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SPECIAL FEATURE

CAN SCIENCE DO WITHOUT ANIMAL TESTING?

ENVIRONMENT AND SOCIETY

DISCOVERING UNTAPPED VALUE IN EUROPE'S FORESTS

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EDITORIAL

by the editorial team

CAN SCIENCE REALLY MOVE AWAY FROM ANIMAL TESTING?

'Animal testing is bad science.' The slogan, defended by the biggest international organisation for the ethical treatment of animals (PETA) is well ingrained in citizens' minds. In June, an EU-wide campaign to ban experiments on animals from all European labs gathered an impressive 1.17 million signatures. This result made the proposal eligible for examination by the EC under the European Citizens' Initiative which, when positive, can lead to a legislative proposal.

This time, however, the Commission rejected the bid. While its official communication states that 'the EU shares the Citizens' Initiative's conviction that animal testing should be phased out',

'A total of EUR 250 million was invested under FP7 to develop viable alternatives.'

it also points that 'considerable challenges remain' on the path towards the development of alternative approaches, and that 'the complete replacement of animal studies is currently not possible while needing to ensure a high level of protection of human and animal health and the environment'. The message of the EC is clear: if the ban comes too soon, animal testing will just be moved to

more permissive countries, only steering scientific innovation away from Europe without helping the cause of those who want to defend animals.

This setback doesn't make, the ban of animal testing a lost cause, however. In 2010, the EU instigated the 3Rs legislation to replace, reduce and refine the use of animals wherever possible. A complete marketing ban on cosmetics products tested on animals has already been imposed, and a total of EUR 250 million was invested under FP7 to develop viable alternatives. These efforts will be pursued under Horizon 2020.

This year promises to be fruitful in this regard: in December, the six FP7 projects in the SEURAT-1 cluster — a EUR 50 million initiative focused on the cosmetics industry to improve *in vitro* testing and identify obstacles to its successful adoption — will come to an end. Early results from some of these projects are covered in the special section of this magazine, and what exudes from the interviews is a firm belief that the research efforts undertaken by these projects will benefit sectors beyond just the cosmetics industry. Other, non-SEURAT-1 projects are also discussed, including the work of a Lithuanian SME which was recently granted Horizon 2020 funding for a new biosynthetic hydrogel which they hope will significantly reduce the need for animal testing.

This section is followed by our usual insights into biology and medicine, social sciences and humanities, energy and transport, the environment, IT and telecommunications, industrial technologies and physics and mathematics, along with a list of upcoming scientific events.

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



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Tackling
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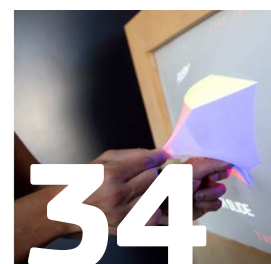
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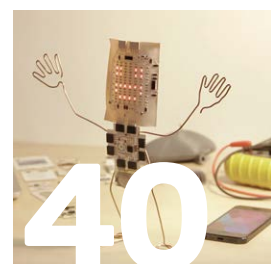


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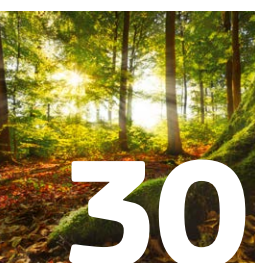


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SPECIAL FEATURE

CAN SCIENCE DO
WITHOUT ANIMAL
TESTING?

INTERVIEW

TRADING *IN VIVO* FOR *IN SILICO*: A NEW APPROACH TO
NANOTOXICITY ASSESSMENT

The MODERN project has set out to better understand how nanoparticles affect environmental and human health. Their new approach relies on novel computational methods to characterise the structure of nanoparticles and *in silico* models to assess their effects. It promises to reduce the need for *in vivo* testing.

Historically, market pressure has often resulted in scientific innovation being made available to consumers even before we were fully aware of its ins and outs. This was notably the case with asbestos, and the same scenario could very well be repeating with nanotechnology if proper safety assessment studies are not conducted and political measures taken. According to some of the latest forecasts, the nanotechnology market will grow to reach US\$ 75.8 (EUR 65.8) billion by 2020. And while engineered nanoparticles (eNPs) are already widespread in the likes of cosmetics, paint and electronics, we still don't know much about their possible long-term effects on biological systems.

To gain a better understanding, scientists still rely heavily on animal testing — in spite of efforts from animal protection activists, scientists and policy makers to put the focus on alternative testing methods. In line with the EU's efforts to implement appropriate testing strategies and with a view to overcoming the current obstacles to a wider adoption of *in silico* methods, Prof. Robert Rallo, coordinator of MODERN, initiated the MODERN project in January 2013.

A couple of months before the end of the project, he tells us about its achievements and expected impact on eNP toxicity assessment methods.

★ **Would you say enough is being done in Europe to measure the toxicity of eNPs before they are put on the market?**

Prof. Robert Rallo: In recent years the EU has initiated a significant effort aimed to define the scientific and

methodological principles for *in vitro* and *in vivo* testing of nanomaterials. Although specific regulations regarding the use of nanotechnology-enabled products are still lacking, the EU is on its way toward providing a basis for the implementation of appropriate testing strategies that will support risk assessment and regulatory decision-making.

The diversity of nanomaterials (e.g. diverse combinations of chemical composition, core-shell structure, shape, functionalisation) makes the exhaustive testing of nanomaterials a daunting task. In this context, the development and validation of high-throughput screening methods together with the implementation of *in silico* tools (like the ones developed in MODERN and in other FP7 NMP modelling projects) will contribute in the near future to providing alternative testing methods suitable for the evaluation of a large number of nanomaterials in an efficient and cost-effective manner.

★ **Why does eNP toxicity assessment rely so much on animal testing?**

The main reason is that current *in vitro* assays and *in silico* tools are not yet accepted as reliable model systems for nanomaterial toxicity. Dealing with 'biological noise' (i.e. data variability) in *in vitro* high-throughput assays is one of the most urgent challenges to be addressed. In addition there is an equally urgent need to develop large databases of high quality experimental data for the development and validation of *in silico* toxicity prediction tools.

★ How do you intend to fill this gap?

At MODERN we are developing *in silico* tools for nanotoxicity assessment by using different types of information about nanoparticles. The project follows an integrated approach that combines different types of information within the framework of specific Adverse Outcome Pathways. Specifically we focus on nanotoxicity effects driven by oxidative stress responses. We have developed novel methodologies for the calculation of size-dependent nanodescriptors using quantum chemistry and molecular modelling approaches, as well as nano-(Q)SAR based on the descriptors developed for a number of ecotoxicity endpoints in different species, including protozoa, algae and bacteria.

Another achievement is the development of a novel normalisation methodology for omics data that is useful to unveil gene and pathway activity at low concentration (i.e. in realistic environmental exposure conditions). Models for predicting nanoparticle cell interactions based on the composition of the nanoparticle's protein corona have also been developed and validated. Finally, we are trying to increase the accuracy of current models by identifying homogeneous categories of nanoparticles and developing new local models for each specific category.

★ Do the models you developed meet your initial expectations?

We have shown that the integration of different types of information (e.g. physico-chemical properties, structural features and bioactivity profiles at different levels of biological organisation) regarding nanoparticles' effects is fundamental for the development of *in silico* tools suitable for risk assessment of nanomaterials and decision-making.

Since computational models can guide the design of new nanoparticles with controlled toxicity, *in silico* tools can also be applied for safe-by-design nanomaterials. However there is still a significant lack of (public) information about nanoparticles' toxicity enabling models to be properly assessed and their applicability domain expanded. As a consequence, current models can only be used as preliminary screening tools that provide an indication of the potential adverse effects of a nanomaterial. Further *in vitro* (and possibly *in vivo*) testing will be necessary to confirm whether or not a given nanoparticle has toxicity implications.

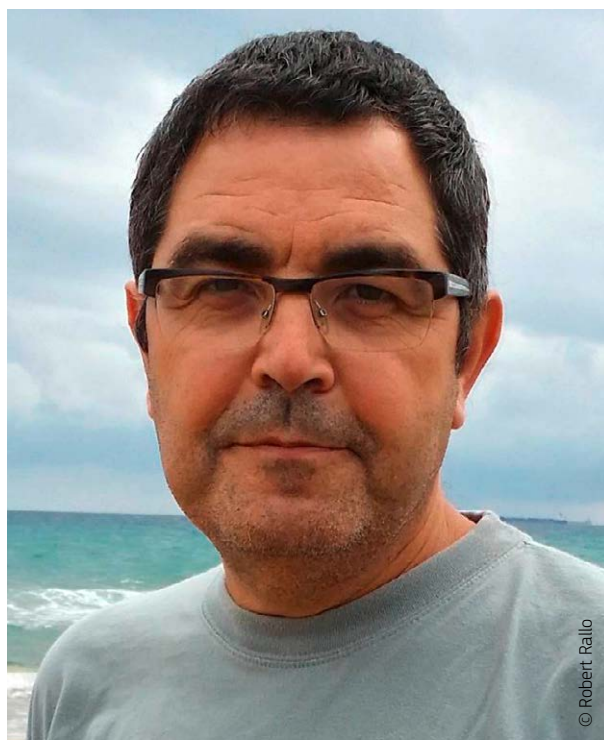
★ Would you tend to agree with scientists saying it's impossible to completely stop using animal testing when it comes to ENP toxicity assessment?

Presently the answer is yes. *In vivo* testing will be necessary to ensure the safety of nanotechnology-enabled products, especially for those nanoparticles used in medical applications. However, the development of more robust *in vitro* assays combined with *in silico* predictive tools will have the potential to contribute to a significant reduction in the number of animals used for testing.

In the near future, with the continuous increase in computing power and with improved understanding of the nano-bio interaction mechanisms, I am confident that we will be able to perform accurate simulations of the interactions between nanoparticles and biological systems that will have the potential to completely replace animal testing.

★ What would you say are the most important things you have learned from your research so far?

The first and most important lesson is that our understanding and modelling capacity for nanotoxicity is still far



PROF. ROBERT RALLO

from what we have for chemical toxicity. There is still a significant lack of knowledge regarding nano-toxicity mechanisms and modes of action. Also, the amount of data available for model development — and more importantly, for model validation — is very limited when compared to the data available for chemicals.

There are still many challenges that hinder the development of *in silico* nanotoxicity screening tools, and the limited amount of data is just one of the limiting factors. Among others, current important needs include the development of a nomenclature to describe nanomaterials unambiguously; standardised protocols for nanotoxicity testing; protocols for high-throughput screening assays and their associated data preprocessing methodologies in order to generate enough data to enrich and improve current *in silico* models; and methods for hazard ranking, risk assessment and decision-making.

★ What do you still need to achieve before the project ends in December?

We are currently evaluating the predictive capacity of the quantum chemistry and molecular modelling descriptors for the metal oxide nanoparticles we developed so far. The computational methods to generate the nanodescriptors are also being refined to incorporate structural changes such as metal doping. In parallel we are using information obtained from nanoparticle categorisation to develop ensemble nanotoxicity models based on a collection of locally tuned nano-QSARs. The information provided by these models will then be used at a final stage to provide hazard ranking and preliminary risk assessment tools for nanomaterials.

