," says Rogerson. "We have developed new theoretical models that are applicable across a wider frequency range."

Industrial applications

Solutions for several challenges related to specific examples were achieved during the project. Potential end users include engineers, who can directly employ the project's methodology to design new types of materials and devices for various applications in industry, medicine and geophysics.

In biomechanics for example, live tissue – such as bone – can be modelled by porous media. The EU's Consumers, Health, Agriculture and Food Executive Agency estimates that 22 % of the EU population experience long-term muscle, bone and joint problems, from which significant economic and social issues result. "Many people worldwide suffer from osteoporosis, a progressive bone disease that is characterised by a decrease in bone mass and density," says Rogerson. "Since osteoporosis itself has no symptoms, the detection of the bone structure using non-invasive testing is a major challenge."

The MUSAL project has shown a correlation between wave speed and bone density. This could potentially be used for the early detection of osteoporosis, helping to slow or even stop progression of the disease through early intervention and therapy. "The results obtained and resulting methodologies established could have far-reaching implications for the detection and monitoring of a number of chronic bone and joint conditions," says Rogerson.

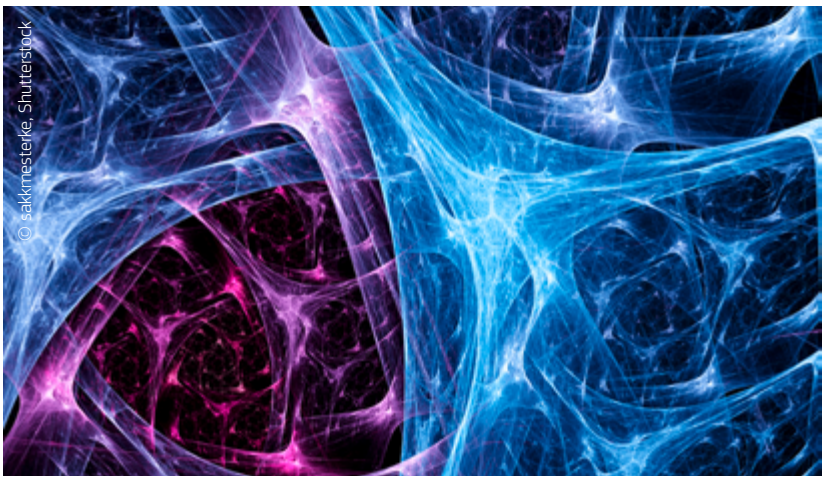
The study of wave propagation in porous media could also be important for geological explorations. Better understanding of how the internal texture of soils and rocks affects the characteristics of travelling elastic waves may help to develop new robust methods for detecting gas and oil reserves. Again, this underlines the far-reaching implications of the pioneering work conducted by the MUSAL project.

MUSAL

- Coordinated by Keele University in the United Kingdom.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/195065
- Project website: https://www.researchgate.net/project/Multi-scale-modelling-of-waves-in-porous-media-with-applications-to-acoustic-control-and-biomechanics

HOW THE STUDY OF DYNAMICAL SYSTEMS HELPS US BETTER UNDERSTAND QUANTUM CHAOS

An EU-funded study into the evolution of dynamical systems has led somewhat unexpectedly to improved knowledge about the chaos of the quantum world.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Within the field of mathematics, dynamical systems theory studies the evolution of systems that change in time. Using the so-called 'evolution rule' within the approach, researchers should be able to describe future states of phenomena, based on their current states. Predictions could benefit a wide range of fields beyond mathematics, including physics, biology, chemistry, engineering, economics and medicine.

The EU-funded LDMRD (Large Deviations and Measure Rigidity in Dynamics) project was set up to develop new tools in dynamical systems theory, while exploring applications for problems related to mathematical physics, geometry and arithmetic. One of the principal objectives of the project was to further investigate 'measure rigidity' which can aid precision measurements when more than one dynamical system behaves very differently over time.

