ISSN 1977-4028

European Commission

research*eu

RESULTS MAGAZINE

N°71
APRIL 2018

SPECIAL FEATURE

NEW WEAPONS IN THE WAR AGAINST MALARIA

ENERGY

SMART TECHNOLOGY FOR MORE EFFICIENT ENERGY USE IN NEIGHBOURHOODS

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research*eu
RESULTS MAGAZINE

Published
on behalf of the European Commission
by CORDIS at the
Publications Office of the European Union
2, rue Mercier
2985 Luxembourg
LUXEMBOURG
cordis@publications.europa.eu

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ISSN 1831-9947 (printed Version)
ISSN 1977-4028 (PDF, EPUB)
Catalogue n° ZZ-AC-18-003-EN-C (printed Version)
Catalogue n° ZZ-AC-18-003-EN-N (PDF)
Catalogue n° ZZ-AC-18-003-EN-E (EPUB)

Luxembourg: Publications Office of the European Union, 2018

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EDITORIAL

by the editorial team

ENDING MALARIA FOR GOOD: THE PATH TO MEETING WHO TARGETS

The 25th of April will be World Malaria Day – an event organised by the World Health Organisation (WHO) to remind us that, although the disease is only plaguing tropical and sub-tropical regions of the world, we should all feel concerned about it. Whilst it may seem abstract to many Europeans, malaria still kills about 400 000 people every year.

Sure, using the right drugs at the right time can cure patients. But the problem lies elsewhere. In the world's poorest and most remote regions, access to treatment and preventive means, such as insecticide-treated nets, is poor or sometimes even nonexistent. Whilst WHO figures show that malaria death rates fell by 29 % between 2010 and 2015, the organisation's objective of reaching a 40 % reduction by 2020 requires much more effort, particularly from researchers.

'In the world's poorest and most remote regions, access to treatment and preventive means, such as insecticide-treated nets, is poor or sometimes even nonexistent.'

Firstly, there is still much we don't know about malaria, be it with regards to insect vectors, which are the cellular and molecular events that enable the malaria parasite to live and replicate in its mosquito and human hosts, or possible new ways of treating the disease or vaccinating patients at risk. Some of the projects selected for this month's special feature section have just so happened to advance research in these fields. These include SugarBlock, which improves our understanding of glycans at the surface of malaria parasites; SPARk, which studied the sexual differentiation process of the deadliest malaria parasite; MultiMalVax and its new malaria vaccine; and PathCO, which studied malaria from the wider perspective of its interaction with other viruses.

Then, there is the need to go beyond the lab by seeing first-hand what the populations at risk truly need, and to see how prevention can be improved. A project such as SUPPORTING LIFE, for instance, can considerably contribute to faster and more informed medical decisions. Sometimes, scientists can even go into the field to start thinking outside the box, just like partners under the PLANTMEDS project did. Together, they put traditional Cameroonian herbal medicines to the test for the identification of novel compounds capable of taking on not only malaria but also cancer.

The nine projects focused on malaria are followed by our usual thematic sections on health, society, energy, environment, aquatic resources, industry, information and communication technology, security 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: editorial@cordis.europa.eu

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Focus on
Laying the tracks for a truly 21st century European railway

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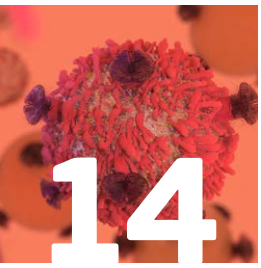

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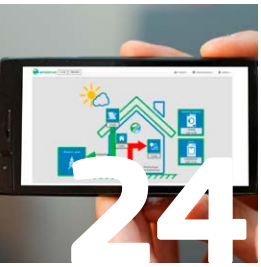

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SPECIAL FEATURE

NEW WEAPONS IN THE WAR AGAINST MALARIA

A NOVEL ANTI-MALARIA VACCINE

About half a million people every year die of malaria. The majority of vaccine candidates developed over the years have failed to achieve malaria control.

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Malaria, caused by the protozoan parasite Plasmodium falciparum, is transmitted by infected female Anopheles mosquitoes. Invading parasites initially migrate to the liver and undergo a complex life cycle comprising four stages, namely the sporozoite, hepatic, blood and mosquito stages.

So far, malaria vaccine development has proved difficult, mainly because of the differential gene expression of each life cycle stage and the substantial polymorphism of many parasite antigens. Vaccine clinical trials have demonstrated the importance of correct antigen conformation during vaccine production and underscored the need for exceptionally potent antibody and T cell responses to induce protective immunity.

Development of whole parasite vaccines has been hampered by challenges in manufacture, deployment and delivery. There is no licensed vaccine to date against malaria, and the most advanced candidate (called RTS,S) targets a pre-erythrocyte stage protein which is required for parasite entry into the liver. Although a large part of the generated immune response is against the viral envelope protein of the hepatitis B virus included in the vaccine, it can produce up to 60% protection on challenge.

A multi-stage vaccine

The EU-funded pan-European MultiMalVax (A Multi-Stage Malaria Vaccine) project brought together leading European academic and industrial experts in the field. "The overarching aim of the MultiMalVax clinical development programme was to develop the concept of a highly effective multi-stage malaria vaccine," states project coordinator Prof. Adrian Hill.

The consortium exploited recent advances in vaccine design including a viral vector approach based on the chimpanzee adenovirus (ChAd63) and the modified vaccinia Ankara (MVA) vectors for prime and boost vaccination. The capacity of this vector combination to generate potent CD8+ T cell responses and high antibody titres against multiple malaria antigens makes it a promising tool for malaria vaccines.

Researchers combined the protective vaccine candidate R21, a next generation virus-like particle targeting sporozoites, alongside viral vectors targeting the liver-stage parasite, the blood-stage antigen RH5, and the transmission blocking vaccine candidate Pfs25. Vectors generated expressing the different-stage components were assessed individually before a recent combination trial.

RH5 proved to be safe as a vaccine antigen in humans and capable of inducing cross-strain growth inhibition. Trial results of the vectored transmission blocking vaccine demonstrated safety and immunogenicity for both antibody and T cell induction.

Advantages of a multi-hit approach

Interrupting malaria transmission is an important goal of malaria vaccination. "The MultiMalVax vaccine approach takes advantage of the potential synergies between vaccine components acting at different stages of the life cycle," explains Prof. Hill. "Another advantage," he continues, "is that a parasite with a variant that allows escape from one immune response should still be susceptible to immunity against other vaccine components."

Pre-clinical data of the MultiMalVax project showed that different mosquito-stage antigens can induce potent transmission blocking against African isolates of *P. falciparum*. Importantly, the combination of anti-sporozoite and anti-liver stage components provided synergistic effects.

The MultiMalVax project has combined some of the most promising antigens and delivery systems for each stage of the *P. falciparum* life-cycle to address one of the major goals of global health research over several decades, a high efficacy malaria vaccine.

Project partners anticipate that the proposed vaccine could be cost-effectively manufactured to meet the global annual need for tens of millions of vaccine courses in developing countries. The next step is to further optimise and evaluate the multi-stage vaccine for malaria-endemic regions in Africa under the new EU-funded programme, OptiMalVax.

MultiMalVax

- Coordinated by the University of Oxford in the United Kingdom.
- Funded under FP7-HEALTH.
- https://cordis.europa.eu/project/rcn/105361

COMMUNITY HEALTH WORKERS DELIVER HOME-BASED MALARIA PREVENTION AND TREATMENT TO PREGNANT WOMEN

Malaria during pregnancy is responsible for as much as 8% of infant deaths in sub-Saharan Africa, and access to prevention, diagnostics and treatment resources is often limited. The COSMIC project has enrolled community health workers to facilitate this access.

Pregnant women are notoriously vulnerable to severe diseases. Malaria is one of these, and it can lead to complications for the mother and baby, including anaemia, low birth weight, poor growth and development, and higher mortality rates. Prevention methods, such as using bed nets, and treatments are effective, but the countries most in need have little access to such solutions.

The truth is that bringing better health care to these communities, who for the most part live in sub-Saharan Africa, is easier said than done. There is no vaccine yet available, no cheap prophylactic treatment, insecticide-treated bed nets are still a rarity, community health workers (CHWs) don't have the resources to test patients before treatment, access to sulphadoxine-pyrimethamine (IPTp-SP)-based treatment is poor, and, to top it all, the symptoms of the disease can be elusive.

"We wanted to break this vicious circle by providing an 'extension' strategy for the standard delivery of IPTp-SP in health facilities, the point of which was to encourage pregnant women to show up at antenatal clinics for the identification and treatment of malaria. Instead, we bring health services closer to where the patients live, using community health workers to conduct antimalarial interventions in populations where access to the formal health system is difficult," explains Dr Henk Schallig, coordinator of the COSMIC (Community-based scheduled screening and treatment of malaria in pregnancy for improved maternal and infant health: a cluster-randomized trial) project.

As cornerstones of the sub-Saharan health system, CHWs provide basic health and medical care to their communities. If they could screen pregnant women for malaria with rapid diagnostic tests (RDTs) between visits to antenatal clinics, and treat them should the test be positive, the odds would be better for both the women and their children.

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"This is what we aimed to do," says Dr Schallig. "By combining existing IPTp-SP with anti-malarials (SST) at the village level as an extension of existing Community Case Management of malaria, we could improve IPTp-SP coverage, allow for systematic screening of malaria infection and consider treatment when the prophylactic effect of IPTp-SP had waned."

The COSMIC approach was tested in three malaria-endemic countries with different malaria epidemiology and cultural backgrounds. The project team could count on a combination of health system research, social science (medical anthropology) and biomedical research, whilst policy panels were organised by the World Health Organisation's TDR to support implementation.

Although Dr Schallig admits that the project didn't meet all his expectations – having failed to show a reduction in the number of placental malaria – other aspects of the project were much more encouraging.

"Whilst the approach did not reduce the number of placental malaria cases, we did see a significant increase in IPTp-SP coverage. In addition, the number of ANC visits also increased in the intervention groups, hence providing more health care to pregnant women. Furthermore, we have noted improved health of the children born from mothers in the intervention group (delay of first malaria attack and reduction of severity)."

Besides patients themselves, CHWs were also very passionate about the project. According to Dr Schallig, health workers, participants and community leaders were equally eager to witness the implementation of COSMIC in local communities.

Since the project was completed in May 2017, the team has been busy disseminating the findings of their project to the widest possible audience, including laypeople, policymakers and scientists.

COSMIC

- Coordinated by the Academic Medical Center in the Netherlands.
- Funded under FP7-HEALTH.
- https://cordis.europa.eu/project/rcn/105395

SPECIAL FEATURE

HALTING MALARIA PARASITE BEFORE INFECTION

Through achieving a better understanding of glycans (or sugar chains) that occur on the surface of the malaria parasite, EU-funded researchers hope to find a way of stopping the disease from even entering the human bloodstream.

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The SugarBlock (Unraveling the protein glycosylation of Plasmodium falciparum is crucial for development of novel therapeutics against malaria) project has successfully shone a light on certain molecular modifications present on the surface of the malaria parasite. The hope is that one of these processes could one day be used to elicit an immune response that halts disease development.

"This is fertile – and unexplored – ground for the discovery of drug targets and molecules with vaccine and diagnostic potential," says SugarBlock project coordinator Prof. Luis Izquierdo Lázaro from the Barcelona Institute for Global Health (ISGlobal) in Spain.

The Holy Grail

While scientists have shown that a malaria vaccine offering sterile protective immunity in humans is theoretically possible, the best that has been achieved to date has been to confer short-term protection against clinical malaria in 35-50 % of recipients. The disease continues to cause 200 million clinical cases and more than 400 000 deaths annually.

"This is fertile – and unexplored – ground for the discovery of drug targets and molecules with vaccine and diagnostic potential."

"In endemic regions, individuals continually exposed to the parasite do develop immunity," explains Izquierdo Lázaro. "But sterile immunity – the inability of the parasite to establish blood stage infections – does not develop in nature. This is why sterile immunity has become something of a Holy Grail to researchers in the field, as this would be a major step towards eliminating the disease."

The SugarBlock project sought to further research into sterile immunity by building on existing scientific knowledge. This includes the significance of certain sugar molecule modifications (called glycosylations) that occur on the surface of the malaria-causing parasite.

"We wanted to completely characterise the modifications expressed by sporozoites (the cells that develop in the mosquito's salivary glands) that travel from the mosquito to the liver," says Izquierdo Lázaro. "One of the key points for me has been a lack of knowledge about the presence of glycans at 'difficult' stages of the parasite, such as the development of sporozoites."

Once in the liver, sporozoites multiply and eventually burst as what are known as merozoites. These then invade the bloodstream, infecting the individual.

"Although I am not an immunologist, I'd say that one of the challenges is making our immune system 'see' and react against sporozoites," says Izquierdo Lázaro. "But perhaps sporozoites are completely adapted to escape the immune system and reach the liver."

A chink in the armour

In any case, Izquierdo Lázaro and his team hoped that an analysis of glycans might expose a weakness in the parasite, which could then be exploited to halt sporozoite development (and eventual infection of the human bloodstream). This in effect would mimic what has been achieved using carbohydrate-protein vaccines against bacterial infections.

Ling, the postdoctoral researcher who received the Marie Curie Individual Fellowship, carried out much of the lab work and has made some significant progress. "He successfully purified delicate salivary gland samples infected with sporozoites," says Izquierdo Lázaro. "And although it has proved incredibly difficult to get enough biological material, Ling was also able to carry out protein analyses of the infected glands. One of the main challenges was – and still is – to get good amounts of sporozoites from the salivary glands of infected mosquitoes to work with."

Preliminary data are exciting says Izquierdo Lázaro, since they seem to point to the presence of unexpected glycosylations at unexpected stages. The final results are to be confirmed, and the project still has a few months to run. Nonetheless, a promising avenue of research – that might one day lead to an effective vaccine that offers sterile immunity against malaria – has been opened up.

SugarBlock

- Coordinated by the Barcelona Institute for Global Health (ISGlobal) in Spain.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/203818

INTERVIEW

SPARK PROJECT SHEDS LIGHT ON SEXUAL DIFFERENTIATION PROCESS IN *P. FALCIPARUM*

Out of the five existing human malaria species, *Plasmodium falciparum* is known to have the most devastating impact. Better understanding its life cycle could lead to more effective treatments, which is precisely what the SPARk project set out to achieve.

Plasmodium falciparum is responsible for over 75% of malaria cases in Africa, and it's also the deadliest form of the disease. But what makes it particularly renowned – or rather, intriguing – within the scientific community is its complex life cycle: During the 14 days after one gets bitten by an infected female Anopheles mosquito, liver-stage parasites will differentiate and undergo asexual multiplication, resulting in tens of thousands of merozoites that burst from the hepatocyte and invade red blood cells.

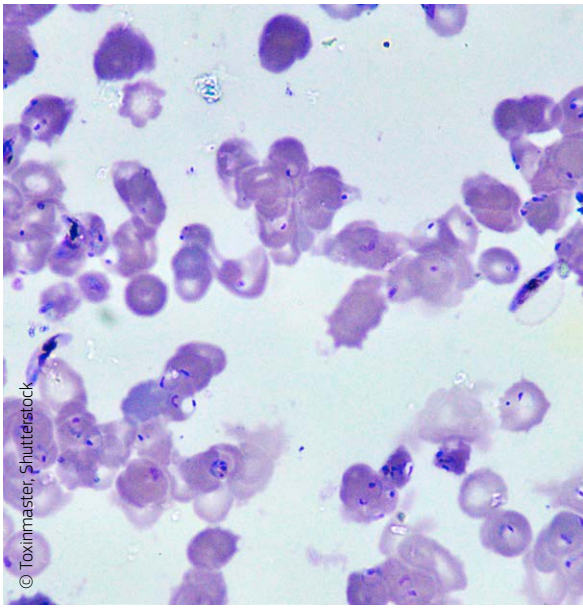
Whilst some of these merozoites divide into schizonts, others turn into sexual forms of male and female gametocyte that are taken up by female Anopheles mosquitoes during their blood meal. But although the process is well known, the mechanisms that see parasite transformation into specialised stages capable of sexual development are still poorly understood.

As she studied gametocytogenesis at the Harvard School of Public Health, Dr Kathrin Buchholz made a breakthrough by identifying pathways specifically upregulated at the onset of sexual differentiation. She found that four genes involved in different aspects of post-transcriptional gene regulation were highly upregulated, and decided to go further in the analysis of this aspect of gametocyte biology thanks to funding under the SPARk (Adding Pieces to the Puzzle of Sexual Differentiation In P. falciparum: A Systematic Analysis of RNA Processing) project.

© Kathrin Buchholz

DR KATHRIN BUCHHOLZ

As the project comes closer to its end, Dr Kathrin Buchholz agreed to discuss her approach and how her research may eventually contribute to improved health conditions in malaria-endemic countries.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Why is parasite transformation into gametocytes so important to study?

Dr Kathrin Buchholz: Most currently-used antimalarials target the parasite stage responsible for the symptoms and the mortality of the disease – the asexually-replicating parasites. But the parasites responsible for completion of the life cycle in the mosquito vectors are the gametocytes. To combat malaria on a global scale, it is necessary to include intervention strategies against gametocytes, since these are the stages responsible for the spread of the disease. With this project, we hope to lay a basis for novel transmission-blocking intervention strategies.

Which knowledge gaps did you specifically aim to close and why?

The different gametocyte stages are accompanied by distinctive patterns of sexual-stage specific gene expression. In recent years, our understanding of sexual commitment and gametocyte biology has become more detailed. This is true especially when it comes to understanding the molecular mechanisms leading to sexual commitment.

However, major knowledge gaps remain, such as details on how external stimuli translate into sexual commitment in *Plasmodium* and further downstream molecular processes, after commitment but early in the *Plasmodium* sexual life cycle. With the SPARk project, I aimed to gain a more detailed understanding of these early events.

How did you proceed to do so?

To gain more information about the importance of the genes selected in this project for sexual differentiation in *Plasmodium*, I used a knock down approach.

The so-called destabilising domain (DD) system enables regulation of protein levels. DD-fusion proteins are expected to rapidly degrade in the absence of a ligand, and stabilise in its presence. Transgenic parasite lines were generated and add this domain to the genes I was interested in.

A major advantage of this system is that it lays a good basis for future pharmacological intervention. This type of method allows for choosing genes with an essential phenotype upon a 70-80% reduction in protein level (each gene will exhibit its own level). These are levels that can also be reached later with pharmacological intervention.

★ What would you say were your most important findings?

SPARk aimed at dissecting the functions of four genes in sexual development. All genes had predicted functions in controlling gene expression. It appears at the moment that two out of the four genes have an important phenotype with an overall reduced number of gametocytes. However, since reverse genetic approaches in *Plasmodium* take a long time and can be prone to technical difficulties, we are in the process of verifying these findings.

★ What kind of new treatments could this project lead to?

There is one approved drug that is part of the WHO recommendation for treating malaria as a gametocidal component: primaquine. But use of this drug is hampered by side effects and it cannot be used in all patient groups.

Therefore, there is an urgent need for target-based drug development directed against *P. falciparum* gametocytes. If we could describe genes with a validated importance for *Plasmodium* gametocyte development, this would allow us to proceed with the development of novel inhibitors. The recombinant protein of this validated gene could then be recombinantly expressed, a high throughput compatible assay could be established, and inhibitors could be screened. Ideally, this would result in a specific inhibitor that acts solely on the validated target.

★ Besides potential treatments, what do you hope will be the impact of the project?

Beside the potential of this project to lead to validated targets for rational drug development, we aim at gaining a better understanding of the molecular mechanisms that happen during sexual development in malaria parasites. Specifically, we hope to describe novel mechanisms that could increase our knowledge of how *Plasmodium* parasites orchestrate complex genetic switches and modulate the cellular response to developmental signals.

★ Do you have any plans for follow-up research?

Yes, the next steps are to proceed with the outlined strategy for rational drug development, e.g. work with recombinant proteins and inhibitor screening. Additionally, we will also try to gain a better understanding of the importance of these genes on a molecular level. Furthermore, the project served as an establishment of the necessary methodologies, and I have already included more genes (e.g. metabolic enzymes) in the work pipeline.

SPARk

- ★ Coordinated by the University of Giessen in Germany.
- ★ Funded under H2020-MSCA-IF.
- ★ https://cordis.europa.eu/project/rcn/201574

ANTIMALARIAL AND ANTICANCER DRUGS FROM CAMEROONIAN PLANTS

Consumer demand for natural and organic products has been growing steadily for the past few years, and once-ignored or forgotten herbal medicines are no exception. In Cameroon, a team of EU-funded researchers has investigated rainforest plants' potential for curing cancer and malaria.

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Modern medicine as we have come to know it has been evolving so rapidly that we may sometimes forget how young it is. Traditional herbal medicine, on the other hand, has been around for centuries and relies on compounds that have been adapting to environmental threats for thousands of years. Whilst both fields may seem worlds apart, bridging the gap only requires meticulous scientific studies and a drug development process able to preserve the benefits of these raw materials.

Prof. Jean-Claude Ndom is one of many researchers personifying the link between modern medicine and its traditional, plant-based counterpart. With funding under the PLANTMEDS (Potential Antimalarial and Anticancer Lead Compound Discovery from Cameroonian Medicinal Plants) project, he spent two years in Cameroon trying to identify antimalarial and anticancer active molecules for new drug development from plants.

"A good number of molecules found in plants show a great diversity of bioactive properties –when directed not only towards threats to the plant but also towards malaria, cancers and other human diseases," he explains. "The Cameroonian rainforest offers a first-grade source of such novel molecular structures and bioactive compounds from plant material, being one of the most biologically diverse ecosystems on earth."