MODERN

- ★ Coordinated by the Rovira i Virgili University in Spain.
- ★ Funded under FP7-NMP.
- ★ http://cordis.europa.eu/project/rcn/106195_en.html
- ★ Project website: <http://modern-fp7.biocent.cat/>



BIOSYNTHETIC HYDROGELS TAKE *IN VITRO* TESTING ONE STEP FURTHER

A two-year-old Lithuanian SME bringing together scientists from Canada, Lithuania, Sweden and India has developed a new hydrogel capable of significantly reducing animal experiments in biological research and product testing. Thanks to EU funding under the SME Instrument, they now have a better idea of how and where it can be commercialised.



Until now, *in vitro* testing of cosmetic and medicinal products has mainly rested on a combination of human tissues and artificial scaffold materials made of polymers, in which cells are seeded to create a cell culture or live tissue in laboratory conditions. But while these polymers benefit from great mechanical strength, they fail to properly recreate the morphology and cell composition of biological tissue.

'Most scaffolds on the market today are polymeric arrangements of either synthetic or naturally occurring materials that are further processed to increase physical properties,' explains Vygasdas Juras, one of Ferentis' four co-founders and project coordinator of BIOTIMA. 'However, they do not have the bioperformance or biocompatibility properties required to mimic native tissue conditions. Naturally-occurring polymers, on the other hand, are biocompatible but often suffer from poor mechanical properties.'

To solve this problem, Ferentis scientists have developed an innovative, patent-pending hydrogel material comprised of functionalised natural polymers. The new material is cell-friendly, stable, biocompatible and optically clear. It can be processed using a variety of advanced nanoengineering and microfabrication techniques. It also has unique biomimetic properties closely mimicking those of real tissue, and enables the creation of

functionally-modified products for a variety of in-lab tissue experiments — thereby reducing the use of animals in product testing and biological research.

Reaching beyond cosmetics

The potential of the technology was recently acknowledged by the European Commission, which granted it funding under Phase 1 of Horizon 2020's SME Instrument. The resulting feasibility study has enabled the company to access a vast number of research materials, gather customer insight, better understand the state of the art in research and industry and, last but not least, realise that market opportunities are far beyond their initial expectations.

Juras recalls: 'Initially we planned to pursue a market entry strategy with a focus on the cosmetics industry: this is a big business with only a few players to target, so you can be quite focused. However we realised that, in this sector, regulatory acceptance of toxicity assays is a formal requirement that is less easily attainable than we previously thought. So we first decided to focus our strategy on academic research and the development of the market for 3D cell culture consumables, before targeting the pharmaceutical and cosmetics industries as a second step. This is a much more diverse market, it has a greater number of potential clients who are more inclined to accept new products, and it is not regulated.'

Thanks to external consultants from the UK, who assisted with customer interviews, the team realised that the unique properties of their hydrogel actually provided countless possibilities for *in vitro* research: 'We learned that the biggest issue involving current cell culture medium products is their inability to sustain, proliferate and differentiate cells for more than two weeks. This "in-use stability" requirement is key across various applications and markets. Batch-to-batch variability also poses a problem, and we believe we can address this with our products,' Juras explains.

But what kind of applications does the company have in mind? 'A large cosmetics manufacturer aiming to develop a new product reinvigorating ageing skin could, for instance, use the micro-patterned hydrogel as a base for reconstructing skin in lab conditions, but also to provide a perfect replica of wrinkled skin. We can also produce exact biosynthetic replicas of corneal models, which can be used as replacements for the thousands of rabbit corneas being used for ocular drug permeability studies in the lab,' Juras enthuses. In another application — skin scratch models where animals are used to test various remedies — Ferentis can create an *in vitro* model that will not only replace animal testing, but will bring the physiology of the model closer to that of a human patient.

This is just the tip of the iceberg: the hydrogel's self-supporting structure allows

Ferentis to micro-fabricate various 3D structures, which with further product development will eventually allow them to create vascularised, innervated tissue models that will fit the definition of organ on a chip.

The next steps: patents, Phase 2 funding and commercialisation

Of the six potential users interviewed, all have either engaged with Ferentis to evaluate BIOTIMA products in their projects or have shown interest in receiving samples to test in their applications. The team hopes this will eventually lead to more in-depth collaboration, but they have already learned a lot thanks to these interactions.

'Before starting the project, we had a very vague understanding of the manufacturability of our hydrogels, due to complex viscous material mixing, dispensing and

printing/moulding processes that must meet unique chemical and physical challenges while not damaging the fragile nano self-assembly mechanisms within the hydrogel. We identified key advanced manufacturing technologies currently available and developed a financial model for the next seven years.'

Of course the road is still long before the technology can be commercialised: 'Translating our tissue matrix product prototypes into industrial-scale production continues to be a major challenge,' Juras explains. 'This will require the establishment of nano and micro-engineering processes and the setup of advanced manufacturing systems, where advanced multidisciplinary engineering expertise will be needed from emerging fields like biomaterial fabrication, 3D bioprinting, electrospinning, micromoulding and others. We plan to address these issues by

applying for Phase 2 funding, with the objective of developing a versatile advanced manufacturing pilot line for a variety of hydrogel products for *in vitro*, as well as clinical applications.'

To protect their work, Ferentis has filed for a number of patent applications focused on BIOTIMA product synthesis, surface modification and specific applications. The company plans to pursue a national/regional patenting strategy once it has attracted an investor.

BIOTIMA

- ★ Coordinated by Ferentis in Lithuania.
- ★ Funded under H2020 SME Instrument.
- ★ http://cordis.europa.eu/project/rcn/196233_en.html
- ★ Project website: <http://www.ferentis.eu/>

INTERVIEW

IMPROVING TOXICITY PREDICTION WITH CUTTING-EDGE DATA MODELLING

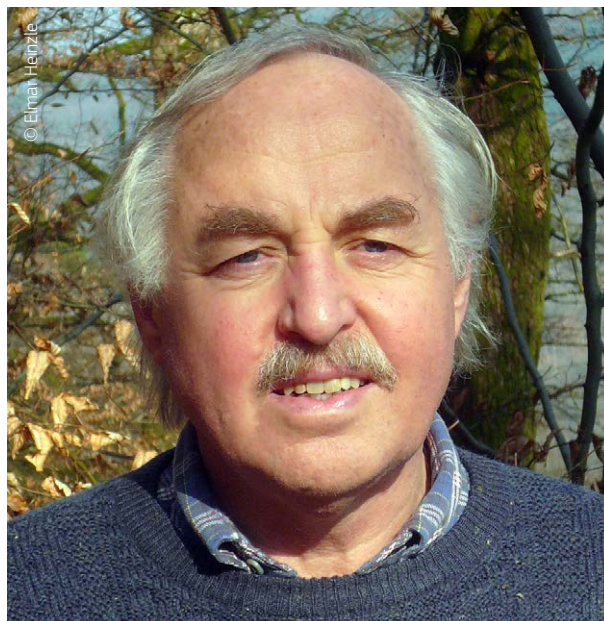
Today's state-of-the-art methods for the replacement of *in vivo* testing for toxicity in humans are on the cutting edge of science. However, they have not yet allowed us to completely eliminate the need for animal testing. The truth is that to improve toxicity prediction, we actually need to harness the power of data modelling and begin thinking beyond the state of the art as it currently stands. This is what the NOTOX project team has been focused on for almost five years.

Using today's most advanced alternative methods as a starting point, the NOTOX (Predicting long-term toxic effects using computer models based on systems characterisation of organotypic cultures) project adopted a 'systems biology approach' to the problem of toxicity assessment. Under project coordinator Prof. Elmar Heinzle from the Biochemical Engineering Institute of Saarland University, the team combined powerful *in vitro* culture and exposure techniques with multi-omics measurements and mechanistic multi-scale modelling to improve toxicity prediction. In the process, NOTOX developed a spectrum of systems biological tools including experimental and computational methods to establish causal predictive models. The result has been improved prediction of long-term toxicity.

With just a few months left before the project reaches completion, Prof. Heinzle spoke exclusively to *research*eu results magazine* about the NOTOX approach, the new tools developed and their contribution to improving toxicity prediction.

★ **The 'typical systems biological setup' is key to the NOTOX approach. What does this mean and why is it important?**

Prof. Heinzle: Our systems biological approach combines (i) organotypic cultures of liver, utilising HepaRG cells in 2D and 3D culture, partly in combination with other types of liver cells, with (ii) comprehensive omics analysis (epigenomics, transcriptomics, proteomics, metabolomics and fluxomics) with extended



PROF. ELMAR HEINZLE

bioinformatic analysis and (iii) various types of computer modelling, from the simple PBPK type to agent-based multi-scale models. Data from newly developed human *in vitro* cellular systems exposed over long periods with repeated doses provide improved prediction of long-term toxicity.

★ **Has the team successfully developed predictive computer models that will address long-term toxicity?**

For various gold compounds selected by the SEURAT consortium (a cluster of projects working towards the replacement of *in vivo* repeated dose systematic toxicity testing), there was highly effective prediction of long-term toxicity in oral-equivalent doses (OED) based on viability assays in long-term cultures. OEDs were



SPECIAL FEATURE

successfully predicted using even simple models. These models are already applicable and can be applied by the user.

Mechanistic models provide a more realistic picture about modes of action. More detailed models focus on the mechanism of action on adverse outcome pathways. We think that most toxic effects follow a limited number of mechanisms. It is therefore meaningful to develop such detailed mechanistic models, e.g. for lipid accumulation (fatty liver) or oxidative stress, which can later be used in many other cases. Mechanistic models incorporated into PBPK models already allow for better prediction. Some of these models are already available through our industrial partner, Insilico Biotechnology.

Mechanistic models also support the identification of meaningful biomarkers that are mechanistically related to the mode of action.

★ **What are the other main outcomes of the project?**

NOTOX has demonstrated the successful application of *in vitro* cultivation methods for long-term testing of liver toxicity applying the hepatocyte cell line HepaRG in 2D and 3D formats to obtain physiologically relevant toxicity prediction. We have also shown that data obtained from these cultures allow for the prediction of OED that would likely lead to toxic effects in humans following long-term exposure.

In general, we have proven that large-scale multi-omics experiments allow for the elucidation of the mechanism of action that is the basis for the creation of mechanistic models with improved predictivity.

Finally, and significantly for other researchers, we have demonstrated that metabolism-induced toxicity can be studied and modelled in combination with cultured cardiomyocytes derived from human stem cells.

★ **NOTOX has produced a film to increase understanding of its work. How important has the communication aspect of the project been?**

Informing the general public about advances in this particular field of research was a very important aspect of the NOTOX project. The NOTOX movie and targeted press campaigns launched over the course of the project, around World Animal Day for example, helped raise awareness for decisive dates, such as the bans on animal testing and the marketing of cosmetic ingredients tested on animals as well as the NOTOX consortium's efforts to develop new alternatives.

We were very happy to see that many different stakeholders, including industry, animal welfare groups and public television channels, were interested in learning more about the project and

its motivation and goals and thus helped spread information about the NOTOX project.