Applying the tools

The so-called 'evolution rule' in dynamical system theory is largely deterministic, meaning that for a specific period of time only, one future state follows the current state. However, some systems are more chaotic in that random external events can actually influence the outcome within systems. It is for this reason that dynamical systems theory has proven particularly applicable to quantum mechanics. As LDMRD project coordinator Dr Tuomas Sahlsten explains, "It has been particularly useful for studies of systems that are 'chaotic', in the sense that two systems can evolve into dramatically different trajectories, even if they start off being close to each other."

The tools required to explore measure rigidity in dynamic systems (based on the work of Bernard Host in the 1990s) were still too far beyond those currently available, which necessitated the team's acquisition of learning from surrounding disciplines. Thus they borrowed from number theory, representation theory, quantum chaos and other disciplines.

As a by-product of this process the researchers discovered the applicability of the project to quantum mechanics which led to a new thermodynamic quantum chaos theorem, combining ideas from large networks. Large networks – such as Big Data, social networks, convolutional neural networks in Artificial Intelligence models – while currently in common use, do not yet have adequate theories to explain how they function. One approach traditionally taken is that of applying spectral theory, and the LDMRD team managed to produce fresh insights into the spectral theoretic properties of large-scale surfaces, which are analogues of large-scale networks.

As Dr Sahlsten reflects, "By far, the discovery of the quantum mechanical connection was the most surprising and exciting aspect of the project. Sometimes it is hard to predict before starting the research what discoveries emerge when you actually begin the process."

Reaching a deeper understanding of quantum chaos

With a deeper understanding of quantum chaos, the project has made a major contribution to the understanding of the time evolution of quantum states in chaotic dynamical systems, viewed over a long time period. Being concerned with pure mathematics, the immediate impact of the project will

be felt most directly by the quantum mechanics scientific community. Indirectly, as this community plays a major role in realising modern scientific advances and technologies, from weather/climate studies to computer engineering, the project will be contributing to some significant social challenges.

In the shorter term as Dr Sahlsten puts it, "The next main step is to continue on the quantum chaos questions that are now wide open after our major breakthrough with colleague Etienne Le Masson. Our work has opened a new emerging direction and could lead to major improvements for understanding the theory of large networks."

LDMRD

- Coordinated by the University of Bristol in the United Kingdom.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/195089
- Project website: http://personalpages.manchester.ac.uk/staff/tuomas.sahlsten//LDMRD.html

GEOMETRICALLY EXAMINING THE EQUATIONS THAT DESCRIBE THE WORLD'S PHENOMENA

The EU-funded GEOGRAL (Geometry of Grassmannian Lagrangian manifolds and their submanifolds, with applications to nonlinear partial differential equations of physical interest) project strove to find a geometric way to characterise a special family of partial differential equations that characterise every single phenomenon of the world we inhabit.

Solving a particular equation can unlock a myriad of potential opportunities for mathematicians, scientists and engineers, but it often takes a long time for those applications to become evident.

The EU-funded GEOGRAL project is focusing on a particular family of equations, called Partial differential equations (PDEs), which can be used to describe many of the phenomena present in the world.

"PDEs are the equations describing virtually every single phenomenon of the world we live in," says Prof. Janusz Grabowski of the Institute of Mathematics at the Polish Academy of Sciences.

Some of these phenomena include: how the economical problem of optimal allocation of resources is described by the so-called Monge-Ampère equation; how the recently discovered gravitational waves were predicted by the famous Einstein equation; and how modern methods for weather forecasting are based on the equations describing the behaviour of fluids. "A PDE manages to formalise, in mathematical terms, the fact that the present behaviour of a phenomenon is dictated by his past history," continues Prof. Grabowski.

A typical example of this is how one of these equations can describe the growth of a population of bacteria. If the initial population consists of a single bacterium, then after one minute there will be two bacteria, after two minutes four, after three minutes eight and so on, in a pattern of exponential growth. The increase in the population depends on how long the multiplication process has been going on: at the very beginning the population grows by only a few elements, but after one hour, billions of bacteria could exist.