In Cameroon, people have been using rainforest plants since ancient times for medical recipes developed after hundreds of years of trial and error, and some of them – Rutaceae and Simaroubaceae – are traditionally used against malaria and cancers. With his research, Prof. Ndom and his team aimed

to find evidence of their benefits with the hope of catching the pharmaceutical industry's attention.

"Some 137 plants from 48 families that are employed by traditional healers have never been investigated for their presumed antimalarial properties, and a similar picture can be drawn for anticancer plants and plants used against bacterial infections," Prof. Ndom notes. "The European pharmaceutical industry decided to focus on synthetic chemistry and high throughput screening (HTS) instead, and it failed."

"Compounds isolated from the stem bark of Citrus reticulata *led to synergistic effects of at least two cancers."*

The result of this failure and accelerating drug resistance has been a paradigm shift towards natural products, and PLANTMEDS played its part by questioning traditional healers, collecting plants and extracting their most promising compounds by applying chromatographic methods of column chromatography and high performance liquid chromatography (HPLC) assisted by antimalarial / anticancer bioassays.

"Once isolated, pure compounds are subjected to structural characterisation by various spectroscopic methods; bioactivity assays combined with toxicity assessment employing human cell lines are carried out; promising compounds are subjected to semisynthetic reactions coupled with bioassays/toxicity assays to improve molecule properties (higher active, lower toxic); and an assessment of quantitative structure-activity relationships (QSAR) is done to select the identified leads for pharmaceutical pre-formulation and formulation studies."

The results were promising. Compounds isolated from the stem bark of *Citrus reticulata* led to synergistic effects of at least two cancers: Significant activity was observed from an extract against the breast cancer cell line MCF7, and a chromatographic fraction displayed extremely low 50 % inhibition concentration values against the human lung adenocarcinoma cell line A549; human breast adenocarcinoma cell line MCF7 and human Caucasian prostate adenocarcinoma cell line PC3. "Importantly, assays employing a normal human cell line indicated very low toxicity of this chromatographic fraction," Prof. Ndom points out.

Although the project was completed at the end of 2016, the team have been continuing their work, notably proceeding with antimalarial tests for parts of Hannoa ferruginea. They also have plans to assay mixtures of seven compounds from the active stem bark fraction of *Citrus reticulata*, to identify the composition displaying the highest activity and lowest toxicity. "The most promising compositions will then be combined with current lung, breast and prostate cancer drugs in various mixtures to identify those with highest activity / lowest toxicity *in vitro*. This will be followed by acute / chronic toxicity assessment in animal models for best drug candidates, and, once passing the *in vivo* assessment phase successfully, clinical trials will be considered," says Prof. Ndom.

PLANTMEDS

- Coordinated by the University of Douala in Cameroon.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/190980

INTERVIEW

NEW MHEALTH APP HELPS MALAWI MAKE BETTER MEDICAL DECISIONS

The SUPPORTING LIFE project has developed an app that makes compliance with the Community Case Management (CCM) strategy much easier than it was, whilst also helping local health assistants make better medical decisions. The app has been tested in Malawi, where stakeholders were quick to adopt it.

In Malawi, Health Surveillance Assistants (HSAs) are working hard to be the bridge that links the most remote local communities with the national healthcare system – both to make patients' life easier and to prevent hospitals from unnecessarily reaching their saturation point. They are working so hard, in fact, that they are in desperate need of easier processes to follow.

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The CCM strategy – a clinical decision tool adopted in many sub-Saharan countries to help HSAs make the right calls – was a step in the right direction. It enables HSAs to promptly identify, from children between two months and five years old, those requiring urgent referral to hospitals

and those who can be treated at the local points-of-care before going back home.

But CCM implementation is not without its shortcomings: the solution is paper-based, and delivering it through a mobile health (mHealth) app is expected to considerably cut the red tape and help them make quicker and better decisions. With their app, the SUPPORTING LIFE (Supporting Low-cost Intervention For disEase control team) project hopes to bring just the solution Malawi is looking for.

★ Why did you decide to focus on Malawi for this project?

There are several countries that met the criteria for our project, but Malawi is one of the poorest countries in the world, with a large population, a very limited healthcare infrastructure and a very low quality of care. We felt that a project like SUPPORTING LIFE was going to be really helpful in remedying this situation. There are great opportunities there with ICT.

"The ministry of health in Malawi is pushing quite strongly to establish a health platform for the whole country, based on CCM guidelines. They felt like SUPPORTING LIFE was exactly the model they were looking for."

★ What kind of help did you aim to provide to HSAs?

HSAs have an extremely heavy workload. They are responsible for managing patients in their community across a number of healthcare disciplines.

With this project we targeted HSAs using CCM guidelines, which require a valid register and a long list of paper forms to be filled in. As if that wasn't enough, HSAs have to fill in all these forms whilst also having to make medical decisions: should the child go home, be treated at the local clinic, or go straight to the hospital? This quickly becomes difficult to cope with, especially when you meet a high number of patients every day.

The point of SUPPORTING LIFE was to make HSAs' life easier and assist in their medical decision making. Our app will help them go through the different questions they need to ask the patient in order to comply with CCM guidelines.

★ As the project moved forward, did you come to identify other unforeseen needs of HSAs?

We did come across a number of them. Simple things like transportation are very challenging. Also, as Malawi has a good telecommunication infrastructure, we first thought that we could go with a web-based app so that it's easier to apply updates and new releases. But then we came to realise that network connectivity was a bigger issue than we thought, so we had to redesign the application to be stand-alone and even work offline.

Power was also an issue, so we had to give all HSAs mini solar panels so they could power their phones. Finally, we found out that not all HSAs were familiar with smartphones, so as part of our trial we had to integrate extra sessions for training just to show the HSAs how to use the phone and the app itself.

★ Speaking of which, how does the app work exactly? What's its added value?

Some digital solutions existed before SUPPORTING LIFE but they weren't 100 % focused on CCM. SUPPORTING LIFE is, and it also integrated with IMCI – the higher-level guidelines for hospital settings. Furthermore, we included sharp training videos within the app, we have the offline mode, the decision support system, the data collection system... All of that is quite unique.

★ What was the feedback from in-field trials?

We spoke to all the relevant senior staff within the ministry of health both on the IMCI and CCM sides, as well as on the IT side. We also engaged with district officers, HSAs and community members. The vast majority of people were in favour of the SUPPORTING LIFE app for two reasons: the technology itself, which made patients feel like they were getting better treatment (feel good factor), and the data collection/decision making assistance process.

In addition, the ministry of health in Malawi is pushing quite strongly to establish a health platform for the whole country, based on CCM guidelines. They felt like SUPPORTING LIFE was exactly the model they were looking for.

★ Apart from this feel-good factor you just mentioned, what are the benefits for patients?

Initially we were looking at very hard clinical outcomes like mortality rates or serious consequences, but we faced a major challenge: Malawi doesn't store the kind of information that would have allowed for a comparison before/after SUPPORTING LIFE. So what we had to do was change our research focus.

In the end, we looked at whether the children were properly redirected to clinics or hospitals. We designed a process to measure this impact and got a sample of over 7 000 children from different regions in Northern Malawi. We are still evaluating the results, but general feedback was that the amount of unnecessary referrals was reduced and that SUPPORTING LIFE helped improved on-site clinic treatment.

★ Do all HSAs have access to the app now?

There are various mHealth projects across Malawi and each of these projects is led by different groups. Certain groups might be using a certain type of smartphone while others would be using a different one and a different app on top of that. So it's all very fragmented, and the ministry of health is well aware of this. Going forward, they will try to create one general platform where all stakeholders can sign up.

★ Do you have any follow-up plans?

We are still engaged very closely with the ministry of health by feeding them with reports, presentations and lessons learned for the future.

SUPPORTING LIFE

- ★ Coordinated by the Imperial College of Science, Technology and Medicine in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ https://cordis.europa.eu/project/rcn/106966
- ★ Project website: http://www.supportinglife.eu/

MALARIAL ENZYME ANALYSIS COULD LEAD TO NEW THERAPIES

Chemical tools that could help researchers identify and analyse enzymatic behaviour in malaria parasites could speed up the discovery of potential new drug targets, say EU-funded researchers.

The MALARIA TARGETS ID (Mapping the Targets of Antimalarial Compounds Through Chemical Profiling) project has applied chemical tools to malaria parasites to help researchers identify possible new drug targets. These tools have helped identify the potential targets of small molecules with antiparasitic activity, as well as profile for the first time the behaviour of certain enzyme families throughout the parasite's lifecycle.

These results will help scientists understand the role of these enzymes in parasite development, which might lead to new antimalarials drug development programmes.

"We are close to the point where we can validate some of these enzymes as potential antimalarial targets, and we'll be speaking to the pharmaceutical industry about the potential for developing inhibiting drug-like molecules," says MALARIA TARGETS ID project coordinator Dr Edgar Deu from the Francis Crick Institute in the UK. "The next step will be to follow through on the biology to understand exactly what these enzymes do."

Fighting resistance

Malaria is one of the most devastating infectious diseases, killing close to half a million people every year. Widespread resistance of the malaria parasite to most frontline drugs and the rapid emergence of resistance against new therapies have made the validation of novel pharmaceutical targets extremely urgent.

"Drug resistance is the main challenge facing researchers and the pharmaceutical industry," says Dr Deu. "It is always a struggle to develop and put on the market new drugs before the parasite becomes resistant to current therapies, and it only takes a few years for this resistance to spread to endemic areas around the world."

To address this challenge, combination therapy has become the standard of care for malaria therapy because it is harder for the parasite to become resistant to multiple drugs. "The problem now is that there are not that many new drugs coming out in order to combine them into a novel antimalarial combination therapy," explains Dr Deu. "Current therapies usually combine a new drug with an old one, which is not ideal given that some parasites might already be resistant to the old drug. The pharmaceutical pipeline is much better than it was 20 years ago, but there are still many challenges to overcome."

Enzymes in action

The pharmaceutical industry has screened millions of compounds to search for anti-parasitic activity, only a promising few of which will ever move forward towards possible development. The MALARIA TARGETS ID project sought to build on this work by combining chemical probes with a library of 400 promising antimalarial compounds. The chemical probes used in the project are small molecules that bind to specific enzymes and can be applied to any type of cells.

"These probes attach to all members of an enzyme family and label them with a fluorescent tag, helping researchers to visualise the activity of dozens of enzymes simultaneously," explains Dr Deu. "This enables researchers to then analyse whether any one of these enzymes is inhibited when a certain compound is applied, instead of having to perform individual screens for every single enzyme."

The project also applied chemical probes to try and better understand the malaria parasite genome itself. "About 50% of the genes in the malaria parasite have not been assigned a putative function because their sequences are too divergent from that of known genes in other organisms," says Dr Deu. "However, it is very likely that some of these genes will be excellent antimalarial targets. Our chemical biology approach has allowed us to annotate the enzymatic function of some of these genes, which is the first step in trying to understand their role in parasite development."

Due for final completion in August 2018, the MALARIA TARGETS ID project will provide a useful resource for scientists interested in identifying viable target enzymes for new therapies. There have been few academic papers on this topic, and Dr Deu expects the project's final report to be the most comprehensive analysis of these enzyme families to date.

MALARIA TARGETS ID

- ★ Coordinated by the Francis Crick Institute in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ https://cordis.europa.eu/project/rcn/186930

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SPECIAL FEATURE

CO-PATHOGEN INFECTIONS IN THE LIMELIGHT

Looking specifically into HIV, tuberculosis, malaria and Hepatitis C, the PathCO project has closed a wide gap in the scientific knowledge of co-pathogen interactions.

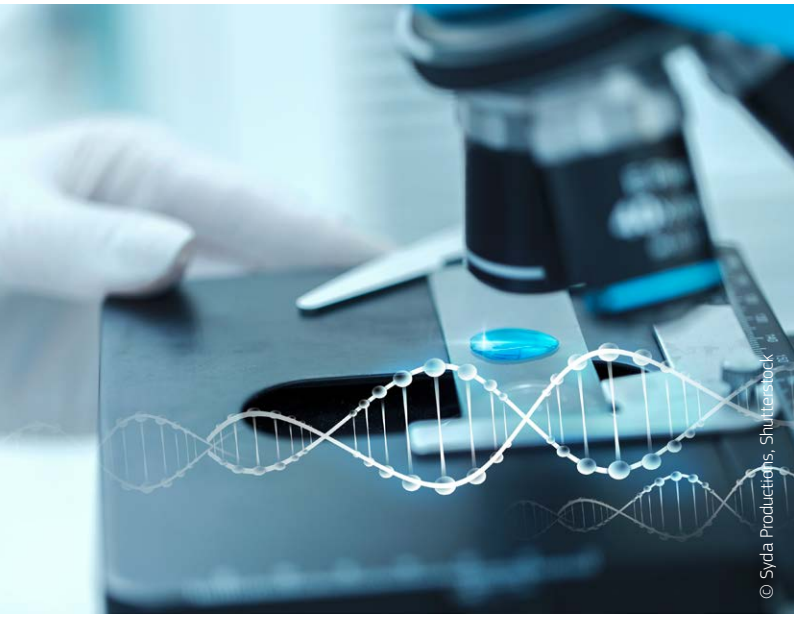
In most cases, researchers striving to unveil the mysteries of a pathogen would let go of all other questions to concentrate on the issue at hand. While this may sound logical, such an approach also means that situations where two or more pathogens interact with each other in the same patient are still poorly understood.

"When individuals perform their early career research, they tend to focus on understanding a specific question relating to a single pathogen. This continues as they become specialised in a specific area and rarely do researchers consider the complexity of co-pathogen interactions, especially when crossing the viral, bacterial, parasite boundaries," says Prof. William A. Paxton, coordinator of the PathCO (Pathogen COinfection: HIV, Tuberculosis, Malaria and Hepatitis C virus) project on behalf of the University of Liverpool.

One explanation for this lack of interest lies in how complex pathogen interactions can be. Deciphering one infection and the replication kinetics of one pathogen is already complex enough, especially when considering the diverse range of possible host interactions. But adding other pathogens to the mix brings about a whole other level of complexity: In the cases of vaccines like HIV-1, interactions become even more complex when considering the disruption to the immune system and the consequences for the replication of other infectious agents.

To tackle this issue, Prof. Paxton brought together experts in various fields to design experiments specifically aiming to understand the consequences of one infectious agent on altering the infection and replication of another.

"We went from specifically studying molecular and cellular interactions between selected pathogens, to developing novel small animal systems that can combine infection with multiple agents, and all the way up to studying and comparing human responses within mono-infected co-infected individuals," Prof. Paxton explains. "The combination of all these studies allowed for a comprehensive programme addressing the effects of co-pathogen interactions at different levels. Each scientist had a specialised culture system, strategy or approach they brought to the consortium that could be exploited to monitor co-pathogen interactions."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The list of PathCO achievements is huge. Among other things, the team notably: identified specific TB molecules able to block HIV-1 interaction with the immune system; developed assays that can monitor TB and HIV-1 infection in the same culture system; found out that oxygen concentration can modulate both HCV and HIV-1 replication; provided evidence that mucosal tissue can be infected with HCV; developed humanised mouse model systems where HIV-1 and Hepatitis B can replicate; and demonstrated different mechanisms of pathogen entry for malaria and HCV.

"We went from specifically studying molecular and cellular interactions between selected pathogens, to developing novel small animal systems that can combine infection with multiple agents, and all the way up to studying and comparing human responses within mono-infected co-infected individuals."

"We have managed to identify a vast array of novel pathogen interactions. This provides for new insights into co-pathogen interactions, but more importantly we have identified new molecular targets that can be exploited in devising drugs or agents to inhibit pathogen infection and replication. A number of unique tissue culture and animal model systems have been developed and will greatly aid in future analysis of co-pathogen interactions and in the testing of new drugs or vaccines aimed at inhibiting these processes," Prof. Paxton says.

Since the project was completed in October 2017, its results have been used to aid in applying for new rounds of funding whilst expanding and developing new collaborations. "The area of co-pathogen interaction studies is gaining pace, with many new initiatives being proposed by funding organisations, and whole conferences or conference sessions being dedicated to this exciting area of research," Prof. Paxton says. In such a context, there is no doubt that PathCO's outcomes will continue to help researchers over the years to come.

PathCO

- Coordinated by the University of Liverpool in the United Kingdom.
- Funded under FP7-HEALTH.
- https://cordis.europa.eu/project/rcn/105687
- Project website: http://www.pathco.org

A GENETIC BREAKTHROUGH TO TACKLE MALARIA

An EU-funded project has pioneered a new genetic approach to understanding the malaria parasite. This could help scientists to identify valuable drug targets for new anti-malarial therapies.

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This work is crucial given the number of deaths caused by malaria annually, and the fact that parasite resistance against available drugs on the market has been detected. What is particularly concerning is that this resistance is spreading. Applying new techniques to better understand the parasite and identify possible targets for new, more effective therapies, could save thousands of lives.

"We were able to finetune a technique known as random mutagenesis, which we are confident will enable us to uncover gene functions that have to date been poorly understood," says GENETICHTS REVEAL PF (Genetic High Throughput Screenings by random mutagenesis to identify Plasmodium falciparum critical genes for asexual growth, sexual differentiation and virulence affecting host immune responses) project coordinator Dr Ilaria Russo from the University of Manchester in the UK. "We were able to solve, one by one, every technical issue we came across. The key breakthrough of this project (the results are still to be published) is that we have shown this technique to be feasible."

Mutagenesis involves deliberately engineering DNA mutations to produce mutant genes or other genetically modified organisms. Various constituents of a gene can be mutated so that the functioning of a gene can be examined in detail. "This allows us to directly analyse genes and better understand what the malaria parasite's essential genes are," says Russo. "Essential genes are valuable drug targets for new anti-malarial therapies."

A misunderstood parasite

While malaria represents one of the most serious global public health concerns, scientists still do not have a detailed understanding of the parasite's lifecycle. This makes it much harder to develop effective treatments and to take preventive measures. Not only does a vaccine against malaria remain elusive, but the effectiveness of existing treatments is diminishing as resistance increases.

"Malaria parasites have several ways of dodging human immune responses," explains Russo. "One way is by changing, one at a time, exposed molecules – called antigens – to resist the body's immune response. The ability to switch antigens means it is much harder to develop a protective vaccine or effective cure."

There are other challenges. After transferring from the mosquito's salivary glands to their human hosts, malaria parasites invade red blood cells, which provide them with the perfect hiding spot. When the parasites burst out of red blood cells and infect their hosts, they are exposed to our immune system for a very brief period – just a few minutes.

Genetic solutions

The idea behind the GENETICHTS REVEAL PF project, which was funded through an EU Marie Curie International Re-Integration Grant, was to develop and apply novel genetic methods to achieve a better understanding of the parasite's lifecycle. The focus has been on genes responsible for asexual growth, sexual differentiation and virulence through interaction with the host immune system, with a view to eventually developing new targeted therapies.

"Challenges related to developing novel therapies or preventions have been largely due to a lack of understanding of the parasite's complex lifecycle," says Russo. "This includes its relationship with its host."

The project's success in developing a methodology for the random mutagenesis technique, and in advancing our understanding of how our immune cells function, will now be built upon. A library of mutated genes will be an important resource for researchers in the field moving forward.

"Our work is focused on the long term, which can be a challenge as we live in a society where short-term economic gains often influence decisions," notes Russo. "This makes the funding we receive so important. We hope to secure further funding to apply our new methodology on a larger scale and make a more significant contribution to both drug discovery and vaccination."

GENETICHTS REVEAL PF

- Coordinated by Manchester University in the United Kingdom.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/97897

HEALTH

T-CELL IMMUNOTHERAPY BECOMES A VIABLE OPTION FOR PANCREATIC CANCER PATIENTS

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T-cell based immunotherapy is certainly one of the greatest breakthroughs in recent cancer treatment history, providing hope to millions of patients across the world. Thanks to research under the TIPC_TIL_IP project, pancreatic cancer patients could benefit from this treatment within the next five years.

First discovered for human skin melanoma, the therapeutic potential of tumour-specific T-cells – commonly referred to as T-cell immunotherapy – is tremendous. Reprogrammed T-cells can effectively target the somatic mutations contained in tumour-specific genomic DNA encoding peptide antigens, which means that other types of cancer carrying these somatic mutations, such as lung cancer, are also sensitive to this form of treatment.

Unfortunately, things are slightly more complicated with pancreatic cancer. Or so it seemed: Until recently, pancreatic cancer was thought to be poorly immunogenic, as histological analyses had given the impression that these tumours harboured very low numbers of infiltrating T-cells. But the TIPC_TIL_IP (T-cell based immunotherapy in pancreatic cancer - basic concepts and pre-clinical development) project team, headed by Dr Isabel Poschke of the German Cancer Research Centre (DKFZ), has spent four years meticulously proving these analyses to be wrong.

"The lack of T-cell infiltrate in pancreatic cancer is a misconception due to technical reasons," says Prof. Dr Rienk Offringa, who brought his expertise in molecular oncology of gastrointestinal tumours to the project. "In the recent past, tumour histology was mostly done by means of tissue micro-arrays, screening small tissue sections. For pancreatic cancer this is a problem, as 50-70% of the tumour mass consists of fibrosis, a 'desert' in which no other cells can penetrate. By examining large tissue sections, we could see that there are plenty of T-cells in the vast majority (75%) of pancreatic cancers, but only in the areas where tumour cells are present."

In other words, pancreatic tumours do harbour T-cells and carry somatic mutations just like lung cancer and skin melanoma do, although in lower numbers – five to ten-fold lower. This implies that the magnitude and power of the spontaneous T-cell response is weaker, and should therefore be amplified to a greater extent than for melanoma.