★ **What has the response been from the different groups that will be affected by your work (stakeholders, consumers, regulatory bodies and producers)?**

Throughout the project we have been in contact with representatives from industry who are very keen on new methodologies allowing for the replacement of animal testing as a means of safety assessment.

As of March 2013, cosmetics and cosmetic ingredients tested on animals are no longer allowed to be marketed in the EU, thus a real need for valid alternatives exists already. Furthermore, the prospects for developing new compounds whose safety has been thoroughly tested with a series of valid computer models or other methods instead of rats or mice are very attractive. This is also true for consumers who, if convinced that alternative testing methods provide at least the level of safety conventional animal testing does, would be very likely to prefer the animal-free option.

★ **What are the next steps for the NOTOX team?**

Although the official end date of the project is December, the consortium will of course continue its work on the basis of the NOTOX results. The next steps will be for NOTOX to complete large-scale case studies on oxidative stress and steatosis (fatty liver), to intensify our study of the effects seen in electron microscopy after seeing typical liver type structures, and to finish a study on the combined application of hepatocytes and cardiomyocytes to detect metabolism-induced cardiotoxicity.

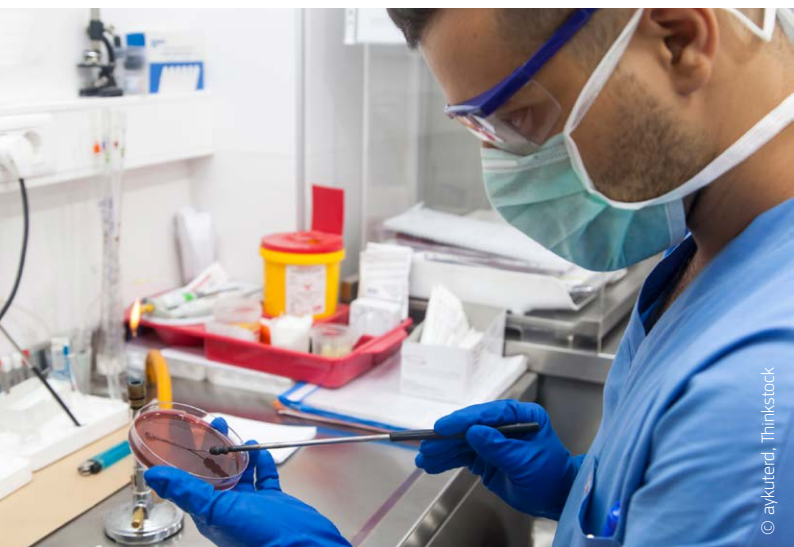
★ **What do you expect the impact of the project to be?**

NOTOX concepts and results support a molecular and systems biological approach to toxicity assessment by combining powerful *in vitro* culture and exposure techniques with multi-omics measurements and mechanistic multi-scale modelling. These have a profound impact from a scientific, ethical, social and economic point of view.

In vitro toxicity assessment is increasingly focused on human cells and on useful cultivation techniques which also support long-term testing. We have strongly promoted the application of 3D cultures of the HepaRG cell line to achieve reliable results. This contributes significantly to the replacement or reduction of animal use in testing.

In NOTOX we developed systems to predict adverse effects in a virtual human population with its varying metabolic capacities and sensitivities. We also paid particular attention to training the next generation of researchers who hopefully will be able to translate basic research into application.

NOTOX will contribute to the further replacement of animal testing through *in vitro*-based test methods that directly incorporate mathematical models and valid alternative computer models will ultimately significantly reduce the chemical and pharmaceutical industries' needs for animal testing.



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NOTOX

- ★ Coordinated by Saarland University in Germany.
- ★ Funded under FP7-HEALTH.
- ★ http://cordis.europa.eu/project/rcn/97714_en.html
- ★ Project website:
<http://notox-sb.eu/>
- ★ <http://notox-sb.eu/film>

BIG DATA REDUCES NEED FOR ANIMAL STUDIES

The DIXA project pulls together results from toxigenomic tests performed by European researchers. Now academics and companies working on new medicines, cosmetics or industrial chemicals can potentially avoid animal studies on chemical safety by tapping into this free database.

Developing new chemical products involves a great deal of safety testing. A particular area of toxicology which has grown in the wake of the 'omics' revolution is toxicogenomics. This field looks at how gene and protein regulation respond to toxic substances.

For universities, start-ups and larger firms alike, chemical safety testing has traditionally meant testing a large number of compounds in animals. But the need for safety data must be squared with the drive to reduce, refine and replace animal studies with alternatives.

Scientists at the DIXA (Data Infrastructure for Chemical Safety) project, coordinated by Maastricht University, have a data-fuelled solution: they have developed an open database which significantly improves the e-infrastructure for toxicological researchers.

EU projects have already produced mountains of toxicogenomic data based on studies of so-called 'omics' technologies. The trouble is that, before DIXA, this information had been stored in hundreds of locations around the world — on university servers, in shared repositories and sometimes even on the personal hard drives of researchers' computers.

'Toxicogenomic research projects often conduct animal studies and *in vitro* tests but, unless the data is stored in a central repository, the data effectively vaporises when the project is finished,' says René Reijnders, Senior Project Manager at the Maastricht University Department of Toxicogenomics.

The DIXA project pulls together existing toxicogenomics data so that researchers can find out what is known about the safety profile of their compound — and similar compounds — without launching an animal study.

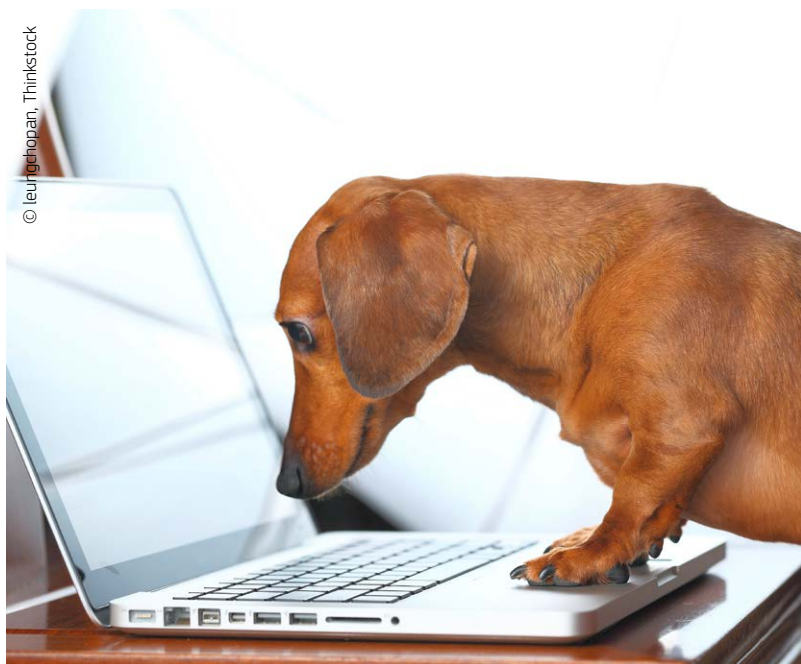
'This data infrastructure draws on insights and expertise from toxicogenomic experiments from FP6 and FP7 projects and puts it in one place,' says Reijnders. 'With this toolbox, you have a free and open first reference set against which you can screen your compounds.'

A research lab may have hundreds of compounds with varying degrees of potential. Based on the information gleaned from the DIXA database, they can instantly dismiss those which are highly likely to fall at the first toxicological hurdle. The efficiency introduced by this approach saves time and money, and potentially, the lives of animals.

Since the data has been assembled, getting this message out there has been an important element of the project. 'We want the research community to know about DIXA and to use it. That's why we publish articles, promote it at scientific conferences and network with other European projects,' says Reijnders.

Online tutorials have been developed to show users how to get the most out of the data warehouse.

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The team behind the project have also been demonstrating the power of the DIXA database by using computational modelling to study carcinogenicity and liver toxicity.

They note that current testing models for predicting drug-induced liver injury are inadequate but that open databases like DIXA have the potential to address this. Similarly, if scientists are to accurately predict carcinogenicity without relying on rodent cancer bioassays, high throughput technologies will be essential.

While the project's initial task was to pool existing data, the new goal is to transform it into a dynamic database which will be updated on an ongoing basis, with current and future EU projects feeding their data into the system. As the volume of data in the warehouse grows, so too will the predictive power of the tool.

While DIXA is a major leap forward for the toxicology community, it may not yet spell the end of animal toxicity studies.

'Some animal experiments will still be needed before human testing. The tool helps to reduce the number of animal studies and refines our approach to toxicology screening but complete replacement is still not possible.'

DIXA

- ★ Coordinated by The University of Maastricht.
- ★ Funded under FP7-INFRASTRUCTURES.
- ★ http://cordis.europa.eu/project/rcn/99771_en.html
- ★ Project website:
<http://www.dixa-fp7.eu>

SPECIAL FEATURE

INTERVIEW

A PUBLIC WAREHOUSE FOR TOXICITY DATA

Growing public pressure to put an end to animal testing, notably in the cosmetics industry, means that isolated scientific advances are not enough. Researchers need a tool to access all available data and share their own findings, which happens to be exactly what TOXBANK provides.

Part of the SEURAT-1 cluster, TOXBANK (Supporting Integrated Data Analysis and Servicing of Alternative Testing Methods in Toxicology) has developed a series of tools for the scientific community which are expected to help them replace repeated-dose systemic toxicity testing historically carried out in animals.

The new web-based tools, which are publicly available, revolve around a dedicated warehouse for toxicity data management and modelling that collects results from SEURAT-1 projects and other sources including public databases. They also include a 'gold standard' compound database and repository of selected test compounds, as well as a reference resource for cells, cell lines and tissues of relevance for *in vitro* systemic toxicity research carried out in SEURAT-1.

Dr Emilio Benfenati, Head of the Laboratory of Environmental Chemistry and Toxicology at the Mario Negri Institute in Italy and coordinator of the project, explains how it will eventually reduce the need for *in vivo* testing, what stakeholders can expect until and after the project's end, and how other sectors, which still use *in vivo* data, will also benefit from it.

★ **Where do you stand with the development of the TOXBANK data warehouse and the overall project objectives?**

Dr Emilio Benfenati: A production version of the TOXBANK data warehouse has been implemented that provides access to the processed data and protocols from the experiments, along with relevant public information. This includes the development and/or customisation of web-based interfaces for linking and uploading data, including raw, processed and model results.

Each step of the experiments is linked to protocols describing the procedures. A web-based user interface for searching, browsing and filtering the results has been implemented to provide access to all protocols and data in a way that is sensitive to any intellectual property restrictions on access. The system has been implemented as a series of REST-based web services which enable interoperability with other systems across the cluster as well as with external resources.

The TOXBANK data warehouse has been publically accessible since the autumn of 2014. We are now incorporating the public data on reference compounds into the warehouse, supporting the meta analysis and risk assessment being carried out in the SEURAT-1 case studies. Thus, the 'engine' is ready, and is now being populated with data arising from the different SEURAT-1 projects, as well as with external data, such as ToxCast.