Geometrically characterising PDEs

The unique research objective of the project was to find a geometric way to characterise this special family of PDEs. There is a long tradition of applying geometry to PDEs that has existed since the beginning of the 20th century. Establishing a geometric methodology could enable mathematicians to distinguish this special family from all other PDEs. However, the skills needed to visualise a PDE as a geometric object require years of study.

Fundamental research into such domains is essential to ensure that science, research and engineering can move forwards based on strong mathematical foundations.

Searching for PDES with certain symmetries

Researchers often have to search to find the equations that might potentially solve a certain phenomenon. They do this by identifying certain 'symmetries' that the phenomenon expresses, and then investigating a series of PDEs until they discover one that expresses the same symmetries. The GEOGRAL team successfully devised a general procedure that, starting from an arbitrary group of symmetries, produces a PDE exhibiting exactly those symmetries.

The project also successfully published several papers that detailed spin-off results. "These results represent a strong confirmation that geometry can be successfully employed in answering questions concerning PDEs," says Prof. Grabowski. "The results obtained by GEOGRAL certainly represent a source of inspiration for working experienced mathematicians and of motivation for the young ones wondering whether to pursue a career in science."

Over a long time scale, he concludes, "it may be speculated that a deeper geometric understanding of PDEs may eventually help in describing physically relevant phenomena, possibly, and hopefully, in synergy with the existing powerful numerical methods."

GEOGRAL

- Coordinated by the Polish Academy of Sciences in Poland.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/194986

CROSSTALK IN SOCIAL DILEMMAS COULD HINDER COOPERATION

A new mathematical framework taking into account 'crosstalk' and incorporating the impact of players' interactions in simulations of repeated social dilemmas could help better analyse cooperation dynamics within a population.

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"In today's highly connected world, a harsh cooperation strategy such as 'tit-for-tat' is particularly unable to deal with crosstalk."

The analysis of social dilemmas, situations in which private interests are at odds with collective interests, has attracted a great deal of attention among researchers. This is not surprising because various challenging problems that we face – from the depletion of natural resources to intergroup conflict – are, at their core, social dilemmas.

Researchers frequently use the experimental games method to study such problems with computer simulations. An experimental game – such as the prisoner's dilemma – is a situation in which participants choose between cooperative and non-cooperative alternatives, yielding consequences for themselves and others.

Analyses of this phenomenon have previously assumed that a player engages in only one repeated game at a time, or that a player's action in one game is independent of all of their other interactions. However, a team of scientists, supported by contributions from the EU-funded GRAPH GAMES (Quantitative Graph Games: Theory and Applications) project, argued that these assumptions don't necessarily apply to real-life social dilemmas where humans are often involved in many simultaneous games, and interactions with other players spill over into other games, meaning these games involve crosstalk.

In such social dilemmas, mutual cooperation is better than mutual defection, and yet there is an incentive to defect. Direct reciprocity, which is based on repeated interactions between the same two players, is a mechanism for cooperation: 'I help you and you help me'. Cooperation can be achieved if participants in such games adopt conditional cooperative strategies such as 'tit-for-tat' (I begin by collaborating and then I'll do whatever you did last), or 'win-stay, lose-shift' (I begin with cooperation, then I'll continue doing what I'm doing until I lose).

Researchers from IST Austria and their collaborators at Harvard, Yale and Stanford Universities examined cooperation dynamics through repeated games and introduced a new framework to analyse crosstalk between a player's concurrent games. Writing in the journal 'Nature Communications', they said "a player's decision is subject to 'crosstalk' when an interaction that a player has in one repeated game influences how the very same player behaves in another repeated game."

In order to quantify the overall effect of crosstalk, the researchers represented the structure of the population by arranging players on a graph. The team's findings showed that in the presence of crosstalk, even a single defective player can cause the complete breakdown of cooperation in a society. "Nevertheless, cooperation can prevail if the population is structured and if subjects are sufficiently forgiving," the researchers noted.