"A very effective way is to harvest the T-cells from tumour biopsies, culture them under optimised conditions in the lab so their number and activity increase, and infuse them back into the patient so they can attack the tumour. The work performed by Dr Poschke in the context of the TIPC_TIL_IP project has shown that the protocols developed for preparation of T-cells from melanoma can also be successfully applied to pancreatic cancer," says Prof. Dr Offringa.

The project focused on patients with primary resectable pancreatic cancer. These patients would generally have the main tumour removed by surgery, but not before it has started seeding metastases which can neither be removed, nor be treated using chemotherapy. The team's plan consists in counteracting this 'tumour recurrence' by infusing patients who already went through surgery with their own T-cells so they can destroy the metastatic cells. As Prof. Dr Offringa puts it, "we select a patient population where the tumour load is very low, which sets the 'numbers game' in favour of the T-cells."

As each patient is different, the therapy's effectiveness will first be tested in mice. The team will inoculate the patient's T-cell cultures and tumour cell lines in special mice lacking an immune system, so that the tumour cells cannot be rejected and start growing.

Although the project was completed in August 2017, Prof. Dr Offringa and Dr Poschke plan to kick start a T-cell therapy trial for melanoma based on protocols that were proven to be effective in studies by scientists at the Netherlands Cancer Institute. "In melanoma, we know the treatment should have clinical impact in approximately 50% of the patients. This 'benchmark' will allow us to check whether we are doing things correctly, independently of potential pancreatic cancer-specific issues," Prof. Dr Offringa says. He hopes to be able to move forward with pancreatic cancer in five years, and until then will be scrutinising the T-cell response in pancreas in greater detail.

TIPC_TIL_IP

- ★ Coordinated by DKFZ in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ https://cordis.europa.eu/project/rcn/109769

STEM CELL THERAPY FOR NEUROLOGICAL DISORDERS

Stem cells are emerging as a fundamental tool for regenerative medicine, with European researchers advancing their use in therapies to improve the clinical outcome of neurological disorders.

Parkinson's Disease (PD) and Huntington's Disease (HD) are two neurological disorders that represent good candidates for cell replacement therapy. In both cases, the leading cause of disability is linked to a defined, localised degeneration of neurons.

Experience gained from clinical trials using dopaminergic neuronal progenitors obtained from human foetal brain tissue provides the proof of principle that replacing damaged cells with new neurons can work in PD patients. These donor cells persist over decades in the host patient brain, release dopamine and in some cases induce long-term clinical improvement.

At the same time, these results highlighted the need for readily available and renewable cells for large-scale applications. The EU-funded NEUROSTEMCELLREPAIR (European stem cell consortium for neural cell replacement, reprogramming and functional brain repair) project worked to significantly advance stem cell therapy for PD and HD patients through new stem cell sources of dopaminergic neurons that die in PD or of striatal neurons that are lost in HD. The consortium comprised academic partners, three SMEs and one industry, bringing together world-renowned expertise in stem cells, neurobiology and bioengineering.

Novel cell sources for transplantation

"With the advent of induced pluripotent stem cell technologies and direct reprogramming of somatic cells, further sources of transplantable cells have become available," explains project coordinator Prof. Cattaneo. NEUROSTEMCELLREPAIR researchers also investigated the reprogramming capacity of human fibroblasts as well as of cells from neonatal human cord blood and adult peripheral blood to generate therapeutically relevant dopaminergic neurons. The identification of specific compounds, morphogens and transcription factors enabled them to achieve neuronal conversion with high efficiency and purity.

The most significant achievement was the generation of authentic dopaminergic neurons from human embryonic stem cells (hESC). Researchers successfully obtained reproducible and safe neuronal preparations that were transplanted *in vivo* in a PD animal model. Similar strategies were also used in the generation of striatal neurons suitable for HD treatment. Furthermore, NEUROSTEMCELLREPAIR obtained novel developmental biology insight that significantly advanced the translation of hESC-derived dopaminergic neurons in clinical trials.

In the extensive *in vivo* work conducted by consortium members, various technologies have been employed to trace synaptic connections from grafted neurons and evaluate their long-term function in transplantation studies. Researchers observed that integrin expression was fundamental for successful functional integration of cells in the recipient brain.

On another level, significant advances were made towards understanding neurodegeneration in HD patients. Researchers genotyped a large cohort of HD patients to identify new inflammation-related genetic variants that contribute to the disease process and clinical expression. These not only serve as future therapeutic targets but also help determine the host environment prior to neuronal engraftment.

Next generation cell replacement strategies

"To date, engraftment and differentiation of transplanted cells has relied on the spontaneous unfolding of developmental programmes imposed onto donor cells *in vitro*, but adaptation to the host milieu is not guaranteed," continues Prof. Cattaneo. NEUROSTEMCELLREPAIR has successfully controlled the *in vivo* maturation of grafted cells through the controlled expression of key molecules involved in differentiation. Significant efforts were also devoted to the scaling up of clinical grade cells suitable for use in transplantation procedures. This is a prerequisite for granting regulatory approval of the final cell derivative before therapy.

Overall, through standardised reagents and highly reproducible production procedures, project partners can envision the next generation of cell replacement therapies for PD and HD. The NEUROSTEMCELLREPAIR toolbox of new cell sources, reprogramming factors and small molecules promises to advance current protocols of cell therapy and achieve enhanced tissue integration. Furthermore, validated new imaging technologies demonstrate the performance and integration of the transplanted cells.

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Essentially, project results have minimised the gap between development and clinical implementation of stem cell therapy in PD and HD, promoting brain repair and functional recovery in afflicted individuals. Importantly, the application of the generated platform extends beyond these two conditions for treatment of a wider spectrum of neurodegenerative disorders.

"Consortia like NEUROSTEMCELLREPAIR were established on the idea of supranational research in a very competitive yet collaborative manner. This was made possible under the EU umbrella, further emphasising the importance of a 'Union' when it comes to the fight against human diseases," Prof. Cattaneo concludes.

NEUROSTEMCELLREPAIR
- ★ Coordinated by the University of Milan in Italy.
- ★ Funded under FP7-HEALTH.
- ★ https://cordis.europa.eu/project/rcn/110638
- ★ Project website: http://www.neurostemcellrepair.org/

INTESTINAL WORMS CAN INFLUENCE ALLERGY AND ASTHMA RISK IN HUMANS

With the prevalence of allergy and asthma on the rise around the world, the race is on to explain this increase and stem the tide. A recent study finds a clue in an unlikely source... intestinal worms.

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It is known that children brought up on farms often develop an immune response to allergies, as their immune systems are trained through regular exposure to micro-organisms. Conversely, pathogenic infections early in life, for example those caused by the Respiratory syncytial virus (RSV), can equally result in a remodelling of the pulmonary immune system which can actually result in an increased risk of allergies.

Recent findings, to which the EU-funded ALEC (Aging Lungs in European Cohorts) project contributed, revealed that youngsters infected with a particular species of helminths (intestinal worms), passed on from animals, were four times more likely to develop asthma and allergies, compared to others. According to one of the lead researchers, Professor Cecilie Svanes from the University of Bergen, "Usually, we consider a 50% higher risk as being high, but here we see a 400% higher risk."

The intergenerational puzzle

Perhaps the most surprising aspect of the study's results was that the pronounced effect on asthma and allergies for carriers of the helminths (both the Toxocara and Ascaris species) seemed to hold true only for the younger generation, as it did not have the same affect on their parents. This is a finding that the researchers cannot readily explain, though they have hypothesised that being able to do so in the future will solve the riddle of the global increase in allergies over recent decades.

Writing in the journal 'Clinical & Experimental Allergy', the researchers outlined how they worked on data-sets from two Norwegian cohorts: 171 parents born 1945-1972 and their 264 offspring, born 1969-2003. They recorded allergy prevalence through interviews and clinical examinations, which included serum Immunoglobulin E (IgE) blood allergy tests and skin prick tests.

Amongst the study participants, the researchers found antibodies against Toxocara (associated with pets, especially cats) and Ascaris (associated with livestock, especially pigs) in 12% and 18% respectively. They also discovered more exposure in the older parental cohort (those born 1945-1972) compared to the offspring cohort. A surprising finding was that paternal exposure to Toxocara increased the allergy risk in daughters, as maternal exposure seemed to do in sons. Additionally, adjusting the data for pet-keeping made no difference to the associations, indicating that the findings could not simply be explained by shared environments.

The worldwide rise of allergies

Extensive research shows that globally, over the last few decades, the prevalence of asthma and allergies has increased significantly. The reasons for this are not yet fully understood, but researchers believe it is linked to our increasingly sterilised environment, whereby people come into contact with chemicals more often than microbes, which could otherwise strengthen our immune systems. Added to this is the concomitant explosion of urbanisation, leading to fewer opportunities for contact with natural immune boosters.

"Extensive research shows that globally, over the last few decades, the prevalence of asthma and allergies has increased significantly."

The Horizon 2020-funded ALEC project, whose research contributed to this study, was set up to better understand the factors which lead to poor lung function, respiratory disability and the development of Chronic obstructive pulmonary disease (COPD).

Through the investigation of various determinants of poor lung function such as behavioural, environmental, occupational, nutritional and genetic (including epigenetic) factors, the study is developing a predictive test. The project aims to build an online tool for personalised risk prediction to be freely available to patients and health care providers. It is anticipated that this will lead to improved preventative treatment.

ALEC
- ★ Coordinated by Imperial College London in the United Kingdom.
- ★ Funded under H2020-PHC.
- ★ https://cordis.europa.eu/project/rcn/193189
- ★ Project website: https://www.alecstudy.org/

YOUNG 'ETHNOGRAPHERS' INVESTIGATE THE IMPACT OF ONLINE PORNOGRAPHY

A major interest for almost every adolescent, male and female, young researchers have been exploring the uses and impact of pornography on young people in an EU-funded project on sexual health and education.

In the UK, the highest rate of certain Sexually transmitted infections (STIs) is among people under 21 and the majority of pregnancies among under-18 year olds are unplanned. At the same time the ubiquity of online sexualised and pornographic content is believed to be transforming attitudes and behaviour among young people in ways that are not well understood.

The EU-funded PE4PPI (Peer ethnography for the promotion of patient and public involvement: young people and sexual health service development) project used an anthropological form of inquiry by peer group researchers the same age as the study target group of 16-18 year olds to better glean insights that can inform and improve sexual health services for young people, as well as Sexual relationship education (SRE) which will become compulsory in all British schools from September 2019.

Young people took on the role of researchers to reduce the barriers in talking to people their own age. "We call it peer ethnography because the approach goes beyond classic interviewing and discussions, it includes observation and analysing conversation," says anthropologist Joanna White, senior research fellow at the Bristol Centre for Public Health and Well-being at the University of the West of England, Bristol.

The World Health Organisation definition of sexual health includes "...physical, emotional, mental and social well being in relation to sexuality" and the project used this broad definition to explore young people's experiences and views. Consulting the users is essential if you want to improve sexual health services and SRE, Dr White says, and the researchers elicited new knowledge on gender conditioning, role models and pressures relating to behaviour in intimate and sexual relationships.

The role and impact of internet pornography

The research also revealed the inadequacies of SRE in schools, which is currently "underserving young people at critical stages in their emotional and sexual development," says Dr White, who received a two-year EU Marie Skłodowska-Curie fellowship to conduct the research. "In schools there is too much emphasis on biological aspects of sex and limited discussion of relationships and what intimacy means."

"None of the young people involved in the project ever had a detailed conversation with their parents about sex. Young people are in need of information and advice," she says. Perhaps unsurprisingly some go online, pornography being readily available.

The ethnographic research examined how 16-18 year olds use the internet as a source of information on sex and revealed varied exposure to, and interest in, online pornography at different ages. Some found it informative, but a number of young men said they regretted their early exposure, watching it less once they had a sense of what a 'real' relationship could be like.

Input into better sexual health services and education

SRE literature refers to an age-appropriate response, but this is not defined. "We need a clearer understanding of what it means, given what we know about young people's exposure to sexualised online content at an increasingly early age," says Dr White.

"We confirmed existing concerns regarding the role of pornography in sexual expectations amongst certain young heterosexual men," she continues. "In particular the harassment elements of sexualised 'male banter' in the school setting, often informed by pornography, which appears to have become normalised, is an issue which requires immediate and urgent attention."

The young researchers are providing input into the development of new online sexual health services for Bristol, North Somerset and South Gloucestershire in Western England to better meet young people's information needs.

PE4PPI

- Coordinated by the University of the West of England in the United Kingdom.
- Funded under H2020-MSCA-IF.
- http://cordis.europa.eu/project/rcn/196147

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EXPLORING FUNGAL BIODIVERSITY FOR THE NEXT GENERATION OF MEDICINES

The diminishment of antibiotic effectiveness, alongside a reduction of pharmaceutical companies able to produce them, has resulted in an antibiotic crisis globally. The first European training platform for the production of novel bioactive compounds based on fungal synthetic biology and supported by the EU, holds out hope for future medicines.

There is growing concern that the overuse of antibiotics globally has led to a pronounced rise in multiresistant bacteria that cannot be controlled by the current range of drugs. Researchers are exploring a wide range of potential bioactive molecules, as sources for new pharmaceuticals, including amongst filamentous (thread-like) fungi, due to their generation of natural products called secondary metabolites.

The EU-funded QuantFung (Quantitative Biology for Fungal Secondary Metabolite Producers) project was set up to further explore these fungi. Support from the Marie-Curie Action 'Initial Training Networks' fund enabled 15 young scientists to work on fungal biotechnology, focusing on the discovery of secondary metabolite gene clusters, targeted activation of gene clusters, quantification of secondary metabolites in industrial hosts and bioactivity testing to identify their mode of action.

Already the project has generated notable results which have caught the attention of the research community. These include the establishment of a CRISPR/Cas9 based genome editing tool for the fungus Penicillium chrysogenum, the sequencing of nine different Penicillium genomes and the identification of 1 317 putative secondary metabolite gene clusters within them, and the establishment of a multi-gene expression system in the fungal cell factory Aspergillus niger, as a tool for the production of secondary metabolites.

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Bioengineering fungal organisms

The search for promising bioactive fungal products actually extends well beyond the antibiotics crisis and encompasses the need for novel drugs for multiple human health problems including a variety of cancers and neurodegenerative diseases. For the QuantFung team this quest necessitated the bioengineering of fungal organisms, using cutting-edge synthetic biology tools to give them new characteristics.

One such tool was the gene-editing technique, CRISPR/Cas9. The team wanted to identify the genes that encode the biosynthetic pathway responsible for forming the secondary metabolite, calbistrin, found to have anti-cancer properties. They first investigated the structure of the fungal compound to identify enzymatic activities likely to contribute to its formation. By comparing the genome sequences of three species of fungi that all produce this calbistrin, the team was able to predict which genes are likely to be responsible for coding for secondary metabolite. Once they had identified the likely gene cluster, the team used CRISPR/Cas9 to delete those genes, finding that the resultant mutant strains indeed no longer produced calbistrin.

As project coordinator Professor Vera Meyer, summarises, "The different techniques used by the team members of our consortium along with the knowledge gained, could lead to the development of new metabolic engineering strategies to improve the production of medicinal products such as calbistrin in fungal cell factories. This would be of benefit for a range of health applications, especially those designed to tackle cancers."

Getting from promising results to a new class of drugs

One of the hallmarks of the QuantFung project was its multidisciplinary nature whereby the expertise of its 11 early-stage (ESR) and four experienced researchers (ER), ranged across modelling, network analysis, systems biology, molecular biology and synthetic biology. The training included periods spent in different QuantFung laboratories and secondments as part of public and private sector collaborations, to achieve new secondary metabolites for health, nutrition, agriculture or health applications.

Professor Meyer puts some of the project success down to this multidisciplinary approach, along with the mobility required of the students, both physical and intellectual. As she reflects, "There are so many complementary effects to everyone studying the same phenomena, in this case in fungi, working towards the same goal but with different tools, methodologies and backgrounds. That's how you actually make breakthroughs."

The collective project efforts have also generated comparable data sets useful for further research. As Professor Meyer elaborates, "QuantFung is a good starting point for future researchers as the fellows really got to know the various procedures and techniques in the labs where they were based. With a longer-term funding commitment, this could enable standardisation within the field, actually leading to new classes of drugs and antibiotics, feasible given the involvement of industrial partners in our network."

QuantFung

- Coordinated by TU Berlin in Germany.
- Funded under FP7-PEOPLE.
- http://cordis.europa.eu/project/rcn/110354
- Project website: http://intern.mikrobiologie.tu-berlin.de/

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SOCIETY

A NEW VISION FOR ERADICATING POVERTY

After conducting over 120 studies on poverty, the EU-funded NOPOOR project has proposed a new, long-term vision for eradicating global poverty.

In 2000, the United Nations made eradicating extreme poverty and hunger the first of its eight Millennium Development Goals. This was followed by the 2030 Agenda for Sustainable Development, which makes ending poverty its top priority. Although, thanks in large part to efforts like these, the global poverty level has dropped by over 35%, it remains a critical issue.

The key to reducing poverty is to first understand it, which unfortunately is easier said than done. This is because poverty is a multifaceted challenge affected by a range of factors – from globalisation to domestic policy, climate change and geopolitics.

The EU-funded NOPOOR (Enhancing Knowledge for Renewed Policies against Poverty) project set out to improve society's understanding of the poverty problem, and thus our ability to best address it. To accomplish this, the project conducted over 120 different studies that explored numerous dimensions of poverty in developing and emerging countries. The result is a new vision for poverty policies geared towards a globalised world.

Getting to the root of the problem

When it comes to eradicating poverty, NOPOOR researchers found that most countries have strategies in place. For example, one of the most common strategies is cash transfer programmes. However, researchers discovered that often times these programmes offer only short-term solutions and do little to help create the jobs needed to take people permanently out of poverty.

"Having a job is the best way for poor people to get out of poverty," says Project Coordinator Xavier Oudin. "From our research, we found that poverty reduction policies do not focus enough on work as an instrument against poverty."

As an example, Oudin points to how many workers in the informal sector receive low incomes and are kept out of social insurance schemes. As a result, they have difficulty accessing financial credit. "From this finding, we recommend that creating quality jobs should become a core objective of poverty reduction policies," he adds.

This is just one example of what Oudin calls a general failure of many governments in developing countries to provide satisfactory public goods, which are typically underfunded and/or ineffectively supplied. This is particularly true in education. In its study of a large number of developing countries, NOPOOR researchers found that even when enrolment rates are high, education tends to be of a low quality. "Policies raising the quality of education and of teachers should be implemented to make education a more efficient mechanism for reducing inequalities," commented Oudin.

Fostering long-term development

What these examples show is that poverty is best tackled by addressing the foundational problems, such as employment and education. But herein lies the problem:

those countries most in need typically are the ones who lack good institutions.

Currently, donors tend to resolve this dilemma by bypassing weak state institutions and delivering more aid through NGOs and multilateral organisations. However, in doing so, they often forego the opportunity to help improve local institutions and thus fail to foster long-term development.

"Poverty must be analysed in its dynamics, and although many of today's policies succeed in reducing severe poverty, they fail in terms of the long-term objectives of poverty eradication," explains Oudin. "The interaction of different dimensions such as education, work, infrastructures and housing – to name only a few – are to be taken into account because progress in one field alone is insufficient to eradicate poverty."

NOPOOR

- Coordinated by the Research Institute for Development in France.
- Funded under FP7-SSH.
- https://cordis.europa.eu/project/rcn/103688
- Project website: http://www.nopoor.eu/
- http://bit.ly/2FCdkse

BUILDING INCLUSIVE PUBLIC SPACES

An EU-funded project has used art and design to learn how people use public zones, and has created ways to improve people's overall experience of public spaces.

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From the main square in a major city to shared spaces in apartment blocks, public areas are used by different people in a multitude of different ways. Planning how to design these spaces to be as inclusive as possible was the core focus of the EU-funded TRADERS (Training Art and Design Researchers in Participation for Public Space) project.

The project saw artists and designers engage with users of public spaces in unique and innovative ways, gaining fresh insights into how they feel when in a public zone. The findings were then taken up by the authorities in charge of planning the spaces.

"From groups of people found on the fringes of society to children, the way people feel and act in a public space is underexplored. TRADERS tested and developed a set of participatory and engaging research methods which art and design researchers can use to explore the human side when working on researching public space," says Jessica Schoffelen, TRADERS co-project coordinator.

The project trained five early stage art and design researchers and one sociological researcher on participatory research methods including intervention – or new ways of getting people to take part – specifically focussing on children and performative mapping, essentially getting people to map how they feel in public spaces.

In one project, artist Pablo Calderón Salazar focussed on the Belgian city of Genk which has recently suffered from the closure of a Ford factory forcing a considerable number of people into unemployment.

In a bid to spark debate about work and help people explore new job opportunities, Salazar created a bike designed to hold a printing press. He travelled around the public spaces in Genk talking to people about how they conceive work. Using his printing press, he helped people make posters displaying their skills. He also collated the skill sets he found on a blog hoping to build connections between people.

In Gothenburg, Sweden, designer Annelies Vaneycken explored children's play. Instead of allowing adults to design inclusive public spaces, Vaneycken got the children themselves involved, contributing their own ideas about areas designed for their use.

Another project saw designer Naomi Bueno de Mesquita create a smartphone app which allows people to map how they use public spaces. She focussed on marginalised groups like refugees, mapping their emotions in different parts of public spaces. She found, for example, that refugees feel uncomfortable in areas with a lot of security cameras. Her work allows other people, including public space planners, to experience what other people feel in public spaces.