★ **What do you think will be the impact of your work on research in this field?**

The TOXBANK project establishes critical infrastructure and service functions to all SEURAT-1 projects, providing a centralised and standardised set of data resources, compounds and biological samples, accompanied by standardised operating procedures and guidance. The provision of quality sources of compounds, cells and tissues for research will promote novel human cell-based assays that will facilitate more accurate evaluation of toxicity.

These resources will ensure that the alternative *in vitro* assays developed by

SEURAT-1 researchers are guided and supported from an early stage of design so as to maximise their chances of reaching the pre-validation stage as defined by ECVAM and eventually receiving validation and regulatory acceptance as required under REACH. Thus, regulatory agencies are our target beneficiaries for this infrastructure.

REACH also places a significant demand on the businesses operating in the European marketplace that are involved in importing and manufacturing products involving chemical entities. Wherever possible, companies are required to address the '3R' principles as well as to evaluate and potentially use and report on alternatives. Thus, industry is another major target for our infrastructure, since industry-standard resource facilities such as TOXBANK are required for safety assessment activity. SMEs in particular will be challenged by REACH as they generally do not have in-house tools and knowledge resources for assessment work.

We should also have a beneficial impact on Cosmetics Europe and other organisations affected by the Cosmetics Directive, which placed a very strong 3R requirement on consumer product companies, by requiring all systemic toxicity animal experiments to be replaced as of 2013.

Finally, we expect to generate a snowball effect where all data will progressively be made available, with the possibility of exploring the multiple associations between different sets of data. We think that there will be heightened impact due to the fact that the results of TOXBANK are easily accessible from a simple computer.

★ **When will the platform be fully operational?**

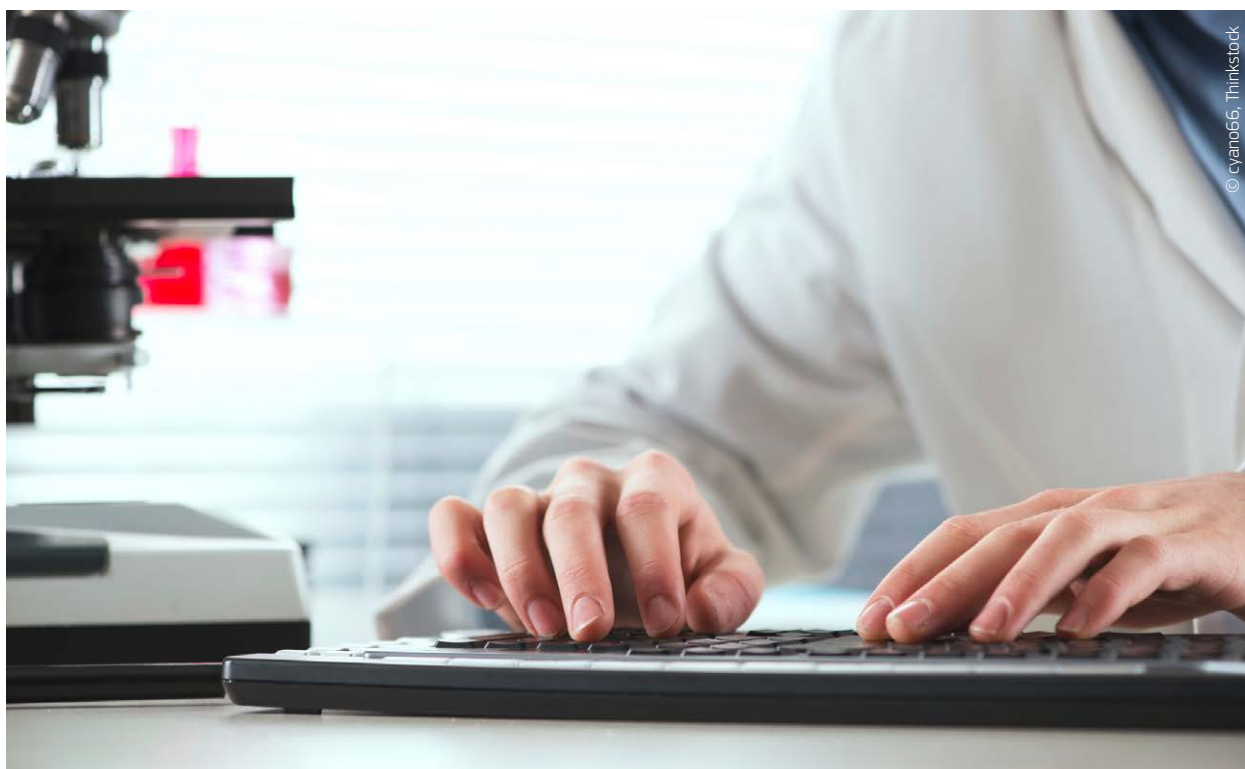
TOXBANK can already be used. To date, 61 protocols and data on 39 assays have been uploaded into the data warehouse, with 8 investigations currently being prepared.

TOXBANK also translated the data files and databases made available by the US EPA into the ISA-Tab so as to upload them into our data warehouse. The project will end in December 2015, thus we expect further data



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DR EMILIO BENFENATI



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collection from our SEURAT-1 partners in the final months.

★ **What can you tell us about the researchers' feedback so far?**

TOXBANK has been presented at various conferences and events. The interest focuses on two aspects. First a practical issue: access to data which is usually hidden in reports from individual experiments. TOXBANK provides stakeholders with a 'panoramic' perspective on the data, which can be exploited to minimise the use of animals. The cosmetic industry is of course very interested in the weight-of-evidence perspective in order to assess the safety of cosmetic ingredients. For this industrial sector it is vital to optimise the use of all data.

"Regulators involved in REACH are looking with interest at the results of TOXBANK and SEURAT-1."

The second reason for interest is theoretical: in general terms, the ability to fully exploit the data. This is of interest not only to the cosmetic industry. Regulators involved in REACH are also looking with interest at the results of TOXBANK and SEURAT-1. EFSA is also actively working on the use of all data and methods producing information from a weight-of-

evidence perspective. In even more general terms, researchers are interested in extending the access and the use of the data. This is strategic for toxicology.

★ **You will hold the TOXBANK public forum in October. What can stakeholders expect from this event?**

The event is dedicated in particular to industrial stakeholders. The cosmetic industry is forced to explore all possible ways to prove the safety of cosmetic ingredients, without resorting to animal tests. For this industrial sector it is vital to get sufficient evidence of the safety of their ingredients as soon as possible. TOXBANK will help by enabling the exploration of available data on substances in a transparent and efficient manner, integrating evidence from multiple sources, which would otherwise be difficult to merge. What TOXBANK provides is an advanced, powerful platform. But this event will also be an opportunity to get in touch with stakeholders and solicit future interaction as well.

★ **Do you feel that the EU is on the right track in meeting its objective of replacing animal testing?**

The EU is a complex entity, with many different Member States, and many regulations. It indeed aims to replace animal testing, but there are other objectives such as human safety

and the protection of the environment, which in some cases may conflict with the phasing out of animal testing.

Surely the EU is very close to the replacement of animal testing for cosmetic ingredients, but other regulations go in a different direction. To replace animal testing while at the same time protecting human health and the environment, we need a shift similar to what was done for instance in the USA, with a unified strategy embracing different regulatory agencies and a common vision.

★ **What are your plans after the project ends?**

The EU, with the H2020 initiative, plans to keep supporting research on the replacement of animal testing. A new project, called EUTOXRISK21, will proceed along this way, joining dozens of laboratories. Some of the partners of TOXBANK will participate in this new project, which is due to start in January 2016, and the experience and the resources of TOXBANK will certainly be useful.

TOXBANK

- ★ Coordinated by the Institute of Pharmaceutical Research Mario Negri in Italy.
- ★ Funded under FP7-HEALTH.
- ★ http://cordis.europa.eu/project/rcn/97715_en.html
- ★ Project website: <http://toxbank.net/>

COSMETIC TESTING: SAFETY IN NUMBERS

Computational models can help to predict the safety of long-term exposure to cosmetic ingredients. A free database pulls together data from the US and Europe, allowing researchers to freely search for information on the safety of cosmetic ingredients.

COSMOS, one of the seven projects run under the SEURAT-1 initiative, is developing methods to predict the effects of long-term exposure to cosmetics using *in silico* approaches which tap into the potential of big data and computational modelling.

One of the major achievements of the project has been to build a database (COSMOS DB) containing an inventory of cosmetic ingredients and related toxicity data. It pools data donated by the US Food and Drug Administration (FDA) and cosmetics companies, along with other published studies and data harvested from reports from the European Commission's Scientific Committee on Consumer Safety.

"By looking at the distribution of toxicity values we can calculate the concentration or threshold at which you could say a compound is safe."

The first version of the database was published in 2013 and a new version is anticipated later this year. Not only will the updated database be open to all, but users can download the entire dataset of repeat dose toxicity data. It will also contain information on whether a chemical can get through human skin, which is important to understanding its toxicological profile.

Having free access to this wealth of information allows scientists to calculate the safety profile of certain chemicals. 'By looking at the distribution of toxicity values — the no-observed-adverse-effect-level (NOAEL) — we can calculate the concentration or threshold at which you could say a compound is safe,' says Professor Mark Cronin of Liverpool John Moores University, who heads up the project.

Based on knowledge of how much of a product we are exposed to, for

instance, daily use of a shampoo or face cream, if the concentration of a compound is below the so-called threshold of toxicological concern (TTC), companies can reasonably assume the ingredients in their product are safe for use.

The COSMOS team are looking at modelling biokinetics which could help to estimate the impact on the liver or other organs of certain exposures to cosmetic ingredients. The modelling in COSMOS, in combination with the data held within the database, can also be used to extract information on the kinds of chemicals that cause liver toxicity. A 2D liver model is under development which seeks to simulate the effect of chemicals on the body's own detox organ.

The tools developed in COSMOS are freely available via the website and are of major interest to the cosmetics industry and to regulatory agencies around the world, as well as to academic researchers.

So do *in silico* models fill the gap left by the prohibition on animal testing? Not quite.

'To replace a rodent assay where you get all sorts of different organ-level effects is very complex,' says Professor Cronin. 'When the ban came in we were not yet at the point where we could get the same information from non-animal technologies — and we still have a way to go.'

'It's not a case of simply replacing animal models with computer modelling,' explains Professor Cronin. 'To make it work, computational models must be combined with *in vitro* assays and other tools from molecular biology and mechanistic modelling.'

COSMOS

- ★ Coordinated by Liverpool John Moores University in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ http://cordis.europa.eu/project/rcn/97712_en.html
- ★ Project website: <http://www.cosmostox.eu>



INTERVIEW

LIVER-SIMULATING DEVICE SURPASSES ANIMAL-BASED ALTERNATIVES

The HEMIBIO project has developed a Hepatic Microfluidic Bioreactor mimicking the structure of the human liver. The project team is confident that the new device will eventually help remove the need for testing chemicals on animal subjects.

The liver plays a key role in transforming and clearing the chemicals we absorb every day, which makes it one of the main target organs for toxicity tests. But scientists are still looking for the perfect testing method: the latter frequently involve animals, and therefore often fail to reflect the actual impact of tested chemicals on human livers with 100% reliability.