According to a statement by one of the research institutes involved in the project, "crosstalk also necessitates strategies with the 'correct' level of forgiveness: too harsh, and you end up with a society where no one cooperates, too generous, and defection can also spread as players learn to take advantage of other players."

The paper concluded that in today's highly connected world, a harsh cooperation strategy such as 'tit-for-tat' is particularly unable to deal with crosstalk.

Some of the discoveries in the GRAPH GAMES project included the analysis of multi-dimensional quantitative objectives in graph games. Results included applications of graph games in domains such as design of security protocols (that are correct by construction and attack-free), and evolutionary game theory (for modelling problems related to population dynamics or model growth of cancer).

GRAPH GAMES

- Hosted by the Institute of Science and Technology Austria.
- Funded under FP7-IDEAS-ERC.
- https://cordis.europa.eu/project/rcn/100026

EVENTS

JUNE 11

Berlin, GERMANY

WORKSHOP

GERMANY – WORLD CHAMPION OF ENERGY EFFICIENCY?

The EU-funded ODYSSEE-MURE project, in cooperation with DENEFF and eceee, will be running a workshop in Berlin, Germany, on 11 June 2018.

The new German coalition government has announced: "We will make Germany the most energy-efficient economy in the world". But which country is in pole position currently – who is lagging behind – and why? What are the drivers or barriers to success? What can be learnt from each other to achieve higher improvement rates and thus achieve national and international energy and climate targets?

The EU project ODYSSEE-MURE has developed a toolkit for ranking energy efficiency improvements in the EU Member States and also providing in-depth data on key indicators and national policies. The aim of the workshop is to meet with national policy experts and participants from the ODYSSEE-MURE team to discuss methodologies and ways forward regarding policy approaches such as:

- the German National Action Plan on Energy Efficiency (NAPE)
- Danish experiences with Energy Efficiency Obligations
- Carbon taxes or Energy Efficiency Obligations?
- Irish tax incentives for the industry sector (accelerated capital allowances)

For further information, please visit:
https://www.eceee.org/industry/programme/preconf-workshops/odyssee-mure/

JUNE 18▶20

Venice, ITALY

CONFERENCE

FEAST 2018 CONFERENCE

The EU-funded SIGN-HUB project will be holding a final project conference in Venice, Italy, on 18-20 June 2018.

The seventh meeting of the Formal and Experimental Advances in Sign language Theory (FEAST) colloquium will take place at the University of Venice on 18, 19 & 20 June 2018.

FEAST is the official conference of the research project SIGN-HUB (The Sign Hub: Preserving, Researching and Fostering the Linguistic, Historical and Cultural Heritage of European Deaf Signing Communities with an Integral Resource) (http://www.sign-hub.eu) (2016-2020), funded by the European Commission within the Horizon 2020 programme.

The official languages of the conference will be English and ASL. Interpreting between ASL and English will be provided.

FEAST is a regular forum for discussing formal approaches to sign language grammar (in particular in the generative tradition), experimental approaches to sign languages and their interaction.

For further information, please visit:
https://sites.google.com/site/feastconference/feast-2018-venice

EVENTS
For more forthcoming events:
http://cordis.europa.eu/events

JUNE 19

Amsterdam, THE NETHERLANDS

WORKSHOP

REFRESH POLICY WORKING GROUP ON VOLUNTARY AGREEMENTS

The EU-funded REFRESH project will be running a workshop in Amsterdam, the Netherlands, on 19 June 2018.

Interactive working group in Amsterdam: How can Voluntary Agreements between food value chain stakeholders be a key policy instrument for food waste reduction?

This working group is the first in a series of four workshops focusing on policy options to reduce food waste (held between June 2018 and January 2019). The event aims to put the spotlight on Voluntary Agreements as a policy instrument for more sustainable food systems. Member State representatives and policy experts will be invited to discuss this subject during the working group in June, targeting two key questions:

- Why are Voluntary Agreements key instruments for food waste reduction?
- How can they be set up at the national level?