"TRADERS was all about participation and inclusivity through the arts. We built a community of people involved in the design of public spaces, creating social insights they may not have had access to before," says Veerle Van der Sluys, TRADERS co-coordinator.

Throughout the project TRADERS organised several public events on participatory art and design. The events, which attracted designers, local organisations and authorities, explored ways to boost citizen participation, how artists and designers can make a difference via their work, and how they can empower others to bring about social or political change.

The project also produced a book on its findings called 'Trading Places: Practices of Public Participation in Art and Design Research.'

TRADERS

- Coordinated by UC Limburg in Belgium.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/109368
- Project website: http://tr-aders.eu/

NEW WAYS OF PRESERVING EUROPE'S CULTURAL HERITAGE

The EU-funded ITN-DCH project has used innovative modern technologies to capture and digitise Europe's diverse and unique cultural heritage.

Cultural heritage is the cornerstone of European history. From the tangible to the intangible and including books, images, paintings, maps, artefacts, sites, uniforms, music, folklore and theatre, cultural heritage is everywhere. As a result of its ubiquity, cultural heritage is important not only for the creation of a common European identity, but also for the continent's social and economic development.

With Europe's heritage being built on each country's individual histories and traditions, the EU is committed to conserving this unique collective past and providing a legacy for its future. One way of doing this is through Digital cultural heritage (DCH), or the use of revolutionary ICT that brings together Europe's diverse array of cultural heritage and makes it available to citizens across Europe. For example, through a virtual museum, a visitor in Greece can see the works of art hanging in the Louvre in Paris, or a school class in Estonia can listen to a classical piece of music from Vienna.

Thanks to the efforts by such EU-funded initiatives as the ITN-DCH (Initial Training Networks for Digital Cultural Heritage: Projecting our Past to the Future) project, Europe's cultural heritage is becoming more comprehensive and increasingly accessible. "ITN-DCH set out to bring a more holistic approach to Europe's currently fragmented DCH," says project coordinator Marinos Ioannides. "Our goal was to create a cost-effective documentation, preservation, protection and presentation system covering all aspects of cultural heritage."

Seeing old sites through new technology

To accomplish this, researchers organised a variety of case studies that set an example of how to take a holistic approach to preserving DCH's entire lifecycle. For example, in the village of Nikitari in Cyprus, the research team used different data acquisition techniques to get a complete picture of the UNESCO World Heritage listed Asinou Church. Using drones, laser scanners, 360-degree cameras and ground-based multi-spectral devices, the recorded data was uploaded onto a visualisation system and edited. "Now, users can take a virtual tour of the church from their own personal device," explains Ioannides. "They are even guided by a self-narrating priest!"

Meanwhile, in Germany, an ultralight paraglide trike was used to take aerial images of Donaustauf Castle. Researchers then used laser scanning and photogrammetric techniques to create a 3D model of the castle's internal structure, along with a database of all on-site findings. Based on the combined recordings, a full 3D model of the castle was also generated. Everything was then fully digitised and made available online.

At Carnuntum, an important archaeological site in the ancient Roman province of Pannonia, in Austria, ITN-DCH researchers tested a range of reconstruction methods, from digital visualisations to the actual physical re-building of selected houses on their original foundations. The recorded data was then logged into a custom application that is now being used as a platform to experiment with location-based content and augmenting 3D objects.

Giving cultural heritage a boost

Collectively, these case studies produced a number of key innovative methodologies and results. For instance, they introduced a series of new forms of personalised services that mix physical (tangible/intangible) and virtual objects, resulting in virtual surrogates that allow for the re-use of cultural heritage in real-life application environments. It also identified such cost-effective methods as virtual capturing, 3D modelling, web-semantic, archiving and representation to transform human creativity into tangible 'digits'.

"In the end, the project successfully boosted the added value of cultural heritage assets by demonstrating how to use and re-use them in real application environments, including education, tourism and entertainment," says Ioannides. In fact, the project's exceptional approach was recently acknowledged by UNESCO with the unique prestigious UNESCO Chair Award on Digital Heritage. "This is especially exciting as it comes just as Europe begins to celebrate the EU's Year of Cultural Heritage in 2018," adds Ioannides.

ITN-DCH

- Coordinated by Cyprus University of Technology in Cyprus.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/109830
- Project website: https://www.itn-dch.net/
- http://bit.ly/2FGmSCc

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EU-WIDE RESEARCH NETWORK HELPS TO REDUCE PERSON-JOB MISMATCHES

The socioeconomic and psychological dynamics of matching labour supply and demand can be complex. Understanding how this approach works can prevent mismatches concerning skills and qualifications, leading to a better balance between the supply of, and demand for labour.

Increasing segments of the demand and supply side of the job market are becoming digitised. These range from employment sites and CVs on social networking services to extensive databases with job descriptions and related skills demands. Such developments pose challenges to matching procedures.

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Interdisciplinary training network explores matching practices in EU labour market

"EDUWORKS trained 12 early-stage researchers and three experienced researchers in the interdisciplinary area of labour market matching processes," says Dr Gábor Kismihók, coordinator for the EU-funded EDUWORKS (Crossing borders in the comprehensive investigation of labour market matching processes: An EU-wide, trans-disciplinary, multilevel and science-practice-bridging training network) project. "The goal was to acquire state-of-the-art knowledge in the skill set components needed to analyse matching processes at individual, meso-, national and European levels that are focused on individuals, organisations and education." The project's combination of research and training centred on five domains: labour economics, sociology of occupations, human resource management, lifelong learning and knowledge management.

EDUWORKS brought much-needed expertise and insight to four important academic discussions. The first concerned the changing nature of jobs. Technological innovation is increasingly disrupting the labour market. Research found that other factors, including migration patterns and changes to education systems, are also having significant effects.

The second discussion dealt with migration and refugee labour market integration. To investigate the paths migrants take to employment, researchers collected labour market data from refugees in Greece and the Netherlands. Findings show that people need to be more flexible in their career transitions and proactive when managing career development. The third involved lifelong learning and technology. By studying the effect of physically contextualising learning, researchers found that this learning isn't necessarily superior to decontextualised learning. They also examined how employers use social media as recruitment screening tools and how job seekers exploit such means to present their skills.

Lastly, research in vacancy mining and analysis looked into how the demand for work and the content of jobs are changing over time. Findings show that economic trends can be explained using detailed vacancy data, thus providing a degree of clarity for economic models.

Three summer schools and one winter school provided the fellows with 18 courses on transversal skills. They completed 195 courses on research-specific skills and organised 16 research webinars. Three global conferences, 16 international workshops and three hackathons were also organised.

Project partners spread the EDUWORKS message to 13 research and professional communities. Contacts have been established with 15 national and European research initiatives that share the project's objectives.

"EDUWORKS should boost the EU's capacity to assess, forecast and anticipate the skills needs of its citizens and companies, and to help ensure a better match between skills and labour market needs."

One-stop shop for transversal skills training

The consortium realised that no systematic approach existed to train researchers in transversal skills in an interdisciplinary setting at European level. "To address this need, we designed our very own training portfolio and flexible training management programme for the 15 researchers," Dr Kismihók explains.

After EDUWORKS ended in September 2017, the initiative evolved into TranSkills, a portal for the transversal skills training of European researchers run by the Amsterdam Institute of

Advanced Labour Studies. Efforts are now underway to make the site sustainable. The European Commission and the Marie Curie Alumni Association see its value for other European research communities, too. The Association is co-organising courses with TranSkills to conduct a series of pilot studies until February 2018.

"By creating a strong foundation for interdisciplinary learning and collaboration, EDUWORKS should boost the EU's capacity to assess, forecast and anticipate the skills needs of its citizens and companies, and to help ensure a better match between skills and labour market needs," concludes Dr Kismihók.

EDUWORKS

- Coordinated by tUniversity of Amsterdam in the Netherlands.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/109508
- Project website: http://www.eduworks-network.eu/
- http://bit.ly/2GuaL8H

GENDER POLITICS IN THE UNIVERSITY OF OXFORD'S COLLEGIATE CHOIRS

It wasn't until the 1990s that girls had the opportunity to become choristers in English cathedral choirs. The EU-funded OXFORDCHOIRS project examined the gender politics of choirs at the University of Oxford.

The choirs at Oxford have long been acclaimed for their world-class performances, but until recently, the choirs have been entirely made up of boys and men.

Even today, the gender-based exclusion of women and girls in the three choral foundations is still a topic of political debate. Young women at Oxford currently have the opportunity to sing in three services per week (with one choir), whereas men can sing in up to seven.

Dr Sigrun Lilja Einarsdottir of the University of Oxford studied this phenomenon as part of the EU-funded OXFORDCHOIRS (Cultural Policy and Choral-Historical Identity in the Choral/Musical Life of Oxford University Colleges and Halls in the 21st Century) project. The aim was to observe both the culture and the policy perspectives of the historic Oxford collegiate choral tradition, with a particular focus on the recent introduction of female singers to some of the choirs. The project also sought to address the issue of elitism in terms of access to quality music education.

"The fact that socio-economic background of parents is a deciding factor in whether a student can or cannot attend private school in order to get proper musical training sounds odd," said Dr Einarsdottir. "Furthermore, the fact that if you are a boy, your possibilities for advanced choral/musical training as a chorister are significantly more than if you were born as a girl sounds strange."

Why women have been excluded

The project showed that there are three main reasons why women haven't been fully accepted yet into the choral sphere at Oxford; firstly, the issue of aesthetics and preservation – the all-male choirs are considered to be a cultural phenomenon. Those who want to preserve the tradition argue that girls and boys have different-sounding voices, however some scholars say that the unique sound of the boy choirs is the result of intensive training, and that if both girls and boys were subject to the same musical education, those differences might not be noticeable.

A second argument that was voiced by choral members and music directors is that boys would stop participating in the choirs if women were allowed to sing. Previous research shows that boys often fear being accused of 'sounding like a girl' or 'sounding gay', which discourages them from taking part in choirs.

A third issue is the case of male versus female altos. Even in 2017, adult female altos were a rare sight in English cathedral choirs. In the three choral foundations of Oxford, women are so far not admitted. This puts female choristers at a disadvantage, because these choirs are amongst the most prestigious in the UK and have a reputation worldwide for prestige and excellence in terms of musicality. Furthermore, in some of the mixed-voice choirs, certain choral scholar positions are earmarked for counter tenors and so these opportunities are not available for female altos.

A changing landscape

The landscape is changing, however, with more and more of Oxford's choirs accepting women in recent years. Now, mixed-voice choirs are the most common forms of choirs, although, as Prof. Einarsdottir says, "boys and young men have, still today, better access to performance opportunities and training. That is a fact that is specifically tangible within the collegiate choirs of Oxford."

The next steps for the OXFORDCHOIRS project will be to write a book, outlining the stories of the young women and girls that currently sing in the choirs. The focus of the book will be on their experiences within this male-dominated environment.

OXFORDCHOIRS

- Coordinated by the University of Oxford in the United Kingdom.
- Funded under H2020-MSCA.
- http://cordis.europa.eu/project/rcn/205910
- Project website: https://oxfordchoirs.wordpress.com/

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ENERGY

SMART TECHNOLOGY FOR MORE EFFICIENT ENERGY USE IN NEIGHBOURHOODS

Energy efficiency for a sustainable society faces several challenges, not least of which are the rational consumption of available resources and the reduction of environmental pollution. Creating intelligent solutions that control energy production and consumption has enormous potential to optimise efficiency.

Reducing consumption is only a partial solution to achieving energy efficiency, as is applying energy sources without smart management systems, which may lead to grid failures or wasted energy. "Renewable energy isn't available constantly, but rather in peaks," says Professor Peter Langendörfer, project coordinator for the EU-funded e-balance (Balancing energy production and consumption in energy efficient smart neighbourhoods) project. "When a peak occurs without proper consumption, this energy is wasted, such as renewables disconnected from the grid," he adds. "When energy consumption is high, renewables may not be available."

Grid resilience and efficiency through better energy exchange

Prof. Langendörfer explains that the grid needs to be able to cope with peak loads if renewable energy and fossil energy providers are to be allowed to add energy whenever they can or want. This makes the grid expensive because of the high load situations. If peaks are avoided, the grid's investment cost can be reduced.

To overcome a mismatch between production and consumption, and an imbalance in the electricity grid, both production and consumption need to be monitored and controlled. "Shifting energy needs to when and where energy is provided is one solution," says Prof. Langendörfer. "e-balance introduced a platform, business models and ICT tools to better manage electrical energy in neighbourhoods."

A fine balancing act between renewable production and consumption

e-balance developed an energy management platform to better balance electrical energy production and demand on every voltage level of the distribution electricity grid. This balance ranges from local neighbourhoods to geographically dispersed groups of users. Sensors and algorithms are used to boost the grid resilience of several functionalities, including fraud detection and location, calculation of losses, and detection and location of fused luminaires.

The platform helps people manage their own energy consumption, thus reducing the energy needed and allowing the use of distributed renewable sources. It keeps the energy distribution as local as possible, allowing for the consumption of energy in a certain area instead of letting it travel through the grid for long distances. The innovation reduces the number and duration of failures and helps to increase the quality of energy distribution.

Furthermore, the solution can be adapted to any legal requirement and communication infrastructure. Its energy management approach can be applied to all grids.

e-balance also designed new business models to achieve an effective energy balance where distribution system operators, energy aggregators, and prosumers (producers and consumers) cooperate seamlessly. According to Prof. Langendörfer, this innovative business model framework has the potential to increase revenues and reduce energy costs.

A guidebook was prepared for electricity market and distributed energy operators, city authorities and smart appliance manufacturers to make the most of the project results. It explains how to use the e-balance solution, and can help estimate the improvements that can be made and expected costs.

Balancing energy in homes has very little impact on the grid because appliances don't consume much. Prof. Langendörfer notes that additional means to increase flexibility need to be investigated in the future. Work is now underway in this direction.

"Energy can be used far more efficiently, resulting in positive impacts for CO_2 emissions and the environment overall," concludes Prof. Langendörfer. "Improving grid management will ultimately lead to better quality of service for end users, who will also be motivated to use photovoltaic panels more efficiently to supply their own energy."

e-balance

- Coordinated by IHP GMBH – Innovations for High Performance in Germany.
- Funded under FP7-ICT.
- https://cordis.europa.eu/project/rcn/109894
- Project website: http://ebalance-project.eu/
- http://bit.ly/2pdRalG

ENERGY-EFFICIENT SOLUTIONS RETROFITTED TO COMMERCIAL BUILDINGS

An EU-funded initiative has developed a systematic methodology for retrofitting cost-effective energy-saving solutions to commercial buildings and tested them in the real world.

Commercial properties can achieve significant energy savings by refurbishing the building envelope and applying easy-to-install and cost-effective building services solutions. These improvements in the building's operation and maintenance can also contribute to a more sustainable, cleaner and healthier built environment.

The ECOSHOPPING (Energy efficient & Cost competitive retrofitting solutions for Shopping buildings) project developed holistic retrofitted solutions for commercial buildings that reduce primary energy consumption to less than 80 kWh/m² per year. The initiative also increased the share of Renewable energy sources (RES) to more than 50% compared to the state-of-the-art. This was achieved by developing novel thermal insulation systems based on cost-effective materials that further reduce thermal losses and energy consumption.

Easy-to-install light emitting diodes together with daylighting technologies that use natural light illumination systems also improved comfort and reduced bills. The retrofitted heating, ventilation and air conditioning system was based on harnessing the buildings' thermal mass, photovoltaic-powered heat pumps and a next-generation capillary tube system for radiant heating and cooling.

Greater control gives greater savings

This approach was founded on an integrated environmental and acoustic sensor network complete with a mobile robot platform. Project coordinator Enrique Grosser Lagos says: "The network gives a cheap, energy-efficient yet adaptable system that monitors the occupancy level, temperature, humidity and noise in buildings and surrounding areas, transferring the data in near real-time to the Intelligent automisation unit (IAU)."

The IAU serves as the brain of the building to give greater control in terms of time, cost and demand, resulting in greater energy efficiency. Furthermore, the system's status can be compared to historic data to identify faults and ineffectiveness within the system. "A web platform was also developed, allowing the building operator to plan the maintenance schedule better, thereby reducing energy consumption and avoiding unexpected interruptions in service," comments Grosser Lagos.

These technologies were demonstrated in the IKVA shopping centre located in Sopron, western Hungary in order to test them under real-world conditions. "The goal was to enhance the energy efficiency of the shopping centre by increasing its use of RES and simplify its operation and maintenance, while providing optimal indoor environmental quality and comfort for a safe, healthy and sustainable environment," explains Grosser Lagos.

Importance of working together

Demonstrating ECOSHOPPING included establishing a lab environment within the shopping centre, where the technologies could be easily implemented and the results precisely measured. This enabled project partners to learn about implementation issues and how to overcome them, whilst providing instant feedback from stakeholders and end users. By working closely together, tenants, owners and researchers realised it was vital to integrate each other's efforts and interests in order to successfully retrofit energy-saving systems.

ECOSHOPPING involved different fields of research covering insulation, daylighting, RESs, computing, communication, performance optimisation and construction. It will also create new market opportunities and related economic benefits through a new business model for the building sector, resulting in new management services for SMEs and creation of energy service companies.

ECOSHOPPING

- Coordinated by EnergoSys in Hungary.
- Funded under FP7-NMP.
- https://cordis.europa.eu/project/rcn/109127
- Project website: http://ecoshopping-project.eu/
- http://bit.ly/2piLqGm

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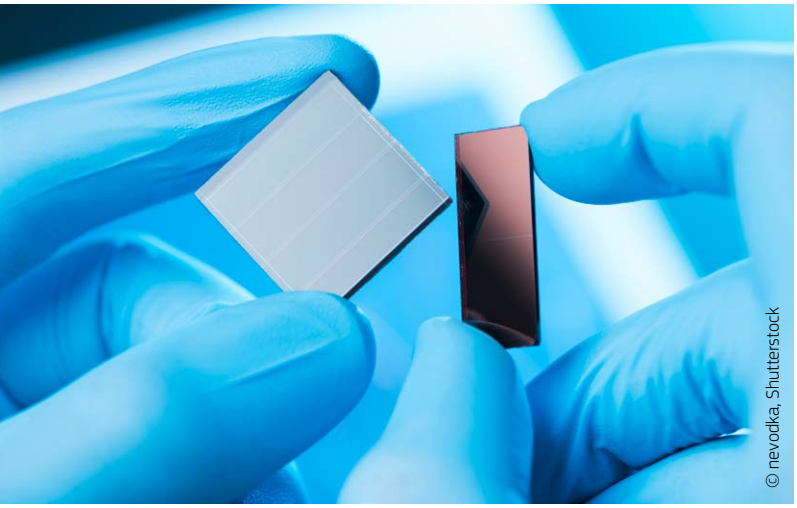
REACHING A BETTER UNDERSTANDING OF MOLECULAR SELF-ASSEMBLY IN ORGANIC SOLAR CELLS

The EU-funded NeutronOPV project successfully harnessed neutron scattering techniques to unveil the connection between organic photovoltaic device design, its nanoscale structure and its performance.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Organic solar cells offer the prospect of not only a cheaper alternative to the dominant silicon variety, but also increased flexibility of application. Owing to their thinness, they could be used across larger surface areas and could be applied directly to building materials of varying shapes, unlike conventional Polymer solar cells (PSCs) which are limited to flat surfaces.

However, working out the relative merits of organic semiconductor coatings presents an experimental challenge to researchers, partly due to the thinness of their layers, rendering performance effects subtle and so hard to measure. The EU-funded NeutronOPV (New neutron techniques to probe bulk heterojunction solar cells with graded morphologies – understanding the link between processing, nanostructure and device performance) project took up this challenge at a general level to develop a better understanding of the relationship between processing conditions, active layer morphology and device performance in solar cells. They also specifically sought to develop new and more exacting characterisation techniques, for the study of solar cells.

Neutrons and the nanostructure

In order to gain a systematic understanding of how subtle changes in solar cell film composition resulted in changes to cell efficiency, the NeutronOPV project processed a variety of semiconducting polymer mixtures. The researchers then took these step-graded variations in composition to generate a series of devices with different morphologies, which could then be measured against criteria such as charge mobility and photovoltaic performance.

These very thin (less than one micron) films were created by both the laboratory-based spin-coating method and also the industrially-scalable method of spray-coating. As Professor Richard Jones further explains, "The process by which we make these is very simple – just like painting a varnish on a surface – but what goes on during that process – what the molecules are doing – is very complicated. They arrange themselves to form particular nanoscale structures, and it's the nature of that structure that determines how efficient the solar cell is."

In order to better understand the self-assembly of the molecules, the team used techniques which direct a beam of neutrons at the sample and then measure how these neutrons were scattered by the nanoscale structures present in the layer. As Professor Jones elucidates, "While this approach is much more powerful than other techniques, in that it gives us quantitative results representative of the whole of the film, it is difficult to do on very thin films as the effect individually on the neutron beam is very weak."

To overcome this challenge, the project's Research Fellow Gabriel Bernado devised a method of stacking a large number of films together to multiply the effect. The neutron-based approaches were also complemented with more conventional laboratory-based techniques.

Towards the low carbon economy

There are seen to be multiple benefits to this mixed composition approach. It offers the prospect of a more sustainable production, for example by offering substitutes for halogenated solvents, which have been demonstrated to be hazardous to human health as well as the environment. Additionally, as organic solar cells promise to be cheaper, easier to apply to large areas and much more adaptable to varying surfaces than traditional silicon options, they are likely to be readily adopted, thus supporting efforts to build a low carbon economy.

As Professor Jones enthuses, "I'm passionate about the potential that self-assembly – where molecules arrange themselves, following simple rules, to form complex structures – offers for functional devices that do interesting and useful things, like convert light to electricity. I want to understand how those processes work, so we can exploit them to the benefit of society."