To overcome this problem, the HEMIBIO consortium has set out to develop a device able to simulate the complex structure of the human liver and to make it available for preclinical toxicity testing as part of the SEURAT-1 initiative.

Now a few months away from the end of the project, the team has successfully developed a liver-on-chip device capable of maintaining metabolically active liver organoids for over a month *in vitro*, with 99% accuracy in toxic concentrations measurements.

Prof. Catherine Verfaillie, coordinator of the project and Director of KU Leuven's Stem Cell Institute, highlights some of the key findings of the project and the future plans of the consortium.

★ How did the HEMIBIO project come about?

Prof. Catherine Verfaillie: HEMIBIO was born from previous collaborations between many of the project partners (Drs Verfaillie, Luttun, van Grunsven, Rogiers, Sancho-Bru, Collas, Nahmias and Van Fleteren) that aimed to create an *in vitro* model of human liver for the study of toxicity and viral hepatitis, as well as studies related to the creation of parenchymal and non-parenchymal liver cells combined using small microfluidic bioreactors.

As we all had a strong interest in liver tissue engineering, from an applied and basic science point of view, we saw HEMIBIO as an opportunity to extend our collaboration across Europe and make a real impact on the development of alternatives to *in vivo* toxicity testing. We recruited excellent partners with expertise in liver biology, toxicology, genome engineering, sensor technology and microfabrication, and put together a proposal that was much greater than the sum of its parts.

★ Why do you feel like animal testing needs to be replaced?

At the time of submission of the HEMIBIO application multiple projects had been funded by the EC which aimed at decreasing the need for animals in toxicity testing.

However the assessment of the toxic effects of chronic exposure not only to drugs and chemicals, but also cosmetics, still required a relatively frequent use of animals. Moreover, aside from ethical considerations, there was also a great need for suitable human cells to be used in toxicity testing, due to the often poor concordance seen between toxicity in animal models and actual effects in humans.



★ What was your key objective?

Our belief was that, in order to recreate a liver-simulating device that is suitable for long-term toxicity testing, the cellular components of the liver need to be viable for extended periods of time (more than 1 month), with appropriate metabolic and transport function, and a physiology comparable to an *in vivo* liver.

To achieve this we had to consider the flow through the device, the zonation of the hepatocytes (and some non-parenchymal liver cells), and the impact of non-parenchymal cells on the function and downstream toxicity of the parenchymal component — in particular where one of the toxic endpoints, liver fibrosis and cirrhosis, was concerned.

Liver fibrosis and cirrhosis is caused by an interplay of hepatocyte toxicity and hepatic stellate cells activation which cause a deposition of collagen, along with changes in the liver sinusoidal endothelial cells which lose their specific fenestrated membrane. Such changes can only be studied within a device where the different cell components are present.



© Catherine Verfaillie

PROF. CATHERINE VERFAILLIE

“Some of the partners are considering setting up a company over the next couple of months that will provide screening services for the cosmetic and pharmaceutical industries.”

★ **What would you say are the main achievements of the project so far?**

HEMIBIO has led to five major advances. First, we developed a liver-on-chip device capable of maintaining metabolically active liver organoids for over a month *in vitro* under oxygen gradients mimicking the native microenvironment. This demonstrates the specific advantages of human-on-chip technology, as current methods rely on daily drug exposure and dozens of end-point assays — resulting in limited kinetic information and prognostic value.

A second achievement was the generation of a diverse library of proliferating, metabolically functional, polarised cultures of primary human hepatocytes — the gold standard for drug toxicity studies. We notably showed that the cells could accurately predict the TC50 [50% toxic concentrations, ed.] profile of 12 compounds with an unprecedented 99% accuracy (compared with 60% of HepG2/C3A cells). We generated five different genotypes from patients from a wide ethnic background, thereby allowing unique studies into inter-patient variability and idiosyncratic toxicity events in large populations.

A third achievement was, by using cocultures of hepatocyte and stellate cells, the creation of a unique *in vitro* model to study repeated dose toxicity ultimately leading to liver fibrosis was developed.

The fourth success is the development of genome-engineered pluripotent stem cells — hPSC master cell lines — suitable for FLPe recombinase-mediated cassette exchange (RMCE) in the AAVS1 locus that allow generation of

transgenic lines within 3-4 weeks with 100% efficiency and without random integrations. Using RMCE, we successfully incorporated several transgenes useful for lineage identification, cell toxicity studies, and gene over-expression.

Finally, HEMIBIO provided a novel definition of the transcriptional, miRNA and epigenome phenotype of quiescent and activated human hepatic stellate cells, as well as novel culture systems to maintain human stellate cells quiescent *in vitro*.

★ **When do you think your device could be made available on the market?**

The group of Prof. Nahmias at the Hebrew University of Jerusalem, in partnership the Fraunhofer Institute and Upcyte Technologies, demonstrated the ability to expand human hepatocytes and sustain their function in a microfluidic bioreactor for over 28 days under continuous oxygen measurement. This liver-on-chip technology accurately predicted the TC50 values of acetaminophen, amiodarone, troglitazone and rotenone, a number of toxins on the fold compound list from Seurat-1, with an R2 of 0.9 in *in vitro* - *in vivo* correlation. The sensitivity of the device enabled the detection of a new mechanism of acetaminophen toxicity as well as new insights into the development of troglitazone-induced damage.

Several provisional patent applications have been submitted for the bioreactor, methods and sensors. Some of the partners are considering setting up a company over the next couple of months that will provide screening services for the cosmetic and pharmaceutical industries. In addition, the Verfaillie group has now created an iPSC platform for drug-screens, which in the near future will hopefully be automated, so that large numbers of lines can be generated, differentiated and used in high throughput screens.

★ **Is it realistic to think it could replace *in vivo* testing in the near future?**

We are convinced that the progress made within HEMIBIO will contribute to the possibility of replacing animal testing by *in vitro* testing, even if a lot of studies that will address *in vitro* - *in vivo* correlation will still be needed to completely replace animal studies by *in vitro* human cell loaded bioreactors.

★ **What are your plans until and after the project ends?**

Several partners from the HEMIBIO consortium (and other Seurat-1 clusters) are involved in follow-up local grant schemes (van Grunsven, van de Water, Verfaillie), as well as follow up EC-H2020 schemes (Verfaillie, van de Water), and directly with cosmetics companies (Nahmias) on studies related to the creation of *in vitro* liver models for toxicity. These should eventually enable the replacement of animal studies by human *in vitro* studies using composite liver organoids in microfluidic bioreactors. Hence the progress made within HEMIBIO will be taken forward in these subsequent efforts.

HEMIBIO

★ Coordinated by KU Leuven in Belgium.

★ Funded under FP7-HEALTH.

★ http://cordis.europa.eu/project/rcn/105662_en.html

★ Project website:

<http://www.hemibio.eu/>

BIOLOGY AND MEDICINE

HOME-BASED BRAIN-COMPUTER INTERFACES TO ENHANCE THE LIVES OF PEOPLE WITH DISABILITIES

The BACKHOME project has turned home-based usage of brain-computer interfaces (BCIs) from a dream to a reality in a matter of three years. Its compact BCI system, along with a wireless biosignal acquisition system and other telemonitoring technologies, is already on the market.

For people affected by severe disabilities, the idea of a cure remains far-fetched in spite of researchers' continuous efforts. What is more tangible, however, is a brain-computer interface that would allow them to recover part of their independence. This technology has evolved considerably over the years: new application prototypes for the likes of communication, movement control, environmental control, locomotion and neuro-rehabilitation have been demonstrated and provide patients with a concrete hope for better days. But so far these prototypes have been confined to labs and closely-monitored environments.

'Home usage had been demonstrated, though only with ongoing expert supervision,' notes Felip Miralles, director of the eHealth R&D Unit at Eurecat, a Catalan technology centre which resulted from the merger of Ascamm, Cetemmsa, Barcelona Digital, Barcelona Media and CTM in May 2015. 'A significant advance in BCI research and its implementation as a feasible assistive technology (AT) is therefore the migration of BCIs into people's homes to provide new options for communication and control that increase independence and reduce social exclusion.'

Felip Miralles knows very well the ins and outs of this situation. For the past three years he has been in charge of BACKHOME (Brain-neural computer interfaces on track to home — Development of a practical generation of BNCI for independent home use), a project which aimed to enable the migration of BCI technology from the lab to the home and therefore bring it to mainstream markets. Now completed, the project is responsible for five key innovations: an architecture able to meet the requirements of a multi-functional BCI with remote home support; novel BCI equipment setting a new standard of lightness, autonomy, comfort and reliability; easy-to-use services tailored to people's needs with one-click command and adaptive usage; a telemonitoring and home support system; and a web-based application for therapists offering various remote services.

User- and market-centred

These technologies were all tested thoroughly by means of a user-centred design (UCD) approach, where therapists and caregivers, but also users and their families, were able to provide feedback. 'We adopted this approach at each phase of system definition and implementation in order to have a

solution that reflects users' requirements, needs and preferences,' Eloisa Vargiu, technical coordinator of the project, explains. The final system was evaluated by 20 participants through an experimental protocol at the University of Würzburg (both with gel-based and dry electrodes), while five other participants completed the same test on three occasions at the Cedar Foundation.

User feedback showed that the system was stable and satisfied all requirements. 'Caregivers' assessment of the usability of the hardware and software was positive. They felt confident that they could integrate the set-up into their daily routine,' Miralles explains. Extended testing was undertaken with five participants with acquired brain injury using the gel-based system, and two end users tested the system during independent home use over the course of six weeks. The latter opportunity enabled caregivers to set up hardware and software, while end users could use the system independently and were asked to fulfil three predefined tasks per week.

Vargiu says this user-centric approach was at the heart of the project's success. 'The home-based evaluation

provided useful lessons for technical developers indicating aspects that are most important such as the need to be able to use the system without caregiver support, the importance of the infrastructure in the living environment and the importance of advancing the algorithms used to prevent undesired selections. During long-term independent home use, two study participants diagnosed with ALS evaluated the Brain Painting application, which allows them to express themselves artistically by creating paintings on a virtual canvas. Both expressed high satisfaction with the application and indicated that the BCI improved their quality of life.'

Such long-term interaction with end users also helped pave the way for a simpler and easier lab to market transition: although the project was completed in June, several of the main products arising from BACKHOME are already available on the market.

'The g.Nautilus, a novel wireless biosignal acquisition system, and the intendiX, a complete and compact BCI system for patients' everyday lives, are available for end users. Another side product, the eKauri platform, is already in production.

Its sensor-based telemonitoring and home support system provides advanced tele-assistance services, chronic care management and social participation targeting the elderly, those with chronic illness and people living with a disability not necessarily using BCI as the end-user interface,' Miralles notes. A commercial telehealth product called HomePod, commercialised by British company Medvivo, was also reshaped into a new product to remotely monitor and assist stroke patients. This new system, called StrokePod, also integrates BACKHOME's sensor-based telemonitoring system.

All in all, BACKHOME is expected to have a strong impact on Europe's competitive edge in the field. Its technology will also make a real difference in patients', caregivers' and medical professionals' daily routine.