Previous research conducted within the REFRESH project has identified food waste drivers as cross-cutting by nature, and further studies have highlighted the relevance of multi-stakeholder collaboration. In light of these findings, Voluntary Agreements and multi-stakeholder collaboration have been identified as key policy approaches to address the issue of food waste throughout food supply chains.

For further information, please visit:
http://eu-refresh.org/refresh-policy-working-group-voluntary-agreements

JUNE 26▶29

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Corfu, GREECE

WORKSHOP

PEARL WORKSHOP: PATIENT DATA ACQUISITION, ANALYSIS, PROFILING AND PERSONALIZED CARE PLAN

The EU-funded CAREGIVERSPRO-MMD and ICT4Life projects will be running a workshop in Corfu, Greece, on 26-29 June 2018.

CAREGIVERSPRO-MMD and ICT4Life will jointly run the PEARL Workshop: Patient Data Acquisition, Analysis, Profiling and Personalized Care Plan, on 26-29 June 2018, in Corfu, Greece, within the activities of the PETRA (PErvasive Technologies Related to Assistive Environments) 2018 conference.

People with Dementia, Alzheimer's or Parkinson's disease have many problems managing by themselves and require care. As the impairment increases, the caregiver (family member or professional) needs to dedicate much more time and mental and physical effort. Technology along with medical expertise can be used in order to assess the patient's medical and cognitive status, thereby decreasing the need for continuous caregiver presence and, at the same time, increasing the patient's independence and quality of life. To this end, sensors and wearables along with social networking platforms can be used to manage patients' profiles and generate medication recommendations and personalised care plans.

The workshop aims to bring together researchers from various scientific domains relevant to this multidisciplinary field of research, as well as present the results from the two EU-funded projects.

For further information, please visit: http://petrae.org/workshops/PEARL.html

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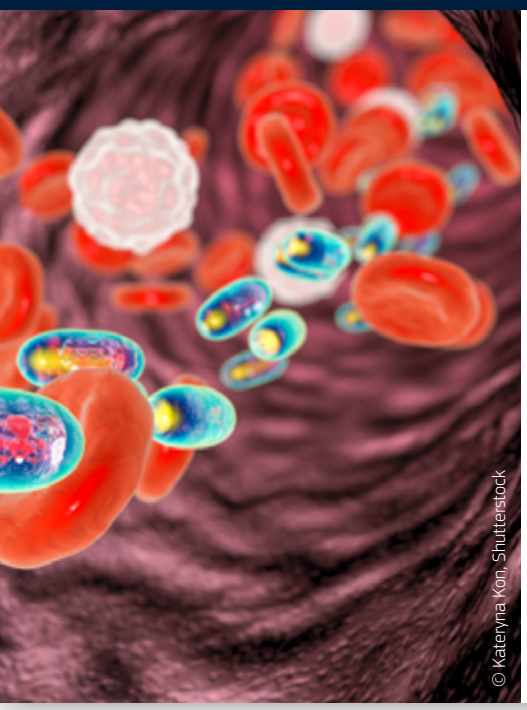

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research*eu Results Pack

Nanomedicine – innovative ways of treating challenging conditions

The application of nanotechnology to health ('Nanomedicine') raises high expectations for millions of patients hoping for better, more efficient and affordable treatment.

Nanomedicine has the potential to provide personalised, yet more affordable, healthcare while at the same time offering improved quality of life for the sick and injured. From drug delivery targeted to specific cells, to regenerative medicine for patients with organ failure or severe injury, nanomedicine opens up numerous potential pathways to improving medical diagnosis and therapy.

This Results Pack showcases 10 projects whose research is opening doors to new opportunities for patients, as well as fostering the vital contacts between researchers, industry and financial intuitions to take these technologies further.

Please see the following link for more information:

https://cordis.europa.eu/article/id/400909-nanomedicine-innovative-ways-of-treating-challenging-conditions_en.html

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