Towards this end the team are now working to apply these techniques and methodologies to a variety of different systems, including hybrids of organic semiconductors and inorganic semiconductor nanoparticles.

NeutronOPV

- Coordinated by the University of Sheffield in the United Kingdom.
- Funded under H2020-MSCA-IF.
- http://cordis.europa.eu/project/rcn/195602
- Project website: http://www.gabrielbernardo.com/neutronopv.html

WINDOWS TURN INTO HEATING AND COOLING SYSTEMS

Researchers with the EU-funded FLUIDGLASS project have developed an innovative concept that can turn everyday windows into solar collectors capable of controlling the flow of energy throughout a building.

What if a window was more than just a sheet of glass that let sunlight in or let you enjoy the nice views outside? What if that same window was creating energy to heat and cool your office building?

Thanks to the innovative concept for multifunctional solar thermal glass façade systems being developed by the EU-funded FLUIDGLASS project, such a system is on the horizon. "The FLUIDGLASS approach turns passive glass facades, such as windows, into active transparent solar collectors that can control the flow of energy throughout a building," says Project Coordinator Anne-Sophie Zapf.

Four functions in one

The science behind FLUIDGLASS is that it combines four functions (solar thermal collector, heating/cooling device, transparent thermal envelope, adaptive shading system) into one integrated system. "We start by feeding the window a special circulating fluid that provides changing levels of shade depending on the season and time of day," explains Zapf. "This fluid lets the outer face collect solar radiation and transform it into energy, which is then used by the inner face to cool or heat the room." The fluid inside the glass is a mixture of water, anti-freeze and magnetic particles.

"The FLUIDGLASS approach turns passive glass facades, such as windows, into active transparent solar collectors that can control the flow of energy throughout a building."

To ensure the long-term stability of the system, researchers used particles with very precise features. "The particles cannot agglutinate, or clump together," explains Zapf. "They also need to stay in the solution and not deposit on the window." Furthermore, the fluid must be injected in a safe, homogeneous and efficient manner.

According to Zapf, finding the right colouring of the liquid needed to get the right level of transparency turned out to be more difficult than expected. "Overcoming this required additional research efforts," she says. "In the end, we were able to determine the right combination of particles, fluid and coating of the glass solution that we could then use in the testing phase."

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Capable of heating and cooling

Researchers began testing the FLUIDGLASS system using sophisticated computer models and, later, with a prototype. "We were able to test the FLUIDGLASS system for the first time in both cold and hot climates in Liechtenstein and Cyprus respectively," says Zapf. "These tests allowed us to measure the system's performance in laboratory conditions using a solar simulator at a level that has never been achieved before."

In ideal conditions, each FLUIDGLASS window was able to produce up to one kilowatt of energy per hour. "These tests confirmed that FLUIDGLASS is capable of providing all of a building's heat and cooling needs, that no additional heating or cooling systems were required," says Zapf.

Zapf says that one highlight was standing inside the testing container and seeing the system running and working. "At this moment, we knew that it was possible to install all the parts of the FLUIDGLASS system," she says. "This was confirmation of the hard work and collaboration of all the project partners, who came together to build a fully-functioning, sustainable heating and cooling system."

Project researchers are now analysing the test results and working to further perfect the colouring needed to ensure FLUIDGLASS' position as a stable, long-term solution. The ultimate objective is to test the system in real operating conditions and, from there, move towards market readiness.

FLUIDGLASS

- Coordinated by the University of Liechtenstein in Liechtenstein.
- Funded under FP7-ENERGY.
- https://cordis.europa.eu/project/rcn/110009
- Project website: http://www.fluidglass.eu/
- http://bit.ly/2jZ7sgr

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ENVIRONMENT

MEASURING THE IMPACT OF CONCRETE FROM CRADLE TO GRAVE

EU researchers have developed a more accurate way of assessing the sustainability of concrete structures which takes into account that structures from so-called 'green concretes' can deteriorate faster than those from traditional concrete over time.

ClimatCon (Climate-resilient pathways for the development of concrete infrastructure: adaptation, mitigation and sustainability), a project carried out at Heriot-Watt University (HWU) in Edinburgh, UK, with Marie Curie Fellow Xiao-Hui Wang as main researcher, has looked at how reinforced concrete beams carbonate when under load. It has compared the performance of conventional concrete, made with Portland cement, to that of 'green' concretes which contain fly ash or ground granulated blast-furnace slag, both by-products of industry.

The concrete industry has a big environmental footprint – contributing about 5 % of global CO_2 emissions, mainly through calcination when making cement. Green concretes, which have been around for a long time, are now growing in popularity as a way of reducing emissions.

Once a reinforced concrete structure has been built, the concrete starts to slowly absorb CO_2 from the atmosphere through a process of carbonation. But while this can be seen as offsetting some of the original CO_2 emissions, carbonation also reduces concrete's alkalinity making the steel inside vulnerable to corrosion.

Corrosion starts earlier

Green concretes are known to carbonate faster than traditional ones. "If you use green concretes, you reduce the carbon dioxide emissions but the rate of carbonation is higher and corrosion can start earlier," says Dimitri Val, project supervisor and professor of infrastructure, safety and reliability at HWU, "so you need to spend money to do repairs which pushes up costs and causes additional emissions."

The ClimatCon team set out to find a way of measuring how sustainable the different kinds of concrete really are by evaluating the environmental impact and costs over the whole life of structures. This cradle-to-grave approach improves on previous methods which had paid little attention to the effects of deterioration.

Beam specimens made of six different concretes were put into a special chamber and subjected to accelerated carbonation for 120 or 240 days. "It is known that if concrete is loaded, its rate of carbonation is higher so we put loaded specimens in the chamber," says Professor Val.

Surprising results

Measuring the rate of carbonation produced some surprises. "Loading affected the rate in green concretes much more than in normal concrete and this increase was much higher than expected," says Professor Val. This could have consequences for how green concretes perform in real structures but more research is needed into why this occurs – "we need to look at what happens … at material level," says Professor Val.

The team then produced a numerical model which can predict how fast concrete will carbonate and how much CO_2 it will take up, accounting for factors including load, cracks in the concrete, temperature and humidity.

The final output is a probabilistic method for evaluating the whole-life performance of reinforced concrete structures when subject to carbonation. This takes into account deterioration and the subsequent need for maintenance and repairs and allows you to predict the associated emissions of CO_2 and balance this against its uptake from carbonation.

By following this methodology, the first to combine both the cost and the environmental impact and account for uncertainties, civil engineers, concrete manufacturers and those in charge of setting building standards will be able to address the sustainability of concrete structures in a much more rational way, Professor Val concludes.

ClimatCon

- ★ Coordinated by Heriot-Watt University in the United Kingdom.
- ★ Funded under H2020-MSCA-IF.
- ★ https://cordis.europa.eu/project/rcn/195610
- ★ Project website: https://www.egis.hw.ac.uk/climatecon/

AN ACCURATE ACCOUNT OF DAMAGE DONE BY BROMINATED FLAME RETARDANTS

Brominated flame retardants (BFRs) are used in many products for fire protection and insulation but their persistence in the environment and widespread, pervasive biotoxicity is a cause for concern. Better methods to determine their environmental fate and behaviour are urgently needed.

Toxic effects associated with BFR exposure include diabetes, neurobehavioural and developmental disorders, cancer, reproductive health effects and alteration in thyroid function. To provide academia, environmental agencies, regulators and industry with reliable information on the effects of BFRs, the EU-funded ELUTE (Elucidating Sources & Pathways of Environmental Contamination with Brominated Persistent Organic Chemicals Using Advanced Instrumental Tools) project has harnessed recent advances in analytical instrumentation.

The overall aim was to collect information on how these persistent organic bromides and other chemicals can be used sustainably. Much of the research took into account that some BFRs such as polybrominated diphenylethers (PBDEs) have been phased out as it is important to distinguish between these legacy compounds and new BFRs.

Accuracy and relevance of instrumentation

Researchers used a hand-held X-ray fluorescence (XRF) spectrometer to accurately measure the bromine content in waste material. One limitation was that a high bromine level was not always due to the presence of a now restricted BFR. "A high bromine level does not necessarily mean that that article exceeds the maximum permissible concentration for a restricted-use BFR. Instead, we have shown that 'false positives' (i.e. where a bromine concentration above the limit value is due to a non-restricted BFR) do occur," explains Professor Stuart Harrad, project coordinator.

This knowledge will help regulators develop pragmatic approaches to prevent articles containing restricted BFRs from entering the waste stream. Practically speaking, a conservative approach may be taken whereby articles exceeding the limit for bromine are assumed to exceed the limit for restricted BFRs.

ELUTE conducted a trial to determine if increased manufacture and use of BFRs has led to increased environmental levels of such PBDEs. "We used a larger than normal diameter corer named Big Ben after its designer. This is crucial as the state-of-the-art techniques required to determine concentrations of legacy brominated dioxins and furans at the trace levels they are found at, require as much sample as possible to give reliable data," comments Prof. Harrad.

Environmental impact and effects on development

The mixture of legacy BFRs and the hundreds of emerging BFRs to replace them presents a complex picture for determining effects of BFRs. In response, ELUTE has generated valuable first insights into the human metabolism of one of the principal BFRs currently in use. "The team has generated baseline data on the presence in sediments of the River Thames of BFRs that are emerging as replacements for recently banned BFRs," informs Prof. Harrad.

To complicate the picture even further, metabolism and degradation of BFRs create new molecules. *In vitro* methods developed by the project have provided the first data on human metabolism of a key BFR, a form of tetrabromoethylcyclohexane (TBECH) that causes developmental disturbances in zebrafish. Furthermore, TBECH changes androgen receptor regulation in response to mutations associated with prostate cancer. Commenting on the significance of their work, Prof. Harrad points out, "Our data on metabolism of TBECH is important, as it allows us to predict concentrations in human blood that will arise as a result of our exposure to it."

Training for future BFR research and recycling applications

ELUTE is a Marie Curie Initial Training Network programme that was designed to provide a knowledge base as well as experience to four Early stage researchers (ESRs). In addition to developing their transferable skills for future careers, their studies will ensure a sustainable future research platform for investigation into dynamic areas such as BFRs.

Project success is reflected in the two patent applications in the field of analytical chemistry instrumentation by one of the ESRs, who is now employed by Thermo Fisher Scientific in Bremen, the non-academic partner in ELUTE. Applications of the project results include use of the hand-held XRF that has been fed into a project the team were conducting for the Environmental Protection Agency of Ireland.

Of extreme significance is the link with recycling materials containing BFRs. "We are also working on new projects with a major UK plastic recycler to evaluate approaches that will allow waste plastics that are currently unrecyclable because their BFR content exceeds legislative limits to be made into sustainable and commercially viable products," states Prof. Harrad. "This will help the development of Europe's circular economy."

ELUTE

- Coordinated by the University of Birmingham in the United Kingdom.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/109121

HOW CHANGES IN BIOTIC INTERACTIONS IMPACT DRYLAND ECOSYSTEMS

The negative impact of a lack of plant functional diversity on ecosystems is well-documented, and can be seen in action in most dryland ecosystems. However, the indirect effects of biotic interactions – activities of certain living organisms that can impact the survival of others – are still unknown. The DRYFUN project set out to lift the veil on this issue.

Drylands account for 45% of the Earth's land surface. Fighting land degradation and desertification has become a priority in these regions, and vegetation attributes are expected to play a crucial role in this endeavour. In order to implement effective counter-measures, however, stakeholders need to understand all the factors at play.

As Dr Fernando Maestre, coordinator of the DRYFUN (Linking plant functional diversity to ecosystem multifunctionality in arid systems worldwide) project on behalf of Rey Juan Carlos University, explains, biotic interactions constitute an important gap in our current understanding of dryland environment functioning. "Interactions arising among species, such as competition for resources and mutualisms, largely determine key attributes of natural ecosystems such as the number of species, the diversity of their genes and the functional attributes they contain. Despite their acknowledged importance, very few studies have attempted to evaluate how biotic interactions ultimately influence how natural ecosystems function, particularly in drylands."

The problem essentially lay in a lack of suitable data, an issue that was recently solved by the ERC-funded BIOCOM project. From 2006 to 2013, the BIOCOM consortium collected detailed information on the abiotic factors, structure and functioning of 236 dryland ecosystems from all continents except Antarctica, making it the first standardised survey of its kind.

A mathematical model of dryland functioning

With DRYFUN, Dr Maestre and his team coupled the BIOCOM results with self- or database-collected data on key functional attributes of plant species such as plant height and leaf characteristics – a task led by Yoann Le Bagousse-Pinguet, postdoctoral researcher leading DRYFUN and Nicolas Gross, a researcher from INRA who has been working at Dr Maestre´s lab for two years. These data were then analysed with statistical tools that are commonly used in fields such as astrophysics and macro-economy, but that had never been applied to ecology.

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"We found a mathematical relationship between key trends in the distribution of plant functional attributes (traits) that cannot be explained by chance. This relationship predicted that a strikingly high trait diversity within dryland plant communities was associated with a local maximisation of the provision of multiple functions linked to plant productivity and nutrient cycling (multifunctionality)," Dr Maestre explains. "The mathematical relationship identified in our project is also important because it can be used to quantify how much trait diversity is required to maximise multifunctionality at a local level."

Concretely, the findings of DRYFUN indicate that trait distribution can be used to predict the functional consequences of biodiversity loss in terrestrial ecosystems. As such, they can guide management efforts aimed at maintaining key ecosystem services linked to productivity and soil fertility.

The database and statistical methodologies developed under DRYFUN are currently being used within the framework of the ERC-funded project BIODESERT. The project, which runs until December 2020, aims to further scientific understanding of the functioning and resilience of drylands to major desertification drivers.

DRYFUN

- Coordinated by URJC in Spain.
- Funded under H2020-MSCA-IF.
- http://cordis.europa.eu/project/rcn/195204
- Project website: http://dryfun-project.com/

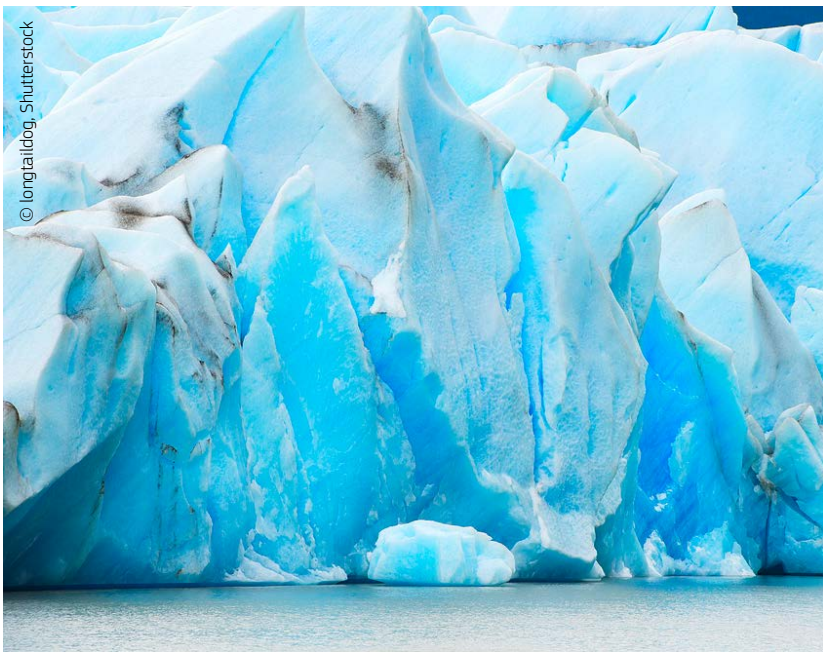
GLOBAL WARMING – WE HAVE LESSONS TO LEARN FROM THE PLIOCENE EPOCH

Carbon levels around 3 million years ago were similar to those of today and temperatures were even warmer. If something so significant is mirrored in the past, what else can we learn about extreme climate changes?

Three million years ago the Earth's climate was warm enough for a forested High Arctic inhabited by large mammals to exist. If the idea of melting icebergs, rising sea levels and 400 parts per million of carbon dioxide in the atmosphere sounds all too familiar – welcome to the Pliocene.

For many researchers, the Pliocene, which lasted from 5.3 million to 2.6 million years ago, is our best reference for today's warming. It was the last time atmospheric CO_2 levels were similar to today's, trapping heat and raising global temperatures to above the levels Earth is experiencing now. A better understanding of the response of the ice sheets to increasing temperature is needed to make more rigorous projections of how much sea level change could be expected in the future.

We live in uncertain times when it comes to the impact of climate change and global warming, so any insight we can gain from the past is an area of scientific interest. EU support under the Plio-ESS (Pliocene Constraints on Earth System Sensitivity) fellowship is helping to further our understanding of the responses of the ice sheets to a warming climate.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When it comes to ice sheets, one size does not fit all

Recent research by a team of scientists, including Plio-ESS, has been considering how the planet responded to Pliocene warmth. They have published a new paper presenting, for the first time, the transient nature of ice sheets and sea level during the late Pliocene. They show that the Greenland and Antarctic ice sheets might have responded differently to Pliocene heat, melting at different times.

Their transient ice sheet predictions are forced by multiple climate snapshots derived from a climate model set up with late Pliocene boundary conditions with different orbital forcing scenarios appropriate to two Marine isotope stages (MISs): KM5c (from 3.226 to 3.184 million years ago) and K1 (from 3.082 to 3.038 million years ago).

Their findings support previous studies, which have shown model results indicating that peak MIS KM5c and K1 interglacial temperatures were not globally synchronous: there are leads and lags in temperature in different regions.

When it comes to modelling, this highlights the potential pitfalls of aligning peaks in proxy-derived temperatures across geographically diverse data sites. A single climate model simulation for an interglacial event is inadequate for capturing peak temperature change in all regions.

The team explains, "We present a first step toward a fully coupled system of ice volume and climate variability across the late Pliocene (...) The model simulations presented here attempt to capture the transient response of climate and ice volume to orbital variations."

The shape of the Earth's orbit, the tilt of its axis and the fact that it wobbles, all have a part to play

The episodic nature of the Earth's glacial and interglacial periods within the present Ice Age (the last couple million years) has been caused primarily by cyclical changes in the Earth's circumnavigation of the Sun. The study found that when the cyclical change known as precession variability is large, caution is advised when directly inferring the behaviour of ice sheets from oxygen isotope records in the Pliocene.

"The model simulations presented here attempt to capture the transient response of climate and ice volume to orbital variations."

Their simulations indicate that the asynchronous response of ice sheets, combined with their transient modelling, is indeed a key factor in predicting an orbital timescale sea level for a climate that is warmer than ours is now.

The Plio-ESS fellowship ended last year. Its goal was to reduce the uncertainties associated with future projections of sea-level change.

Plio-ESS

- Coordinated by the University of Leeds in the United Kingdom.
- Funded under FP7-IDEAS-ERC.
- https://cordis.europa.eu/project/rcn/100206

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AQUATIC RESOURCES

NEXT-GENERATION WEB-ENABLED *IN SITU* SENSOR SYSTEMS FOR THE MONITORING OF A CHANGING OCEAN

Marine scientists collaborated with industrial partners to develop new low-power, cost-efficient acoustic and optical sensors along with interoperable and antifouling technologies to improve the long-term monitoring of the ocean and the study of its ecosystems.

Ocean processes are biological, geological or chemical in nature and may take place in less than a second or over centuries, at a scale that extends from a few microns to many kilometres. Effectively sampling the ocean, which covers over 70% of our planet, is therefore no easy task and costly in terms of time and resources.

Most sampling techniques are based on expensive laboratory analysis and field work with data collected over a limited time and area, resulting in poor sampling resolution. The EU-funded NeXOS (Next generation, Cost-effective, Compact, Multifunctional Web Enabled Ocean Sensor Systems Empowering Marine, Maritime and Fisheries Management) project responded to this challenge by developing eight new low-cost, compact, multifunctional sensor systems for deployment on multiple platforms like floats, gliders, moored observing systems and vessels of opportunity, such as ferries.

The sensors are based on optical or acoustic technologies and address descriptors identified by the Marine Strategy Framework Directive for Good Environmental Status (GES). Project coordinator Dr Eric Delory says: "They will allow scientists to measure more variables relevant to climate change, in particular those related to ocean acidification and the carbon cycle, and help research ecosystems and study biodiversity from phytoplankton to whales." Two of the new sensors contributed specifically to the Common Fisheries Policy, with variables relevant for an ecosystem approach to fisheries.

Improved reliability and data traceability

The team developed downstream services for the Global Ocean Observing System and the European Common Fisheries Policy.

New interfacing capabilities of the NeXOS sensor package are meant to allow real-time data to be collected without the need for a specialist going to the actual location to install the sensors or take measurements. "Standard metadata descriptions make it possible to trace and easily deliver all the data collected by the NeXOS sensor package to global data brokers," explains Dr Delory.

Project partners also developed a very low-power smart anti-fouling system based on electrochlorination to increase data quality and sensor reliability for long-term deployment. The system reduced maintenance costs and improved the quality of data collected by limiting biofouling-related interference and avoided the unnecessary introduction of potentially harmful chemicals from anti-fouling agents into the marine environment.

Better predictions for ocean health

As a result of increasing human activities, the noise added to the marine environment is now becoming a concern and passive acoustics can help characterise and eventually reduce the impact. "NeXOS has developed new passive acoustics sensors in the form of smart hydrophones for the measurement of both human and biological sources and underwater noise in general, and demonstrated them on gliders, Argo floats, and fixed observing platforms," states Dr Delory.