BACKHOME

- ★ Coordinated by Eurecat in Spain.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/news/rcn/123828_en.html
- ★ Project website: <http://www.backhome-fp7.eu/>
- ★ <http://bit.ly/1mW54yw>

NANODIAMONDS TO CURE INFECTIONS

Modern medicine increasingly depends on advances in nanotechnology. European scientists used diamond nanoparticles to develop novel strategies for fighting off bacterial infections.

Bacteria have the unique capacity to grow in biofilm communities, posing a great health threat. Microorganisms in biofilms interact to evade immune system responses and enhance their tolerance towards antibiotics. As a result, biofilm-based infections are very difficult to eradicate.

To make matters worse, the injudicious use of antibiotics has led to the emergence of antibiotic-resistant bacteria, aggravating the threat of biofilm-related infections. To address the issue of resistance, scientists directed their efforts to the design of non-biocidal strategies as alternatives to antibiotics. One such approach utilises anti-adhesive molecules to prevent the initial interaction of bacteria with medical device surfaces.

The EU-funded PHOTORELEASE (Fabrication of particles with photo receptors: bio-analytical application such as controlled drug delivery) consortium decided to develop nanoparticles that display activity against biofilms. They selected diamond nanoparticles, also called nanodiamonds, as they are inert, biocompatible, and importantly, they are easily functionalised based on the application. Nanodiamonds are increasingly being used as imaging probes and drug carriers.

PHOTORELEASE researchers developed sugar-coated nanodiamonds as novel inhibitors for Escherichia coli-based biofilm formation. Optimisation activities led to nanodiamonds with improved functionalisation that displayed significantly improved anti-biofilm activity.

The unique properties of diamond nanoparticles make them promising for a variety of applications. With the imminent

threat of antibiotic-resistant strains, such engineered biomaterials could prove vital to the treatment of infections.

PHOTORELEASE

- ★ Coordinated by the Lille University of Science and Technology in France.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/92244_en.html



NEURAL RESPONSES OF BIRDS TO SOUND SEQUENCES

Birdsong exhibits phonological syntax in which sounds are put together in an organised syntactic structure that produces meaning. The first use of electrodes to study sequence rule learning in non-human animals has shed light on neural mechanisms.

Birds are particularly adept at recognising syntactic patterns. Scientists set out to investigate potential similarities in neuronal processing of syntax between birds and humans with EU funding of the SYNTAX (Neurophysiology of birdsong syntax perception) project. Using an array of 64 intracerebral electrodes, researchers recorded electrical activity from populations of neurons in auditory and song system nuclei during stimulation with artificial song-like sequences.

The team used the zebra finch, a widely studied animal model of speech and language-related neural mechanisms. Due to the nature of the experiment, it was performed under anaesthesia, specifically isoflurane. This anaesthetic induces a sleep-like state in which primary and secondary cortical areas still respond in a stimulus-specific way to complex sequences, including natural song.

Unexpectedly, researchers identified spontaneous travelling waves of both individual (action potential) and population (field potential) activity throughout most of the forebrain, both inside and external to auditory areas. This activity has also been seen in the cerebral neocortex.

Researchers then investigated changes in this activity in the auditory cortex as a result of stimulation using artificial sound sequences based on natural song syllables. One of the most important project results was the finding that the zebra finch exhibits both memory-based stimulus-specific adaptation and rule learning. Until now, the sequence rule learning that is key to human syntax capabilities has only been studied behaviourally in non-human animals, with highly controversial results.

SYNTAX went on to identify neural response patterns consistent with neural processes that involve prediction of future input based on short-term rule learning. In other words, this activity could reflect short-term predictability of syllable occurrence within a sequence.

The results expand the utility of the zebra finch animal model to include a role as a comparative neural model system for syntactic rule learning. They could also lead to better understanding of changes in evoked responses, reflecting a change in expected stimulus sequence (mismatch negativity). The phenomenon has been implicated in a number of cognitive functions and has been linked to disorders including dyslexia and psychiatric diseases.



Establishment of an animal model of syntactic rule learning will no doubt have far-reaching impact.

SYNTAX

- ★ Coordinated in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169455_en.html

SMART TECHNOLOGIES TO THE RESCUE OF FALL-PRONE SENIORS

Recently completed, FARSEEING is making waves in the field of fall prediction, identification and prevention. The project has come up with novel, user-centric technologies, an online fall repository and recommendations that hold the promise of truly independent living for senior citizens.

It is often a heartbreaking moment when a family is forced to place their elderly relatives in a nursing home. But it is also, to a certain extent, a source of relief: each year, 35 % of over-65-year-olds experience one or more falls, and this percentage rises as we grow older. Such falls can result in serious injury and even death, which means that enjoying a fully independent retirement at home is not always an option.

Even in the safest nursing homes, a few seconds of inattention can have serious consequences and the absence of witnesses or monitoring systems in real world situations

means the circumstances of these falls often remain unknown. But what if smart devices could help us better predict and prevent these falls?

With its new technological infrastructure, its fall repository, a telemedicine service, a brand new fall algorithm, and extensive research into users' interactions with technology, the FARSEEING (FALL Repository for the design of Smart and sElf-adaptive Environments prolonging INdependent livinG) project has made independent living a realistic option even for high-risk subjects, while taking their opinions and expectations into account thanks to real-life testing. Completed

in May 2015, the project offers a 360-degree perspective on how to prevent, detect and manage falls in various environments.

The FARSEEING technology relies on two core components. First, a smart home system tracks the user's movements in the house thanks to environmental sensors and a distributed audio and video system. The data is collected and processed by means of a local unit, and a so-called scenario programmer is set up to define and manage up to 300 fall scenarios. These scenarios can either be triggered by the user themselves or by events like door openings, movements, temperature changes or detected falls. The system is backed by smart wearables and smartphones, with applications including a dedicated smartphone app featuring a real-time fall detection algorithm, and a novel smart shoe-based activity monitoring system.

'Our system offers better fall prediction, as well as the potential to understand what happens physically before someone falls, and sets up preventive measures accordingly,' explains Prof. Lorenzo Chiari, coordinator of the project and vice-director of the Health Sciences and Technologies — Interdepartmental Center for Industrial Research (HST-ICIR) at the University of Bologna.

'Preliminary results about the predictive validity of the smartphone-based assessment are available and show that, by instrumenting the Timed Up and Go test — a traditional clinical test — using smartphones, we can measure fine details of movement that are strongly associated with the history of falls and, more important, features such as the smoothness of the sit-to-walk transition, that are highly predictive of the probability of falling within 6 months,' he continues.

Besides prediction, prevention was also an important part of the research, as the team tested various exercise video games available on the market and provided recommendations for the development of new games specifically dedicated to older people.

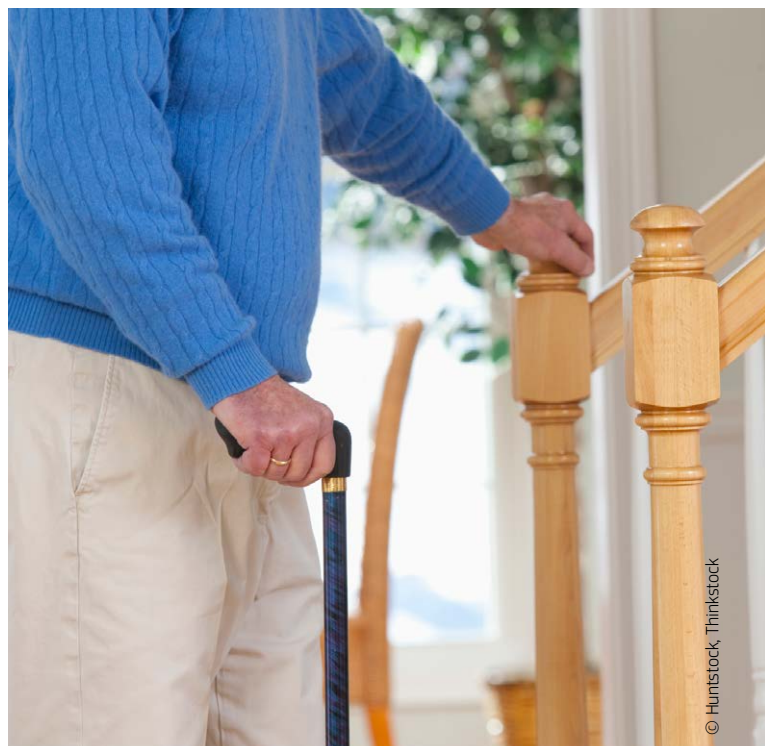
The world's largest fall repository

But the project goes beyond the prevention and solving of individual fall scenarios: all data collected by FARSEEING sensors feeds into a fall repository — the world's largest, according to the project team — where relevant features in the user's motor profile and functional level, predictive of future falls, are stored.

'The falls repository contains information from over 200 real-world fall events,' Prof. Chiari notes. 'Falls have been measured in different settings such as community

dwellings, rehabilitation clinics and nursing homes, and in different disease groups — mainly geriatric rehabilitation, Parkinson's disease, cerebellar and sensory ataxia. Based on this data a new classification system has been

established to help improve detection of falls from sensor data.'



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The system will soon be open to any external parties interested in contributing to or using this database, which will be accessible from the project's website. To maximise the exploitation potential of the data, the consortium even created a common language between researchers, engineers, users and health professionals, to ensure consistency in study descriptions and reporting.

Although the project, which received an 'excellent' rating from the Commission, is now completed, work will continue over the coming months. First, some of the results of FARSEEING are being used to improve the assessment of fall risk in a randomised control trial about fall prevention (the Precisa study) funded by the Emilia-Romagna Health & Care Agency. Furthermore, a spin-off company, mHealth Technologies, has been set up by researchers at the University of Bologna to bring to market the smartphone system developed as part of FARSEEING. The company has already had preliminary contact with potential customers for the system, and some members of the FARSEEING consortium were recently awarded further EC funding under the Horizon2020 PREVENTIT project to conduct a feasibility trial to further develop the system.

'This is just a start,' Prof. Chiari concludes. 'Our plan is to continue building on our work to maximise the opportunities provided by ICT within the field of fall prediction, detection and prevention.'

FARSEEING

- ★ Coordinated by the University of Bologna in Italy.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/news/rcn/123864_en.html
- ★ Project website: <http://farseeingresearch.eu/>

"Our system offers better fall prediction, as well as the potential to understand what happens physically before someone falls and set up preventive measures accordingly."

FAST, ACCURATE AND COST-EFFECTIVE DIAGNOSES TO TACKLE RESPIRATORY INFECTIONS

Guidelines on treating patients with both HIV and tuberculosis (TB) should be updated, according to a new study part-funded by the EU RID-RTI project.

Recently published in the *Annals of Internal Medicine*, the study found that starting anti-HIV treatment within two weeks of TB being diagnosed improved survival rates among patients with both infections who had very low immune-cell counts. Those with strong immune systems, however, appeared to benefit from waiting until after the end of the six-month TB treatment before initiating anti-HIV therapy. The study recommended updating guidelines to take these findings into account.

Treating HIV and TB simultaneously has proved challenging for a number of reasons, including the requirement for patients to take multiple pills, as well as drug-to-drug interactions and overlapping side effects. This particular study sought to investigate the optimal timing of HIV treatment initiation in light of recent clinical trials.