Techniques utilising inherent optical properties like fluorescence and absorption can be used for long-term monitoring as these properties are independent from ambient light conditions. They can provide information about many components of the marine environment, which include contaminants as well as dissolved and particulate constituents of the biological carbon cycle.

"NeXOS promoted innovation through the development of new compact low-power multifunctional optical sensors, based on fluorescence, absorption and spectrophotometric techniques and demonstrated them on deep gliders," comments Dr Delory. "Deploying NeXOS sensors from ferries and on fishing nets and on cost-effective autonomous platforms will increase our capacity to sample the ocean, thus reducing uncertainties in predictions of parameters or indicators of ocean health," he concludes.

NeXOS

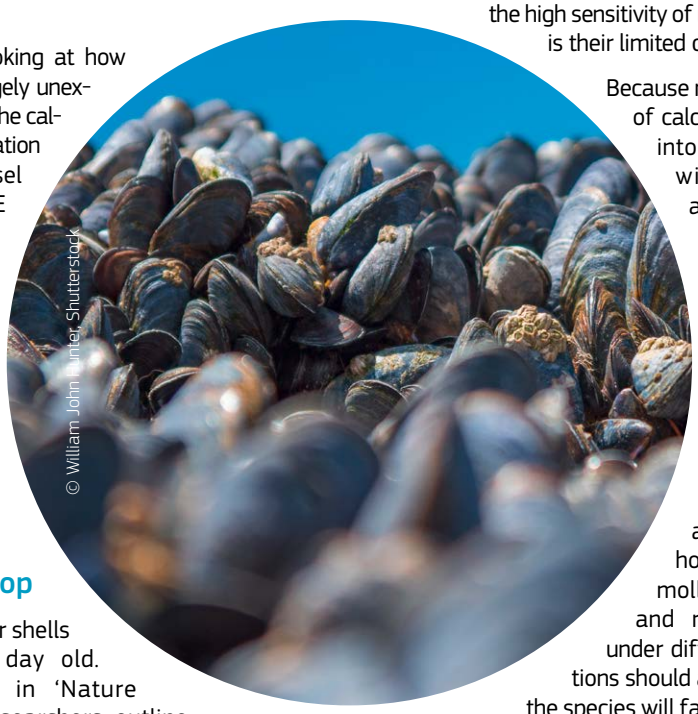
- Coordinated by Consortium for the design, construction, equipment and exploitation of PLOCAN in Spain.
- Funded under FP7-ENVIRONMENT.
- http://cordis.europa.eu/project/rcn/111405
- Project website: http://www.nexosproject.eu/
- http://bit.ly/2Gu9UF1

A HARD SHELL: HOW MUSSELS ARE AFFECTED BY OCEAN ACIDIFICATION

Research carried out on day-old mussel larvae explores the effect of a changing climate on shell development, with potential applications for aquaculture and biotechnology.

Scientists studying calcium in a marine environment have discovered a direct link between the acidification of the seas in a changing climate and the rate at which mussels develop their calcified outer shell. The shell of a mussel protects it from predators and is formed at a very early stage of development. At this point, they are particularly sensitive to low pH levels in the ocean caused by increasing uptake of carbon dioxide from the atmosphere dissolved in seawater.

An EU-funded study is looking at how acidification affects the largely unexplored mechanisms behind the calcification, growth, malformation and dissolution of mussel shells. The findings of CACHE (CAlcium in a CHanging Environment) help explain how the larvae of bivalves such as mussels form shells under moderate acidification scenarios and provide a direct link between ocean carbonate chemistry and the rate at which larvae calcify.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A new look at how mussel shells develop

Mussels begin to form their shells when they are just a day old. In a report published in 'Nature Communications', the researchers outline how they used micro-electrodes and fluorescent dyes to track the deposition of calcium carbonate in one- to two-day-old shelled larvae. They found that calcium was not formed intracellularly, as previously thought, but is more likely extracted from seawater and transported via specific proteins before calcium carbonate is formed.

They then studied the conditions directly beneath the shell. This examination showed that the larvae were able to increase the pH and carbonate concentration beneath their shell, leading to higher rates of calcification. In more acidic conditions, the larvae's ability to calcify decreased; at the highest CO_2 concentrations, researchers noted greater dissolution of shells, leading to increased mortality.

Bivalves provide several essential ecosystem services, including as bioindicators to monitor the levels of pollutants in a body of water, and as biofilters. They are particularly vulnerable to ocean acidification, but until now, little has been known about how they regulate calcium to produce a shell, how this process might be affected by changing environmental conditions, and what the consequences are for the population. This lack of knowledge restricts the ability to predict future biodiversity and the consequences for the aquaculture industry. The research carried out under CACHE suggests that the reason for the high sensitivity of mussel larvae to acidification is their limited capacity for ion regulation.

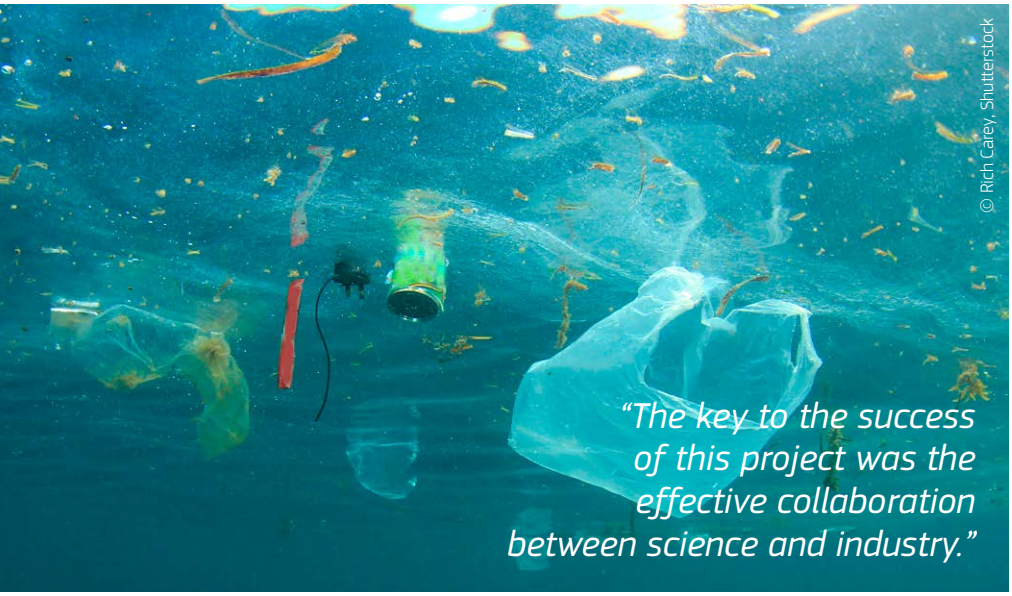
Because molluscs take a soluble form of calcium in seawater and turn it into an insoluble compound, without requiring huge amounts of energy, understanding the process may have potential applications for biotechnology. The aim of CACHE is to increase knowledge about calcium production in the marine environment and train young scientists to tackle complex biological problems using multidisciplinary approaches. Understanding how commercially important molluscs produce their shells and regulate shell production under different environmental conditions should also provide insight into how the species will fare in a changing climate and provide resilient stocks for aquaculture.

CACHE

- Coordinated by the Natural Environment Research Council in the United Kingdom.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/109120
- Project website: https://www.cache-itn.eu/

A NEW MULTIFUNCTIONAL SENSOR PACKAGE TO MONITOR THE OCEAN

The ocean provides us with food and raw materials, as well as vital transport routes and opportunities for leisure activities; however, it is under pressure from climate change and pollution. Sustainable ocean management that relies on detailed, continuous monitoring of the marine environment is urgently needed.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"The key to the success of this project was the effective collaboration between science and industry."

Water samples are normally taken from the ocean and analysed in land-based laboratories, but this approach is costly and provides a mere 'snapshot' in time and space. The EU-funded SenseOCEAN (Marine sensors for the 21st Century) project brought together leading developers of marine sensors from academia and industry to create a reliable, accurate and cost-effective solution to deal with the challenge of ocean monitoring.

The consortium developed a range of miniaturised chemical, electrochemical and optical sensors, including a lab-on-a-chip sensor. They harmonised their function with common interfaces, plugs and connectors, and standard data formats to produce a multifunctional, *in situ* marine biogeochemical sensor package. "Combining new technologies such as 3D printing and new techniques for microfabrication enables us to ensure cost-effective mass production," says project coordinator Professor Douglas Connelly.

A wide range of uses

The integrated sensor packages underwent thorough field testing in the Kiel Fjord, Germany, and the Mediterranean Sea. Scientists also deployed a fast repetition rate fluorometry sensor for 150 days in the Arctic and a multiparameter nutrient sensor for over two years in a harbour in the United Kingdom. A nitrous oxide (N_2O) electrochemical microsensor is already in use at over 100 wastewater plants, while the monitoring ability of optode sensors that use light to detect and measure specific substances in a sample have been demonstrated at fish farms.

One of the project partners developed the V-Lux multiparameter fluorometer, which can be used for monitoring environmental pollution, algae, sewage and bathing waters, oil spills (including road and airport apron run-off) and point source pollution. It can also monitor coloured dissolved organic matter to assess organic load, coagulation control and filter management in water processing plants, and exhaust gas scrubber wash water.

The sensor package and individual sensors are easily mounted on underwater vehicles, moorings and floats, or frames in the deep sea, and used to conduct environmental analysis. By attaching sensors to gliders large areas may be covered, while autonomous platforms can conduct frequent analyses over the long term. "Special protection systems are used to reduce biofouling, enabling the sensors to be deployed below the waves for long periods of time," explains Prof. Connelly.

Commercial and environmental benefits

Production costs for sensors were significantly reduced by minimising the number of machine parts and through the adoption of new materials and technologies, such as 3D printing, and flexi-rigid printed circuit boards. Techniques like analogous fluidic circuits were also adopted from other fields like digital electronics, in order to reduce the number of stepper motor syringe pumps for the lab-on-a-chip.

SenseOCEAN was the first to integrate multiple sensors into one 'plug and play' sensor package. Furthermore, the sensors were all developed by project partners rather than simply repackaging existing ones. According to Prof. Connelly: "Our SME partners are already benefitting from SenseOCEAN with their products now on the market, including a field data logger and N2O microsensor, a multiparameter fluorometer; other products such as optodes are currently very close to market. The key to the success of this project was the effective collaboration between science and industry."

In the long term, regulatory and monitoring organisations will have a new set of tools that will allow effective legislation and controls for protecting the marine environment. "They will also support research by enabling greater spatial and temporal sampling of the oceans, thereby increasing understanding of marine processes like ocean circulation and nutrient cycling at both local and global scales," concludes Prof. Connelly.

SenseOCEAN

- Coordinated by the Natural Environment Research Council in the United Kingdom.
- Funded under FP7-ENVIRONMENT.
- http://cordis.europa.eu/project/rcn/110898
- Project website: http://www.senseocean.eu/

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INDUSTRY

TURNKEY ROBOT AUTOMATION FOR SMES

As all objects around us become smarter, it seems only natural for old-fashioned industrial robots to follow the movement. The FACTORY-IN-A-DAY project has given them a push, making robot automation a serious avenue even for SMEs producing low volumes of highly diversified products.

Robot automation may stand to reason when you're running a high-throughput assembly line, but the business rationale is not so straightforward for SMEs. One problem lies in installation time and cost, high enough to make it an instant no-go, but there is more.

"SMEs typically have shorter batches, smaller production series, and more process variation. These things are difficult for the old-fashioned robots, which are typically good at highly repetitive tasks in very structured environments for very long periods of time," explains Prof. Martijn Wisse, researcher specialising in industrial robot intelligence at TU Delft. Should an SME decide to go ahead anyway, the required development time for developing task-specific software (such as vision software) and hardware (such as grippers) is so long and the cost so high that the added value would be almost inexistent.

It doesn't necessarily mean that robot automation is out of the question. Or at least, not since Prof. Wisse's FACTORY-IN-A-DAY project successfully developed a technology capable of changing the playing field.

With its 'plug and work' solution, the project proposes a robot that can be installed, customised and programmed for defined tasks within a few days. It's a turnkey package that encompasses tools – notably VR-based – to speed up discussion with customers; 3D-printed application-specific components; a software for self-calibration; an artificial skin that allows the robot to learn from human operators manually guiding it thanks to a teaching demonstration algorithm; a collision avoidance system; and other innovative features.

"The main difficulty lay in connecting all of the embarked software packages together, such as motion control, motion planning, reflexive motions for contact evasion, learning from interaction with users, 2D vision, 3D vision, etc. This is why we decided to adhere to the communication standards and protocols of ROS – the most successful open-source robotics middleware on the market," Prof. Wisse explains.

The FACTORY-IN-A-DAY robots are collaborative, meaning that they can work safely in a human working environment. This results in much less development time, as neither large factory floor re-arrangements nor obtrusive large safety fences have to be designed.

To try it is to love it

All this hard work resulted in the project team winning the 2016 edition of the Amazon Picking Challenge, which allowed them to showcase the intelligent product handling capabilities of their robot systems. The project also largely contributed to advancing the ROS-Industrial software, which is already driving hundreds of industrial robots in factories all over the world.

Prof. Wisse says that SMEs are highly interested in the system, with some even already having a robot system implemented. But reduction of installation time remains an issue, as he explains: "Most SMEs are waiting until robots can be deployed in their factory as easily as a new PC in their office."

The project team have already made great strides toward that goal, but Prof. Wisse admits that there is still room for improvement. He would also like the future versions of the robots to be even more intelligent and more capable of flexibly dealing with variations in their environment.

FACTORY-IN-A-DAY was completed in September 2017, and a follow-up project called ROSIN is already ongoing. "The new project fully focuses on improving the availability and reliability of open-source software components that can make the robots even smarter. European companies can request funding from us if they are interested in developing their own contributions to ROS-Industrial," Prof. Wisse concludes.

FACTORY-IN-A-DAY

- Coordinated by TU Delft in the Netherlands.
- Funded under FP7-NMP.
- http://cordis.europa.eu/project/rcn/109377
- Project website: http://www.factory-in-a-day.eu/
- http://bit.ly/2GwUJL2

APPLYING NONLINEAR MODELLING TO STRENGTHEN THE STEEL SECTOR

The EU-funded HOTBRICKS project is supporting cutting-edge industrial design in Europe through promoting excellence in nonlinear modelling.

Accurately modelling how thermal shock resistant materials will perform in harsh industrial conditions could save manufacturers money and increase safety. A breakthrough in this field has been achieved by bringing together academics specialised in modelling the nonlinear behaviour of materials and an industry leader in the production of refractories (materials that maintain strength at high temperatures) for steel, glass and foundry industries.

"The outcome of this project has the potential to enhance the economic and environmental performance of the steel sector," explains HOTBRICKS (Mechanics of refractory materials at high-temperature for advanced industrial technologies) project coordinator Dr Francesco Dal Corso, Assistant Professor of Solid and Structural Mechanics at the University of Trento in Italy. "A team of highly qualified professionals has now been trained and equipped with a range of technical competencies and practical skills, which will make an immediate impact in the field and fill the skills gap often identified among academia and industry."

Understanding material behaviour

Nonlinear solid mechanics is the study of how materials behave under pressures, temperature changes and other loading conditions. Understanding this is critical in the design of devices used in advanced mechanical applications, particularly where extreme loading conditions are involved. Many applications of nonlinear solid mechanics involve aerospace engineering and robotics for example, and industrial processes that involve metal forming or ceramics.

Rock-like materials, called geomaterials, are a broad class of materials including rock, concrete, soil and ceramic. These materials are of great engineering interest, since they are used for many industrial purposes, like shock and vibration absorbers, fire protection, thermal barriers and of course refractory products. Their high melting temperature and the great thermal and chemical stability make such materials ideal for high-temperature applications, such as work with molten steel and iron.

"The goal of this project has been to bring nonlinear modelling closer to industry in order to achieve mechanical designs that deliver superior performances," says Dal Corso. "Advances in high-temperature industrial applications using geomaterials can only be achieved through nonlinear modelling of complex production processes."

Next generation expertise

The HOTBRICKS research programme, launched in September 2013, brought together academia (University of Trento) and industry (Vesuvius) in order to employ nonlinear solid mechanics in the design of refractories for liquid steel applications. Together, the team has expertise in modelling, numerical simulation, experimental analysis, material characterisation and design optimisation. "Our objective here was to grow a new generation of young researchers in a multidisciplinary and intersectoral environment," says Dal Corso.

The key success of the project has been precise modelling of the mechanical behaviour of refractory materials at high-temperature, leading to a new way of optimising the design of devices involved in high-temperature applications. "The research results

represent not only an advance in scientific knowledge but also a step forward in the mechanical design of refractory components manufactured by industry," notes Dal Corso.

Since official completion of the project at the end of August 2017, new design methods for high-temperature applications have been developed and are currently being exploited by the project's industrial partner Vesuvius. The Belgian firm is using the collaborative expertise to increase safety, reduce material and energy waste and cut environmental pollution in manufacturing processes. "Results from the project will also enable Vesuvius to implement appropriate processes and technologies more sustainably, cost-effectively and faster," adds Dal Corso.

HOTBRICKS

- Coordinated by the University of Trento in Italy.
- Funded under FP7-PEOPLE.
- http://cordis.europa.eu/project/rcn/109958
- Project website: http://hotbricks.unitn.it/

MAGNETIC E-SKINS USHER IN NEW ERA IN SENSOR ENGINEERING

A team of researchers has developed the first-ever magnet-sensitive electronics that can track body movements, opening up exciting prospects for a wide range of industries.

Up until now, to manipulate virtual objects, you needed equipment that relied on the optical detection of moving body parts. However, this equipment usually included cameras, whose resolution is not good enough to reconstruct fine movements of the body, and goggles and gloves, which are bulky and restrictive. With these issues in mind, EU-funded researchers set out to develop versatile sensing devices that interacted with magnetic fields.

In the initial stages of the project, researchers knew that to achieve touchless manipulation of virtual objects, they needed to combine two key functions in a single gadget. These were the ability to detect nearby objects and direction in space. Yet, although the team's early wearable electronics successfully achieved the first function using magnetic field sensors, it wasn't able to analyse spatial directions.

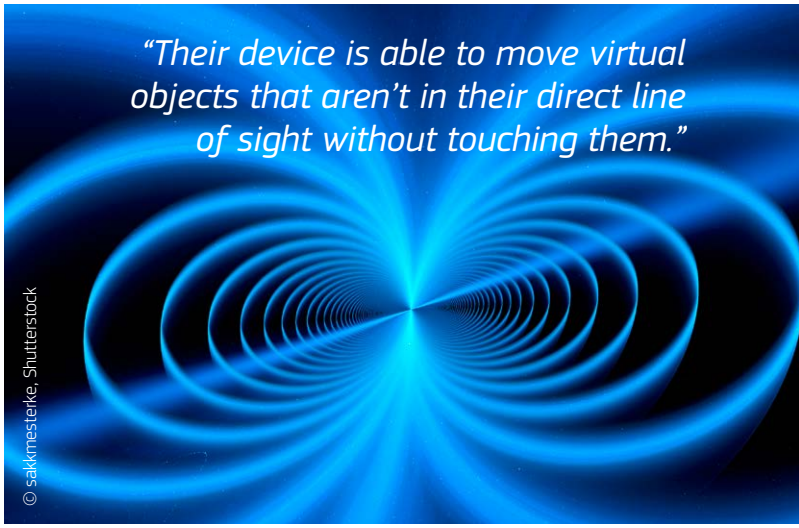
Now the SMART (Shapeable Magnetoelectronics in Research and Technology) researchers have overcome this barrier and developed the first ultrathin e-skins capable of tracking body movements.

e-skin device tracks body movements for first time

The e-skin is essentially a two-dimensional magnetic field sensor attached to ultrathin polyimide foils. Only 3.5 micrometres thick, this stretchable, bendable and printable device can easily be applied to any part of your hand and is practically unnoticeable to the wearer. It can also be integrated with soft and shapeable materials, such as textiles for wearable electronics. What is more, it can withstand temperatures up to 344 °C, which is its breaking point. This is especially remarkable when compared with commercial polymers such as Mylar and the much thicker PET and PEEK, all of which break at less than half this temperature.

The latest accomplishment of the SMART project was presented in a recent paper published in the journal 'Science Advances'. Researchers describe how, by interacting with a magnetic field, their device is able to move virtual objects that aren't in their direct line of sight without touching them.

Researchers demonstrated this concept by mounting the 2D sensor on an elastic wristband to create a virtual keypad. A permanent magnet attached to a person's fingertip provided the magnetic input. When the fingertip approached the wristband at a certain encoded angle (e.g. 90°), the sensor converted the magnet's position into a predefined character (e.g. the number four).



They also showed how a virtual light bulb can be dimmed by touchless manipulation, and relying solely on the interaction with magnetic fields. Here, the e-skin was attached to the palm of the hand. The wearer controlled the light by moving their hand near a permanent magnet acting as a virtual dial. Angles between 0° and 180° were encoded to correspond to the typical movements a hand makes when operating a real dial. Rotating the hand above the virtual dial just a few degrees to the left or right either dimmed or brightened the virtual light bulb, respectively.

Team members believe that this technology will open the way for a wide range of applications not only in sports and gaming, but also in regenerative medicine and the security industry. It's further predicted that additional improvements to flexible sensors will make e-skin interaction with the Earth's magnetic field a real possibility in the future.

The SMART project, which ended last year, aimed to give the EU an advantage in the development of a unique class of devices with important functionality. Fast and flexible, these materials were also designed to react and respond to a magnetic field.