This is one example of how the RID-RTI (Rapid Identification of Respiratory Tract Infections) project, which began in July 2012, has contributed to improving the survival chances of patients with respiratory tract infections (RTIs). These infections are caused by a variety of bacterial, viral and fungal pathogens and are major

causes of morbidity and mortality in adults and children worldwide.

RTIs such as TB and pneumonia are a truly global health problem. In 2013 there were an estimated 9 million new cases of TB, with between 1.3 and 1.5 million associated deaths. More people in the developing world contract TB because of poor immune systems largely due to high rates of HIV infection and the development of AIDS.

According to the World Health Organisation (WHO), pneumonia is the leading cause of death in children globally, killing an estimated 1.4 million children under the age of five each year.

One reason that RTIs continue to proliferate is that they are so difficult to diagnose quickly and accurately. Current tests are intensely time consuming, and as a result, patients presenting RTI symptoms are often treated uniformly with antibiotics without the causative microorganism being accurately identified. This can lead to the inappropriate use of antibiotics, which in turn increases patient morbidity and mortality.

In order to address this issue, the RID-RTI project — built around a consortium of SMEs, universities and hospitals from Finland, France, Ireland and the

UK — has sought to develop a rapid molecular diagnostic test capable of identifying a large range of microorganisms responsible for RTIs. This will lead to more appropriate therapies applied after the very first consultation.

The test, which is being built on a simple 'sample-in, answer-out' diagnostic platform, will be cost-effective and user-friendly, and will be capable of delivering results in under two hours. This sets it apart from current diagnostics technologies. It is hoped that the speed and accuracy of the platform will revolutionise how RTIs are treated.

Furthermore, a feasibility plan is now being developed to ensure that project results can be translated into commercial products. The ultimate objective is for new cost-effective, user-friendly products to be routinely used in hospitals. The RID-RTI project is due for completion at the end of December 2015.

RID-RTI

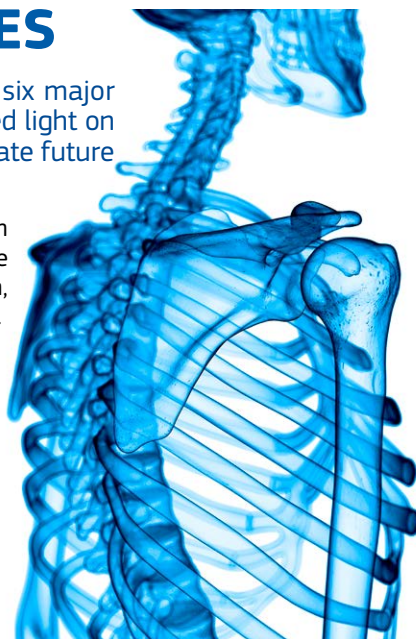
- ★ Coordinated by the University College London in the United Kingdom
- ★ Funded under FP7-HEALTH.
- ★ http://cordis.europa.eu/news/rcn/123586_en.html
- ★ Project website: <https://www.rid-rti.eu>

JOINT EUROPEAN, INDIAN, BRAZILIAN AND AMERICAN EFFORTS LIFT THE VEIL ON HUMAN SKELETON MYSTERIES

INTERBONE has helped train a new generation of bone specialists in six major universities across the world. The results of the project, which also shed light on the interactions between bone and other tissues, are expected to facilitate future international cooperation in this field.

If two heads are better than one, uncovering complex biological mechanisms such as the interplay between bone cells, matrices and systems requires even more grey matter. Whilst bone cells are known to play an important role in metabolism, regulating health and protection from disease, how they do so still remains unclear. Prof. Anna Maria Teti, researcher at the Department of Experimental Medicine of the University of L'Aquila in Italy, led the INTERBONE (The interplay among bone cells, matrices and systems) project for over three years with the aim of increasing cooperation between young scientists to help solve this mystery.

Thanks to more than EUR 230 000 in EU funding and close cooperation between six universities in the Netherlands, Italy, Brazil, the USA and India, Prof. Teti's



multidisciplinary, 20-strong team recently obtained new information on the interactions between bone and other tissues in three key areas of health: energy metabolism; development of leukemia; and fracture healing, tissue regeneration and biocompatible orthopaedic implants. The research built partly on previous findings as well as on *in vitro* and *in vivo* experiments.

‘Our fellows published in top-class journals, including Nature and Cell,’ Prof Teti explains. ‘Major results unveiled, among other things, an important role of lipocalin 2 in bone loss, a role in this context of energy metabolism, the importance of osteoprogenitor cell dysregulation in leukemogenesis, the tight relationship between bone cells and endothelial cells in skeletal unloading impairing osteogenesis, as well as the improved osteointegration of new biomaterials in the bone healing process.’

Prof. Teti insists that these breakthroughs would not have been possible without the project’s focus on staff exchanges, training and networking activities, all organised with a view to

“Our fellows published in top-class journals, including Nature and Cell.”

building strong and long-lasting bridges between Europe and other regions of the world. ‘It has been very fruitful for the

trainees and for the principal investigators. We could challenge ourselves to bring knowledge, technical skills and intellectual approaches to the next level for new and more complex

multidisciplinary studies. We very much appreciated this opportunity, which strengthened existing collaborations and established new ones.’

Participating fellows come out of the three-year project with stronger knowledge and expertise, specifically in the generation of animal models, *in vitro* and *in vivo* assays, endothelial cell biology and cross-talk with bone cells and hematopoietic cells, bone-cell endothelial cell cross-talk in unloading conditions and tissue repair and, finally, the use of innovative biomaterials to improve osteointegration and fracture healing.

While the project is now complete, the consortium intends to keep strengthening the collaboration, perhaps through another similar exchange programme. Over the long term, the knowledge accumulated in INTERBONE related to disuse osteoporosis, leukemogenesis and wound healing could yield considerable benefits for patients.

INTERBONE

★ Coordinated by the University of L’Aquila in Italy.

★ Funded under FP7-PEOPLE.

★ http://cordis.europa.eu/news/rcn/123841_en.html

★ Project website:

<http://www.interbone.org/>

A MODEL PLATFORM TO DEVELOP NEW REGENERATIVE THERAPIES

EU-funded researchers have used ground-breaking stem cell technology to test and assess new approaches to tackling disease.

Scientists have successfully used stem cells to grow fully functional bile ducts in the lab, which could one day help prevent liver tissue damage. Bile ducts are vital to enabling the liver to dispose of waste; malfunctioning bile ducts are behind a significant proportion of all liver transplants (30% for adults and 70% for children). The treatment will next need to be extensively tested in clinical trials before it can be used on patients.

The study, which was recently published in the scientific journal Nature Biotechnology, was made possible thanks to the TISSUEGEN (The production of a 3D human tissue disease platform to enable regenerative medicine therapy development) project. This project, which began in 2012, sought to develop an *in vitro* (in the lab) platform that will help scientists to develop new regenerative medicine therapies.

The platform is based on the *in vitro* generation of human tissue cultured from human-induced pluripotent stem

cells (iPSCs). These are cells that can be generated directly from adult cells, and this opens the door to a virtually limitless supply of a patient’s own cell types to regenerate tissue and organs while avoiding the ethical concerns associated with using stem cells from embryos.

Liver tissues were the focus of TISSUEGEN due to their scientific and commercial significance. During the first stage of the four-year project, which is due for completion at the end of 2015, partners produced an iPSC library from an inherited metabolic liver disorder donor set, and developed



“The platform will also enable the testing of new drugs, and means that regenerative therapies can be assessed in a scalable, cost-effective format.”

key parameters of human pluripotent stem cell culture. These cells, along with human hepatocytes — cells that make up between 70 and 85% of the liver's mass — were then loaded onto the 3D liver tissue platform.

Bioreactors were constructed using a range of innovative microfluidic techniques to produce systems compatible with analysis systems commonly used in laboratories worldwide. A key

benefit of these new systems is that they allow regenerative therapies to be developed and tested on batteries of human tissues in the laboratory in a rapid, cost-effective manner.

To demonstrate that the cells grown in the lab were indeed forming bile ducts, the researchers looked for characteristic markers and functions of the cells. They then compared these with samples from human donors and found that they were almost identical. This suggests that iPSC-derived hepatocytes produced from diseased donors can indeed be used to produce optimised models in which genetic diseases can be faithfully recreated in human tissue.

The approach being pioneered by TISSUEGEN could offer scientists and medical professionals the opportunity

to better understand how organs grow and develop, along with a greater understanding of disease. The platform will also enable the testing of new drugs, and means that regenerative therapies can be assessed in a scalable, cost-effective format. The 3D modelling of cancer tissue is also a possibility, leading eventually to more targeted and effective therapies.

Source: Based on a periodic report summary and study summary from the TISSUEGEN project.

TISSUEGEN

- ★ Coordinated by Cn Bio Innovations in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ http://cordis.europa.eu/news/rcn/123505_en.html

REGENERATING SPINAL CORD TISSUE

Regenerative medicine is a rapidly evolving field that steps in when traditional medicine fails. With the use of stem cells and growth factors, the regenerative approach promises to heal even spinal cord injuries.

The adult nervous system inherently possesses little regenerative potential. Regenerating axons show limited extension capacity and also lack functionality, possibly due to an insufficient number of synapses or a lack of myelination.

To address this challenge, scientists on the EU-funded AXON REGENERATION (Regeneration and target reinnervation after spinal cord Injury) project proposed a spatially and temporally controlled expression of neurotrophic factors. They aimed to enhance the distance of regeneration and target innervation by ascending sensory axons after adult spinal cord injury.

Study results revealed that expression of neurotrophin on its own is not sufficient to sustain regenerated axons following spinal cord injury. This decline in axonal growth is most likely due to alterations in the expression of extracellular matrix components and cell adhesion molecules.

The consortium then explored the potential of adult neural progenitor cells (NPCs) and adult bone marrow stromal cells (MSCs) to differentiate into oligodendrocytes and glia in the injured spinal cord. *In vitro* studies indicate that co-culturing these two types of progenitors enhances differentiation. However, this observation is not recapitulated *in vivo* where MSCs need further modulation to support NPC differentiation and engraftment.

Researchers also examined the capacity of neural stem cells (NSCs) to provide functional assistance to the injured spinal cord. The use of NSCs in animal models offered sensory and motor recovery after a complete spinal cord transection. Additional benefits included the normalisation of basal cardiovascular parameters as well as autonomic reflexes.

Collectively, the findings of the AXON REGENERATION study highlights the role of different stem cell sources to achieve



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phenotypic and functional recovery following spinal cord injury. Although still in its infancy, this approach has great potential for rapid translation into clinical practice.

AXON REGENERATION

- ★ Coordinated by the University Hospital Heidelberg in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169447_en.html

SOCIAL SCIENCES AND HUMANITIES

INVESTIGATING NEW PRACTICES OF CITIZENSHIP

Recent years have seen the emergence of new forms of political engagement, from the Arab Spring to the Occupy movements in different countries, from online campaigning to community organising. With the support of the ERC, Prof. Engin Isin has led research to explore how different traditions and practices of citizenship from around the world are changing the way we think of political participation and activity in Europe.