SMART

- Hosted by Helmholtz-Zentrum Dresden-Rossendorf EV in Germany.
- Funded under FP7-IDEAS-ERC.
- https://cordis.europa.eu/project/rcn/105576
- Project website: http://www.smartsensorics.eu/

INFORMATION AND COMMUNICATION TECHNOLOGY

LEARNING FROM MASSIVE, INCOMPLETELY ANNOTATED, AND STRUCTURED DATA

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Whether it is from DNA databases, online social networks or solar farms, Big Data is being used to train artificial intelligence (AI) systems to solve real-world problems. But vast datasets, or fast data streams, do not always produce information that is in a form machine learning (ML) systems can cope with. Smart software developed by the MAESTRA project aims to fix this.

AI is hot news right now, with its stellar game playing, speech recognition and health diagnosis feats regularly hitting the headlines. But building learning systems is not as easy as some of the media coverage might suggest: the ML technology at the heart of AI faces computationally-difficult tasks in a great many applications.

A major reason for this is that the data such systems operate on come from many disparate sources – such as video, DNA, medical images, sensors or social networks – so it cannot always be moulded into the well-structured formats that ML systems need if they are to be trained well enough to make useful and accurate predictions when fed new raw data.

For instance, to train predictive models, software engineers often need to handle data that is unlabelled (or only partially labelled) with the values to be predicted; datasets that are massive, unwieldy or streaming at rates too high to cope with; or data being generated concurrently by sensors in an extensive, spatially distributed network. Adding to this complexity, the data can sometimes have a combination of some, or all, of these properties, making efficient data mining extremely difficult.

Time to make data make sense

"The simultaneous presence of several of these data complexities is a hard, currently insurmountable, challenge. And it's one that severely limits the applicability of machine learning and data mining approaches," says Sašo Džeroski from the Jozef Stefan Institute in Ljubljana, Slovenia.

So Džeroski, project coordinator of the EU-funded MAESTRA (Learning from Massive, Incompletely annotated, and Structured Data) project, and colleagues in Croatia, Italy, Macedonia and Portugal have been working to clean up this messy data mining situation. After analysing the problems of mining complex data in great detail, they designed tree-based and rule-based ML methods and developed intelligent software that's able to take in massive sets of data, or streams of data, including incompletely labelled data and network data, and make sense of them.

The majority of their developed methods can now make complex predictions, such as the values of several data variables simultaneously. And it's not just theory: to prove their software methods work, the MAESTRA team have also successfully tested them on a number of 'showcase' problems in a variety of fields.

Success is in the genes

The MAESTRA data mining methods were applied to genomic datasets containing DNA sequences from both individual organisms and diverse communities of them, such as human gut flora. The complex genomic data was so thoroughly analysed by the ML systems that they were able to successfully predict gene functions in thousands of bacterial species from data derived only from their DNA sequences. They also predicted the phenotypes of micro-organisms from their genotypes, and identified compounds that may help treat tuberculosis and salmonella, too.

In the solar energy arena, the MAESTRA methods were used to help ML systems predict both the production and the consumption of energy from different kinds of sensor data in different contexts, such as the production of solar energy in photovoltaic power plants and the consumption of solar energy to heat the Mars Express orbiter. In addition, Džeroski's team predicted both equipment failures in trains and taxi demand from transport datasets. It also improved the accuracy of sentiment analysis and image annotation in social networks, too.

Applications set to proliferate

Many of the general purpose data mining methods developed in MAESTRA have already been open sourced but Džeroski nevertheless expects several of those to be harnessed in

commercial AI projects, with organisations customising them for certain applications and adding their own user interfaces. "This will allow MAESTRA partners to develop secondary products in the form of tools and services that are easier to use for potential customers," he says.

Pharmaceutical companies, Džeroski suggests, could employ customised MAESTRA tools to let AI identify new applications for older drugs, i.e., for drug repurposing. In further ongoing research, MAESTRA ideas are also being harnessed in projects using ML in the study of gene function and health, tumour mutation, personalised medicine, brain informatics, sustainable food production and biodiversity.

MAESTRA
- ★ Coordinated by Jozef Stefan Institute in Slovenia.
- ★ Funded under FP7-ICT.
- ★ https://cordis.europa.eu/project/rcn/110992
- ★ Project website: http://maestra-project.eu/

MAKING MOOCS MORE WIDELY AVAILABLE

Researchers with the EU-funded TraMOOC project have delivered a high-quality machine translation service specifically adapted to the MOOC domain.

Massive Open Online Courses (MOOCs) continue to grow in popularity. In fact, an estimated 200 universities around the world now offer over 1 200 MOOCs. These courses are taught by more than 1 300 instructors and are being followed by around 10 million users. Despite this popularity, the uptake of MOOCs is significantly limited by the language barrier, given that the vast majority are held in English.

Although the need for translating MOOC content has been acknowledged by the majority of course providers, the solutions provided so far have been fragmentary, human-based and implemented off-line. The EU-funded TraMOOC (Translation for Massive Open Online Courses) project tackled this impediment by developing a high-quality machine translation (MT) platform that addresses various types of educational MOOC content, including assignments, tests, presentations, lecture subtitles and forum discussions.

The result is the first free and open translation service that uses Neural Machine Translation Models (NMT) for educational content. The TraMOOC system provides accurate and coherent translations of this content from English into 11 European and BRIC languages (BG, CS, DE, EL, HR, IT, NL, PL, PT, RU, ZH) that have proven difficult to translate in previous MT solutions.

"Although existing machine translation services tend to be general purpose, when they are adapted to a specific domain, such as MOOCs, you can achieve significant improvement in the MT's performance for that domain," says project coordinator Dr Valia Kordoni. "The TraMOOC project does exactly this and delivers a high-quality machine translation service specifically adapted to the MOOC domain."

A multi-functional, open-source system

The open source TraMOOC platform uses cutting edge neural translation architecture and innovative domain adaptation techniques. This combination of technology immensely increases the fluency and accuracy of the translation's output. It offers substantial improvements over conventional phrase-based statistical machine translation systems (PBSMT). TraMOOC can translate a wide array of file formats, including HTML, subtitles and Microsoft Office documents using both synchronous and asynchronous translation modes. It is also able to support such file formats as HTML, subtitles and Microsoft Office documents, and return the translated material in the same file format as it was originally received. "Furthermore, as the system is open-source, any MT solution for any language can be easily integrated into the platform," adds Dr Kordoni.

In addition to the TraMOOC platform, project researchers also introduced an innovative translation-evaluation schema that improves existing linguistic tools and resources. "This feature allows researchers to test the advanced tools and solutions that were created within the course of the project, with appropriate license models, as well as software packages for the development of state-of-the-art systems for translating educational texts," explains Dr Kordoni. "Together, the translation model training processes, the resource bootstrapping processes and the text mining methodologies form a library of algorithms that will prove invaluable to the scientific community."

Opening doors

The key outcome of the project is that it allows even more users to access MOOCs. "For many European citizens and people around the world, TraMOOC has opened the door to multimedia educational content previously unavailable due to language restrictions," concludes Dr Kordoni. "Everyone can now take advantage of MOOCs to enhance their education, improve their skills and increase their employability."

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"For many European citizens and people around the world, TraMOOC has opened the door to multimedia educational content previously unavailable due to language restrictions."

TraMOOC
- ★ Coordinated by Humboldt University of Berlin in Germany.
- ★ Funded under Horizon 2020-LEIT-ICT.
- ★ https://cordis.europa.eu/project/rcn/194192
- ★ Project website: http://tramooc.eu/
- ★ http://bit.ly/2FZldY9

CONVERGING NETWORKS PAVE THE WAY TO 5G DEPLOYMENT

By training young researchers and bridging different fields of research, the COMANDER project has successfully helped shape the future of 5G in favour of fibre-wireless networks.

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"COMANDER therefore places network intelligence at the BaseStation – a central location using optical interfaces."

We may not realise it, but the exponential growth in the number of connected devices of all kinds – commonly known as the 'Internet of Things' – is progressively driving current infrastructures into a corner.

As Dr Pleros and Dr Miliou, from the Aristotle University of Thessaloniki, Greece, explain, events with a particularly high concentration of spectators are a good illustration of how this can be problematic: "Imagine 10 000 fans uploading a photo or video of a player scoring a goal on their favourite social network, almost simultaneously. This creates a huge amount of traffic which is very difficult to satisfy, and it only gets worse as objects like cars become connected and self-driving: for the car to make the right decision on how to move, an enormous amount of data from a high number of sensors is required."

This is where Next-generation networks (NGNs) come in, or at least have to. Unlike the linear evolution seen from 3G to 4G networks, the Internet of Things requires a full-blown paradigm shift where each device is served according to its needs. This requires heterogeneous networks, wireless data rates than can go up to 10 Gb/s, latency lower than 5 msec, and the capacity to withstand a much higher end-user density – all this without additional energy cost.

As there is no such thing as a single technological path to get there, finding the right one requires dedicated, well-trained researchers putting potential solutions to the test, together. This is precisely what Dr Pleros and Dr Miliou aimed to do under the COMANDER (Converged Optical-Mobile Access Networks with Dynamic and Efficient Resource allocation) project, with a focus on the seamless convergence of fibre and wireless networks.

"Fibre-wireless networks are currently considered as a must for future 5G fronthaul networks, but back when COMANDER started, we still didn't know whether this solution should be favoured," Dr Pleros explains. "By training young researchers and bringing synergies between people from the fields of photonics and wireless technologies, we could set the first cornerstones towards converging fibre and wireless networks, and help, to some extent, define fibre-wireless networks as the path to be followed."

Intelligent network

The COMANDER approach essentially consists in reducing cost and energy consumption by stripping antennas back to the basics.

"We know that NGNs will feature a much higher number of antennas, basically small-cell antennas that will be plugged on lamp-posts or other convenient locations. But if each of these antennas is intelligent enough to serve its mobile users, as is currently the case, then the cost and energy consumption for the whole system will become prohibitive," Dr Miliou says. "If we want to reduce cost and energy consumption, we need these antennas to be almost dummy repeaters."

COMANDER therefore places network intelligence at the BaseStation – a central location using optical interfaces as well as Medium-transparent medium access control (MT-MAC) mechanisms to ensure NGN intelligence whilst meeting performance targets. As Dr Miliou points out, NGN intelligence is extremely important for low-cost deployment as "it means that the end-user can exchange traffic with the BaseStation regardless of whether the intermediate link includes only wireless, optical or both as transmission media."

All in all, the project team has designed and demonstrated a converged fibre-wireless network architecture for providing up to 1 Gb/s wireless data rates using mm-Wave wireless connectivity. The team even exploited the converged infrastructure to use advanced concepts like Network Coding as ways to further reduce latency and energy consumption.

"We are witnessing increasing interest from major industrial telecom operators and vendors to get involved in activities that promote network convergence and migration from the CPRI standard to Ethernet packet-based communication, while at the same time continuously adopting more optical technologies and photonic chips. All these areas have been pioneered by COMANDER, and we are really proud of this," Dr Pleros concludes.

COMANDER

- Coordinated by the Aristotle University of Thessaloniki in Greece.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/110103

HOW TO TURN THE PUBLIC SECTOR INTO A TECHNOLOGY LEADER

An EU-funded project is showing how the public sector can use new technologies to launch innovative new services or deliver the same ones better to meet social needs.

When you think of the public sector, innovation and technology are maybe not the first words that come to mind. But a team of EU-funded researchers aimed to transform the public sector from a technological laggard into a leading force in using technology to meet the needs of citizens.

The outputs of the SONNETS (SOcietal Needs aNalysis and Emerging Technologies in the public Sector) project include a list which identifies 23 technologies which could have a big impact on the public sector. Yet this is not a project about technology, it is about establishing the link between technology and making people's lives better, says project expert Yannis Charalabidis, associate professor of eGovernance at Greece's University of the Aegean.

SONNETS began by working with individuals, businesses and people from government in Germany, Greece, Italy and Spain to define what they need from the public sector. This was pared down to the top 12, with others further down the list.

Disruptive technologies

A second output is a seven-step methodological framework, including templates for assessing feasibility and impact, to guide the choice of technologies. It includes an analysis of trends in 23 emerging technologies which are currently disrupting the private sector. "For each one, you would need 10 PhD students to identify the further uses and issues," says Dr Charalabidis.

"If you compare the public sector to the private, in terms of management and service delivery the private sector typically directs 10-25% of its efforts to finding and designing new products, but in the public sector no one does that job," he says, "only in a few countries have they realised that you need people devoted to that on a daily basis."

The third output is a series of roadmaps which assign each societal need to one or more emerging ICTs. They describe what needs to be done to take this technology from its current state to a fully implemented version adapted to the public sector and are complemented by research recommendations for policymakers, ICT experts and public sector officials.

Fast pace of change

The rapid pace of change means the SONNETS technology list will quickly become obsolete. But the SONNET framework can equip people in the public sector to take those decisions for themselves by helping "finding their way in this sea of technology," according to Dr Charalabidis.

Above all, it aims to facilitate decision making based on evidence over ideology. "It is a very different ball game to take important decisions in a society where citizens are very well-connected; you cannot take decisions without taking the evidence systematically into account," says Dr Charalabidis.

He believes that technologies such as artificial intelligence and policymaking 2.0 have big potential for enabling new services in the public sector. Blockchain, the technology behind Bitcoin, could remove the need for the authorities to act as trusted third parties for selling a house, storing driving licences or keeping a municipal census.

But a lot depends on how they are used. Ordinary people may fear that artificial intelligence, for instance, could take their jobs and/or end up concentrating wealth in fewer hands.

"No one could say that this period in human history is lacking in innovation, but the issue here is how innovation can provide a better life in the long term for citizens," concludes Dr Charalabidis.

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SONNETS

- Coordinated by ATOS Spain in Spain.
- Funded under H2020-Society.
- https://cordis.europa.eu/project/rcn/200044
- Project website: http://www.sonnets-project.eu/
- http://bit.ly/2pdOc0v

"No one could say that this period in human history is lacking in innovation, but the issue here is how innovation can provide a better life in the long term for citizens."

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SECURITY

A MUCH-NEEDED HELPING HAND FOR CYBER-SECURITY MANAGERS

Being in charge of a company's cyber security can be a real challenge, especially when the company in question provides critical infrastructures and you have to withstand all the pressure that comes with the function. The CyberWiz project comes as a relief, tracking down vulnerabilities within complex systems-of-systems and recommending countermeasures.

The more we rely on IT infrastructures, the scarier a cyberattack scenario becomes. Energy distribution systems and other critical infrastructures are, of course, protected from cyberattacks. But as the number of such attacks increases and ICT architectures grow into a spider-web like system-of-systems, it becomes almost impossible for people in charge of cyber security to have an overview of all vulnerabilities and their dependencies.

This is the context in which the CyberWiz (Cyber-Security Visualization and CAD-Tool for the Vulnerability Assessment of Critical Infrastructures) project was born, as Frank Schlottke, coordinator of the project and CEO of Applied Security GmbH, explains: "Being an expert in cybersecurity is increasingly out of reach, as companies manage large architectures with systems-of-systems. The actual vulnerabilities lie in the details. Understanding how such vulnerabilities relate in these complicated systems-of-systems is central to making the right decisions, and to make things worse, companies' security experts are typically swamped with work."

To lend them a hand, CyberWiz developed securiCAD – a tool providing an overview of relationships and interdependencies between systems, pointing at areas to address and investments to pursue, and helping to manage cybersecurity as architectures are being built or modified.

SecuriCAD is essentially a cyber threat modelling and risk management tool. It will take care of important tasks such as modelling IT infrastructure, simulation of risk use cases, and result reports supporting decision making, all in an automated manner. The point is to boost company organisation with automated expert capabilities and proactive risk management.

Concretely, the system provides a vulnerability 'heat map' for each system configuration, allowing for a user-friendly and visual comparison of the different alternatives at hand. It generates a list of vulnerable assets, tells cyber security experts how likely they are to be attacked, lists the types of attacks that could take place, and recommends countermeasures that could prevent this from happening.

"The system will automatically simulate cyberattacks, reveal all conceivable attack paths, and define the probability and the time it would take for the cyberattack to succeed. Once the recommended countermeasures have been implemented, the before/after situation will be compared and improvements will be tracked over time," says Schlottke.

SecuriCAD was tested in realistic conditions and confirmed to work exactly as expected. "We've had very good results and feedback from our pilot customers who were astonished by how fast we got results in their complex environment," Schlottke explains.

"We could identify additional risks and gaps in their security architecture, and use the feedback to improve the user interface and the 'look-and-feel' of the tool so as to meet the requirements not only of technical people, but also of business-focused ones."

Unlike state-of-the-art methods such as penetration tests, securiCAD leaves the IT infrastructure of the client completely untouched during analysis and evaluation processes, which means that business can run without disruption and interruption. "This saves much time and manpower, so much in fact that we decided to allow the user to run proactive tests that will forecast the effects of possible changes in IT infrastructure. This way, you can invest your unspent IT security budget in the areas that will bring you the biggest benefit," Schlottke concludes.

CyberWiz

- Coordinated by Applied Security in Germany.
- Funded under H2020-SME.
- https://cordis.europa.eu/project/rcn/200381
- Project website: https://www.cyberwiz.eu

COULD INSECTS BECOME BIOSENSORS OF THE FUTURE?

EU researchers believe that inducing addiction in insects could open up a new world of biosensor possibilities, ranging from landmine detection to early medical diagnoses.

With the help of a Marie Skłodowska-Curie Fellowship grant, Dr Vincenzo Di Ilio was able to encourage substance addiction in a certain species of cockroach. If this addiction can be positively associated with a certain odour, these insects could one day be used as living biosensors to carry out a range of useful activities.

"The inspiration for this project came from the identification of a problem that continues to cause immense suffering and economic hardship around the world – the legacy of landmines," explains Di Ilio. "These small plastic devices remain in the ground after wars, resulting in accidents and death and leaving arable land unusable. Detection and clearance remain dangerous, impractical and expensive."

These devices are often triggered by little more than 300 g of pressure, so using dogs to sniff out landmines is not possible. Di Ilio's idea was to investigate the possibility of using insects instead, which could one day be tagged and 'trained' to find explosives. This would enable experts to then identify the location of landmines and send in robots to remove them.

Insects as biosensors

Di Ilio notes that getting to this point will take years, and stresses that the focus of the ActIng (Addiction of Insects for Biosensoring) project was first and foremost to assess the potential of inducing insects to find a particular odour. This process began by selecting the ideal candidate for the job. "Not all insect olfactory systems are the same," he says. "We chose the German cockroach because it is sensitive to a wide spectrum of volatile chemicals, and we figured this insect could be used to find explosives."

The next challenge was finding a way of limiting the animal's interest to just one smell. Cockroaches are voracious eaters, but of course do not eat plastic explosives. "My idea here was to use drugs to alter the insect's perception of its environment," explains Di Ilio. "We sought to induce addiction in insects, and associate drug intake with a certain odour. This was the key objective of my research."

Given the difficulty of securing licences for drugs such as morphine and heroin, Di Ilio began his research by giving cockroaches tiny doses of nicotine. Cockroaches were found to be more sensitive to cigarette smoke than extracted nicotine, and some cues of addiction were successfully recorded.

"I'm currently preparing a paper on these results, due to be published shortly," says Di Ilio. "But towards the end of my Marie Curie grant, I was able to obtain a licence to use methadone and heroin on cockroaches, and preliminary tests recorded clear cues of addiction, which is very exciting. This is the point where we are now."

World of potential

Moving forward, Di Ilio is looking to secure further funding in order to find out how induced addiction can best be exploited, and how it can be properly controlled. From an academic perspective, the ActIng project's early stage research could open up new opportunities to understand drug addiction and the behavioural changes this can cause. It might also help researchers understand how insects perceive their surrounding environment.

"All these preliminary results first need to be verified to validate our hypothesis, but I think there is potential here," he says. "We could imagine associating addiction in insects to, say, their ability to detect tiny changes in the odour of blood, which might lead to early diagnoses of diseases like tuberculosis. Fruit growers would be interested in the early detection of bacterial disease. You could use insects as biosensors for many things."

"Preliminary tests recorded clear cues of addiction, which is very exciting."

ActIng

- Coordinated by Rothamsted Research in the United Kingdom.
- Funded under H2020-MSCA.
- https://www.cordis.europa.eu/project/rcn/197277

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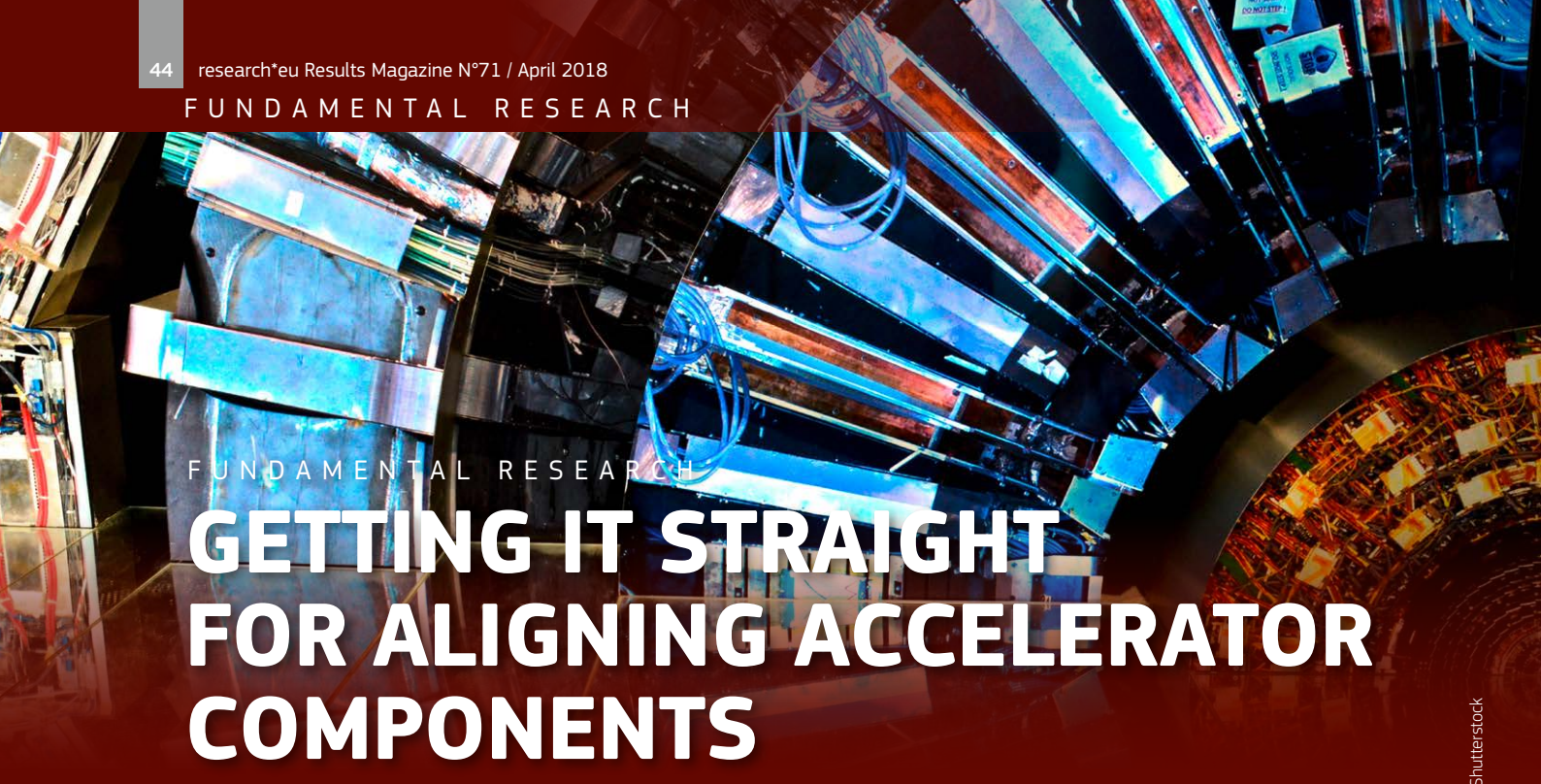

FUNDAMENTAL RESEARCH

GETTING IT STRAIGHT FOR ALIGNING ACCELERATOR COMPONENTS

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An EU-funded doctoral training network at CERN has improved their ability to accurately align accelerator components. This should improve the efficiency of future accelerator experiments, in both the Large Hadron Collider and its successor.

Particle accelerators such as the Large Hadron Collider (LHC) at CERN, represent the pinnacle of achievement in science, but also require the most advanced precision engineering. CERN is studying a new collider, the Compact Linear Collider (CLIC), and as part of these studies, it has set up an EU-funded doctoral training network, PACMAN (A Study on Particle Accelerator Components Metrology and Alignment to the Nanometre scale), to solve some of the technical metrology challenges posed in aligning accelerator components with micrometric precision.

The CLIC will continue the LHC work and allow CERN scientists to study collisions between electrons and positrons at energies up to several Tera-electronvolts. In its final configuration the electron and positron bunches are each accelerated over 25 km from two opposite sides. Since the start of its design it has been clear that a major issue will be aligning the 20 000 modules and associated technical systems within the accelerator tunnel. One of the technical challenges will be to align these components over hundreds of metres to create and maintain the smallest possible electron beam, which will create the maximum number of collision events. For the CLIC, the size of the beam at the collision point will be of the order of one nanometre vertically and 40 nanometres horizontally (the shape of a ribbon).

"The aim of the PACMAN network is to improve the accuracy of the alignment of accelerator components and that involves multi-disciplinary research, combining metrology, high accuracy machining, microwave technology, and magnetic measurements," says project coordinator and CERN scientist, Dr Helene Mainaud Durand. The network, funded for four years, included 10 PhD students and integrated academic and industrial partners.

To experimentally test the new methods developed in each project, the electron beam was substituted by a stretched wire, going through the accelerator components. Using magnetic or electro-magnetic measurements, this then enabled the researchers to tell if the wire was accurately positioned at the centre of components. "This took one year of preparation: all the students needed to agree on the same wire that would be used for all the measurements and agree on the hardware and software to be used," recounts Dr Durand.

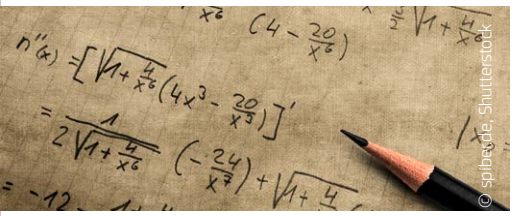
The methods developed showed that for each type of component it was possible to repeatability position the stretched wire at its centre, within one micrometre. "Such accuracies had never been reached before and will allow us to align components quickly, and additionally use automatised methods to gain time," explains Dr Durand. Using external positioning templates they would be able to automatically align the components during assembly in industry or after transportation, in the accelerator tunnel. This could be achieved with an accuracy level below five micrometres.

At CERN, some of the methods developed by the PACMAN network will be applied to components of the LHC as part of an upgrade in 2024 (HL-LHC project) and it should help increase the number of collision events that can be observed in the LHC. The methods developed in the project have also raised interest in the medical accelerator community, where similar tight alignment tolerances are needed for cancer radiation therapy. "Project methods could also be transferred to the aerospace and automotive industries, research telescopes or satellites assembly," adds Dr Durand. A subsequent study has been launched by the CERN knowledge and transfer group to explore these possibilities.

PACMAN

- ★ Coordinated by CERN in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ https://cordis.europa.eu/project/rcn/109143
- ★ Project website: https://pacman.web.cern.ch/
- ★ https://youtu.be/HsYm-rWSSiY

SIMPLIFYING COMPLEX ALGEBRAIC GEOMETRY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Researchers with the EU-funded FOSICAV project undertook a detailed geometric study of various families of sub-varieties.

The EU-funded FOSICAV (Families of Subvarieties in Complex Algebraic Varieties) project is one of complex algebraic geometry – and thus involves complicated explanations and complex results. For example, according to project researchers, one fundamental aspect of algebraic geometry is that varieties vary in families, and the parameter spaces are themselves varieties. By way of definition, a variety is a geometric object defined by polynomial equations in the n-dimensional projective space with coordinates in the field of complex numbers. Project space is a slight enlargement of the usual physical n-space obtained by adding points at infinity, such that two parallel lines in the physical space meet at a unique point at infinity.

Said simply, the project set out to have a substantial impact on algebraic geometry. "We expect our down-to-earth approach to enumerate invariants will enable computations that are, by nature, impossible using current methods," says project coordinator Ciro Ciliberto.

Analysis by degeneration

Here's where things get complex. As the goal of the project was to enumerate curves on K3 surfaces (a complex or algebraic smooth minimal complete surface that is regular and has trivial canonical bundle) using degeneration methods, project researchers undertook the geometric study of various families of sub-varieties of certain complex algebraic varieties of small dimensions and, mainly, of families of curves. According to Ciliberto, Severi varieties are a typical example as they parametrise curves of given degree and geometric genus in the projective plane and the general curve has a prescribed number of ordinary double points and no further singularity.

In addition to exploring these varieties' dimensions, smoothness and irreducibility properties, researchers also determined their Hilbert polynomials, which encode their degrees and are important enumerative invariants. "A central feature of our project was to conduct this analysis by degeneration – to study families of sub-varieties in a given variety X, we let X degenerate and looked at what happened in the limit," explains Ciliberto. "For instance, to study curves on a general K3 surface we let it degenerate to a union of projective planes, the dual graph of which is triangulation of the real two-sphere."

Specifically, the project considered the following families of sub-varieties: families of curves with prescribed invariants and singularities in surfaces, with special attention to the two cases of the projective plane and of K3 surfaces; families of hyperplane sections with prescribed singularities of hypersurfaces in projective spaces; families of curves with a given genus in Calabi-Yau three-folds; and families of surfaces in the projective three-space containing curves with unexpected singularities.

Pure mathematics

What all of this makes clear is that the FOSICAV project is one of pure mathematics. As such, it is meant to stand by itself and not necessarily have any 'direct' or 'everyday' application. "It is a well-documented fact that pure science fuels more applied research, and eventually the development of concrete applications," says Ciliberto. "Thus, it is of crucial importance to maintain open-minded research like the FOSICAV project as a way of exploring paths less likely to have any application, for someday they might be the ground from which a fertile revolutionary idea will grow."

FOSICAV

- Coordinated by the University of Rome in Italy.
- Funded under H2020-MSCA-IF.
- https://cordis.europa.eu/project/rcn/194814
- Project website: http://www.mat.uniroma2.it/

GENETICALLY MUTATED RATS COULD BE A 21ST CENTURY FORM OF PEST CONTROL

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Old adage? Urban myth? Either way the saying 'You are never further than two metres from a rat' tends to make people look around themselves nervously. Since our move into settlements first gave rats the environment they needed to thrive, we've been battling their numbers – for the most part unsuccessfully.

Now there may be a better way to control their numbers. Researchers in Scotland said in December 2017 they had developed two different ways to disrupt female fertility in rats and mice, building on a similar approach that has already been tested in the lab to eliminate malaria-carrying mosquitoes.

Scientists working at the University of Edinburgh's Roslin Institute are looking into a new tool to further the goal by using CRISPR gene editing techniques. CRISPR stands for 'Clustered Regularly Interspaced Palindromic Repeats', chunks of regularly recurring bits of DNA that arose as an ancient bacterial defence system against viral invasions. Gene editing involves the precise cutting using acts like a pair of molecular scissors, and pasting of DNA by specialised proteins – inspired by nature, engineered by researchers.

Using this editing technique, the team is investigating a technology called 'gene drive' as a way to spread infertility in rats and mice – the technique already works for mosquito control. Gene drive is a powerful technique used to ensure that a particular genetic trait is inherited by all descendants. It means that a gene of interest can spread throughout an entire population within a few generations.

Currently, an older approach called 'sterile insect technology' is being used in some areas to fight mosquitoes. Intrexon's Oxitec unit has already deployed its sterile male mosquitoes, whose offspring die when young, in Brazil. But because Oxitec's mosquitoes last only one generation, a vast number must be released to swamp their wild counterparts.

EU support to the INTEGRA (New tools for genetic engineering using targeted integration vectors application to agronomy food safety and gene therapy) project, now over, is feeding into the research assessing the impact of the insertion of 'x shredder' code into the DNA of male rats. This would destroy the 'x' chromosomes in their sperm, meaning they could only pass on a 'y' chromosome, so their offspring would never be female. With fewer and fewer females over time, the population would have to decline.

The rodents would be genetically modified in the laboratory before being released into the wild where they could mate with the native population. Professor Bruce Whitelaw and his colleagues, who published details of their rodent work in the journal Trends in Biotechnology, hope as a next step to build self-limiting gene drives

that would burn out after a certain number of generations. Successful application of the technology would mean the use of poisons, pesticides and other chemicals would be obviated.

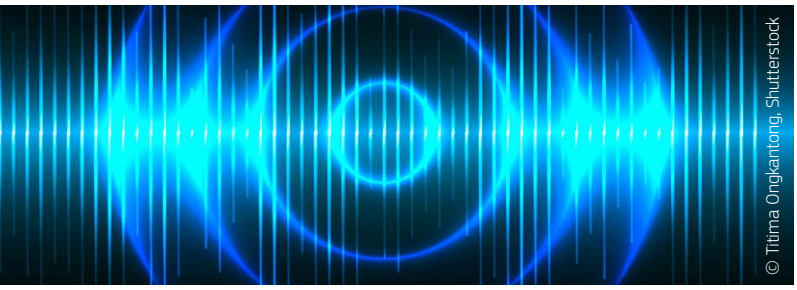
INTEGRA set out to develop new genetic engineering tools to permit the targeted integration of a transgene into the genome of the desired eukaryotic organism. The researchers hoped this would have visible repercussions on fundamental and applied research particularly in pharmaceutics agronomy and food sciences.

INTEGRA

- Coordinated by National Center for Scientific Research in France.
- Funded under FP6-POLICIES.
- https://cordis.europa.eu/project/rcn/90894

PULLING KNOWLEDGE TO PUSH THE STATE-OF-THE-ART IN APPLIED ACOUSTICS

Despite humans being surrounded by sound, created from bongos to BMWs, the field of acoustics has been fragmented and so has not been comprehensively investigated. The EU-funded BATWOMAN project set out to change this, making its contribution to mitigation against an increasingly sonically distracting world.



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Despite essentially exploring the same physical phenomenon, fields such as automotive acoustics, room acoustics, musical acoustics and psychoacoustics, have conducted research independently, remaining relatively unaware of the efforts of each other.

The BATWOMAN (Basic Acoustics Training – & Workprogram On Methodologies for Acoustics – Network) project sought to synergise efforts towards reaching a state-of-the-art across the related fields for sound design, modelling accuracy, efficiency and applicable frequency ranges. Crucially, the project also explored human auditory perception to better understand sound quality parameters and sound's stimulating effects on human wellbeing and cognition, including analysis of the potential harmful effects.

Predicting acoustic effects

The project team set about their research by developing computer predictions of what a listener would hear in certain scenarios, based on physical models of sound sources (such as musical instruments or vehicles) and interior spaces (such as a concert hall or car interior). As the project coordinator Mr Martin Wifling explains, "The computer simulations were optimised, for performance and sound fidelity, to render such virtual sounds in real time, on next generation computer hardware."

A key area of interest to the project was the effect of background sound on cognitive performance. To explore this, one research strand ran experiments to measure how different types of background sounds affected those specific human tasks which require a high cognitive load.

The experiments contribute to a growing understanding in environmental acoustics that the impact of sound on human tasks strongly depends on the nature of the sound, as well as the nature of the task. Relevant distinctions include whether the sounds are perceived as noise or as speech-like, and whether they consist of semantically meaningful speech, or not. Likewise, the nature of tasks undertaken also makes a difference. It matters, for example, whether the task engages short-term memory, whether it involves ordering items such as is the case with memorising telephone numbers, or whether the task comprises more routine, mechanical and repetitive activities.

Indeed, the project's research has already resulted in a new acoustic/auditory parameter indicating spectral variability of the acoustic scene. The parameter allows a sufficiently accurate prediction for one specific cognitive task in which a person has to keep a number of items (e.g. digits) in short-term memory and reproduce them in the correct order. The parameter allows the prediction of distorting effects of background sound on the memory accuracy, using only an algorithm which analyses a recording of the prevailing soundscape.

One implication of BATWOMAN's findings is that results generated from experiments designed using specific tasks cannot be generalised as each scenario contains its own limiting variables. Therefore, if recommendations and regulations are to be accurately developed, then more context specific experimental work is necessary.

Mr Kohlrausch, the coordinator of the perception investigative strand within BATWOMAN reflects that, "This interdisciplinary research field involves environmental acoustics and cognitive psychology and is gaining increasing societal importance due to the growing use of open plan offices and open learning environments."

The sound of the future

From the outset BATWOMAN's young researchers benefitted from the strong involvement of the private sector, which emphasises that basic research, applied research and product development must go together.

By improving controlled design and production processes, BATWOMAN has not only increased acoustic knowledge but also developed practical methodologies to reduce future vehicle noise and vibrations, as well as help improve the sound of future musical instruments, performance spaces and even industrial products.

Looking to the future, as Mr Wifling outlines, "We are planning to take the BATWOMAN research forward and investigate how structural simulations, room acoustics modelling and perceptually correct audio rendering, can be speeded up by the massive parallel processing power of next generation computers."

One practical area the project team is currently focusing on is next generation virtual reality (VR) audio, which could include real-time sounds based on physical reality, something VR developers increasingly depend on if VR is to grow beyond purely gaming and entertainment applications.

BATWOMAN

- Coordinated by the Virtual Vehicle Research Centre in Austria.
- Funded under FP7-PEOPLE.
- https://cordis.europa.eu/project/rcn/109885
- Project website: http://www.batwoman.eu/

EVENTS

MAY 10▸11

Oxford, UNITED KINGDOM

WORKSHOP

COMBATING ONLINE EXTREMISM: STATE, PRIVATE SECTOR, AND CIVIL SOCIETY RESPONSES

VOX-Pol is convening a two-day workshop titled 'Combating Online Extremism: State, Private Sector, and Civil Society Responses' at the University of Oxford, on 10 and 11 May, 2018.

The workshop seeks to explore emerging responses from politicians, think tanks, technology companies and civil society to the proliferation of extremism and hate online. The workshop will take a global, comparative approach with a view to evaluating approaches to combating online extremism, as well as its implications for governance.

In this workshop, we consider how governments, civil society and the private sector are responding to hate speech, cyber-bullying and radicalisation online. These concerns have encouraged governments across the world to develop a variety of responses to online extremism, ranging from producing counter-narratives, empowering 'moderate' voices and calling on social media platforms to regulate content posted by their users. While these responses have multiplied, there have been very few rigorous evaluations of their methodologies and the forms of governance that shape them.

This workshop aims to highlight research that fills this gap, providing insight into the design of effective interventions and mapping changes to security practices in response to online hate and extremism.

For further information, please visit:
http://www.voxpol.eu/events/combating-online-extremism-state-private-sector-civil-society-responses-call-papers/

MAY 10▸11

Budapest, HUNGARY

CONFERENCE

REACH OPENING CONFERENCE

The REACH project will host its opening conference 'Resilient Cultural Heritage and Communities in Europe' in Budapest, Hungary on 10 and 11 May, 2018.

The event is being organised under the coordination of Eötvös Loránd University.

This opening conference will introduce the scope of the REACH project, offering a great opportunity to discuss and compare successful examples of participatory processes and research. During the two-day event, a dedicated poster session will be open where participants can present their own projects.

In particular, the opening conference aims to:
- announce the start of the new REACH social platform;
- present its research themes and their theoretical framework;
- illustrate the mechanisms of participation;
- gather requirements, needs and expectations from the users.

Successful examples of participatory processes coming from other initiatives worldwide will be discussed, with contributions from keynote speakers. Contributions from EC representatives are also expected.

For further information, please visit:
http://reach-culture.eu/events/opening-conference-in-budapest

MAY 21▸22

Edinburgh, UNITED KINGDOM

WORKSHOP

EUROPEAN VETERINARY VACCINOLOGY WORKSHOP

The SAPHIR and Paragone projects in collaboration with the UK Veterinary Vaccinology Network will host the 'European Veterinary Vaccinology Workshop' in Edinburgh, Scotland on 21 and 22 May, 2018.

Co-organised by the H2020-funded projects SAPHIR and Paragone and the UK Veterinary Vaccinology Network, the workshop targets young scientists: students, postdocs, early-career researchers and other members of the animal health profession.

The goal of this workshop is to provide integrated and up-to-date knowledge of the challenges facing the development of effective veterinary vaccines.

For further information, please visit:
http://www.h2020-saphir.eu/news--events.html

EVENTS

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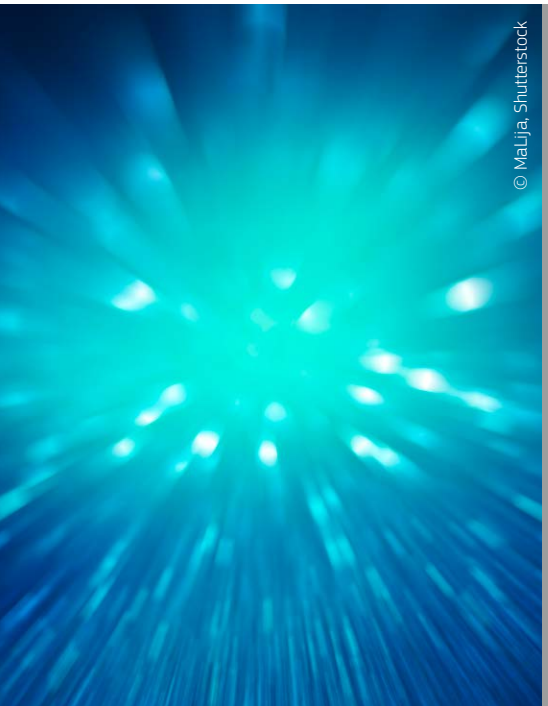
http://cordis.europa.eu/events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MAY 28▸30

Jülich, GERMANY

CONFERENCE

INTERNATIONAL CONFERENCE ON ELECTRON BEAM SHAPING IN SPACE AND TIME

The Q-SORT project, in collaboration with the 'Science and Applications of Electron Wave-functions Shaped and Manipulated by Engineered Nanoholograms' project and with the support of Forschungszentrum Jülich, is holding the 'International Conference on Electron Beam Shaping in Space and Time' in Jülich, Germany from 28-30 May, 2018.

This conference aims to address challenges and opportunities in electron beam shaping and its applications. It will showcase cutting-edge theoretical and experimental developments in the form of invited plenary talks and contributed presentations and include space for product displays. There will be opportunities for networking and discussion, as well as an edit-a-thon, an interdisciplinary workshop and a webinar.

Topics sought for the programme include (but are not limited to):
- coherent manipulation of electron wave functions by light interaction and matter, possibly inspired by recent progress in light (quantum) optics, to produce functional electron waveforms;
- studies of the foundational aspects of quantum physics and their applications to materials science;
- ideas and methods for near-interaction-free and dose-effective imaging of matter.

For further information, please visit: www.qsort.eu/qsort-international-conference-overview/

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