Historically, citizenship has been considered as an exclusive European concept and Europe has long been seen as the birthplace of universal ideas such as 'democracy' and 'rights'. Yet, the notion of citizenship can no longer be thought of as attached to a nation-state, as people across the globe are inventing new ways to claim their democratic rights as citizens. Who is a citizen? What is political participation, and who has the right to it? These questions are among the most discussed today throughout European societies. The integration of migrants and the emergence of regionalism on the one hand, and the increasing importance of supra-national entities like the European Union on the other, all in the context of globalisation, are leading to profound changes in the way we perceive political communities.

Perspectives from outside Europe

To explore how the concept of citizenship is being refigured and renewed around the world, Prof. Isin, a leading expert in the politics of citizenship, decided to look at other traditions of political participation from outside Europe. With his interdisciplinary team, he studied practices from India, Japan, North Africa and Israel, and looked at ways migrants are claiming political rights and influencing legal norms in Europe. His goal: to open up new perspectives to understand

the relationship between individuals, communities and political institutions: 'Our empirical research shows how people across the globe have been inventing creative ways to claim their democratic rights as citizens. The findings of the OECUMENE (Citizenship After Orientalism) project make it difficult to suggest that democratic citizenship is an exclusive European value.'

Thinking beyond imperial powers

'For centuries Europe has asserted its place as the centre of the world,' says Prof. Isin, 'and now we are living the consequences of the decentring and provincialising of Europe and America as other regions become more powerful, and that requires us to change the categories we use to understand the social world.'

The OECUMENE project shows further evidence that Europe is no longer the centre of cultural, economic and social influence and therefore, ideologies based on Eurocentric and orientalist assumptions are being put aside. Racism, sexism and inequalities are the vestiges of a Europe with a history of imperial domination. For the ERC grantee, considering non-European political practices as non-citizenship expressions is part of this legacy. Europe stands today as a different project, with its focus on freedom and the respect of fundamental rights for all.

Acting outside the university

Working with people outside academia, such as activists, civil society representatives and artists, has been particularly important for the research team. For Prof. Isin, this collaboration was essential to explore the new ways citizenship is understood and acted out, as well as for the impact of the project, targeting not only specialists but also society at large.

'OECUMENE was designed as a major collaborative project, requiring an effective research group with expertise in anthropology, sociology, politics, law, psychoanalysis and history. This would have been inconceivable without the ERC funding,' adds Prof. Isin.

The OECUMENE project has led to an important number of publications, events, debates, networking and dissemination activities.

OECUMENE

- ★ Coordinated by the Open University in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://erc.europa.eu/projects-and-results/erc-stories/investigating-new-practices-citizenship>
- ★ Project website: <http://www.oecumene.eu/>
- ★ <http://bit.ly/1KBRam1>

ASSESSING EU CRIMINAL INTELLIGENCE

Researchers examined the quality and effects of EU criminal intelligence. Europe is involved in the practice, but efforts are fragmented and uncooperative; such work may breach presumptions of innocence and is not recommended as trial evidence.

Behind the practice of criminal intelligence is the assumption that the work helps law enforcement agencies discover and prevent crime. Nevertheless, not everyone is convinced, maintaining that the practice must balance civil rights concerns.

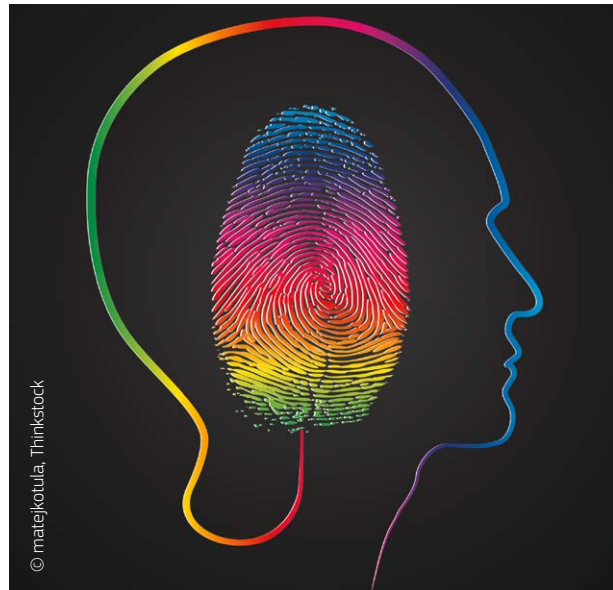
The EU-funded EUCRIMINTEL (Criminal intelligence in the EU) project addressed intelligence fragmentation in the EU, the role and quality of such work, and any conflicts with rights and democratic principles. The project ran for two years from October 2012.

Partners determined that numerous European bodies are involved in intelligence, despite claims to the contrary. Yet the agencies are fragmented and lack coherence, partly stemming from an unwillingness to cooperate.

The project established a general theoretical framework, addressing prevention, the concept of the intelligence cycle and reconciling intelligence with rights. The team concluded that intelligence collection and analysis can only breach the presumption of innocence to a limited extent, specifically when intelligence activities become a form of total monitoring.

Researchers interviewed more than 10 relevant American and European stakeholders, under condition of anonymity, to document how intelligence is crafted and used. This stage confirmed the principle of proportionality, whereby excessive information gathering can hamper intelligence function. European strategic intelligence is apparently very good, yet the same was not demonstrated for operational intelligence.

The project's interviews established that European intelligence is mainly used for strategic policymaking, and for criminal justice only in a very limited way. The study concluded that while



intelligence offers valuable inspiration at the prosecution stage, such information should be banned from trials.

EUCRIMINTEL allows stakeholders to restructure the shape of the intelligence community at national and EU levels. Secondly, the work assessed the quality of intelligence and clarified limits on its usage.

EUCRIMINTEL

- ★ Coordinated by the University of Maastricht in the Netherlands.
- ★ Funded under FP7-PEOPLE.

PATTERNS OF TRANSFORMATION IN VIOLENT CONFLICT

A comparative and in-depth analysis of the micro-dynamics of violence during and after militant insurgencies contributes to understanding trajectories and outcomes of violent conflict.

Phases of violent conflict can change and re-shape forms of violence and violent actors over the course of time. This is mostly the case during the decline phases. At such times, insurgent movements are weakened, isolated and fragmented.

The EU-funded TRANSFORMATIONS (Transformations of violence during the decline of insurgencies) project aimed to pinpoint typical patterns of transformation and examine the mechanisms that propel these processes. The particular areas of focus

were the spread of indiscriminate violence and how political violence intertwines with other forms of violence, as well as the development of hybrid violent actors.

Different types of data were used for the comparative analysis of three cases. These included the violent campaigns by Islamist movements in Algeria and Egypt since the early 1990s, and the violent insurgency of Sendero Luminoso in Peru. The comparison provides an examination of the combination of similarities in the

structures and goals of insurgent movements. It also examines the differences in terms of culture and political settings.

"Findings will be useful in the field of violent insurgencies as they contribute to an innovative wave of current research and can pave the way to a largely unexplored field of study."



One of the project's main achievements was the development of an analytical approach. It built on social movement theory and studies on the operations of violence in civil wars. This offers the ability to trace and explain patterns of transformation in violence by concentrating on the dynamics of interactions between armed groups and their environments.

The work has been presented at several international conferences. Findings will be useful in the field of violent insurgencies as they contribute to an innovative wave of current research and can pave the way to a largely unexplored field of study.

TRANSFORMATIONS

- ★ Coordinated by the European University Institute in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169484_en.html

ARGENTINA'S HAUNTED COLLECTIVE MEMORY

During the military dictatorship in Argentina (1976-1983), around 30 000 people, mostly political dissidents, were kidnapped, tortured, killed and made to disappear. ERC grantee Kirsten Mahlke analysed the haunting effect on Argentinian society of this mass forced disappearance as well as how it is presented in contemporary literature.

This violent period in the Argentinian history is still present in the people's collective memory. The uncertain status of the Disappeared ('los Desaparecidos') has resulted in continuing trauma in Argentinian society. Prof. Mahlke and NOT (Narratives of Terror and Disappearance: Fantastic Dimensions of Argentina's Collective Memory since the Military Dictatorship) team combined literary

studies with political science and social anthropology to examine the different ways in which the Disappeared have shaped Argentinean society. For the first time, specific attention is paid to the

"The impressive reactions to this project on a political and societal level reflect its high significance and impact."

ways in which fantastic narrative characterises the narratives of terror and, moreover, whether the fantastic as a mode of cultural communication, tradition, and art disseminates rather than counteracts the experience of horror.

To understand this, the team interviewed more than 100 individuals — terror victims and relatives, neighbours, lawyers — and analysed oral reports and literature, theatrical plays, religious rituals, judicial documentation and the spatial dimension of terror. The results of the research show that the credibility of reports dealing with the Disappeared has created a specific socio-political and scientific field. Moreover, the Argentine model of dealing with forced disappearances has had effects in other countries affected by similar forms of violence.



The impressive reactions to this project on a political and societal level reflect its high significance and impact. Prof. Mahlke and her team were invited by Argentinian President Cristina Fernández de Kirchner and many other public stakeholders outside the scientific community. The team also presented their research and findings in a TV series for an Argentine educational TV channel.

NOT

- ★ Coordinated by the University of Konstanz in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://erc.europa.eu/projects-and-results/erc-stories/argentinas-haunted-collective-memory>

EMPOWERING CHILDREN AS SOCIETAL ACTORS

European researchers sought to identify how children can be change agents in the science and society relationship, and subsequently catalysts in longer-term solutions to the grand challenges facing society.

The SIS CATALYST (SiS catalyst: Children as change agents for the future of science in society) project was a Mobilisation and Mutual Learning (MML) Action Plan which created mechanisms to help address societal challenges. MMLs are a part of the European Commission's Science in Society (SIS) Work Programme, and the project-specific focus was on the identification, capture and dissemination of mutual learning.

A diverse range of actors examined how children can be included in the dialogue between society and the scientific community. Their work was guided by the idea that children must be included in the decisions of today since they will live with their consequences in the future.

A primary objective was to mainstream SIS activities for children by developing guidelines linked to mobilisation of the political processes needed to bring about change. Project work involved four phases: 'Think Big – Building on Best Practice', 'Start Small – Capacity Building – Piloting', 'Scale Fast – Roll out' and 'Keep Going – Sustainability'.

Work was based around established activities, such as children's universities and university outreach programmes.

The team developed best practices informed by young people, students and key players. SIS CATALYST tools include the Listening and Empowering Toolkit for science communicators, Ethical Guidelines on Children and Student Involvement in SIS Activities, and two Ethical Advisory Reports.

Another deliverable was the strategic paper for sustaining and embedding strategy: 'Children as societal actors for a sustainable future'. This was used as a basis for a series of policy seminars and the development of a Children's Consultation Event.

Dissemination activities included four Policy Practice Interface conferences, four Strategic Development and Embedding conferences, and 20 We Recommend events. These events involved young people from around the world presenting their hopes, aspirations and recommendations for change.

SIS CATALYST has provided tools supporting institutional change and the modernisation of higher education across the EU. The work and its outcomes directly support the Europe 2020 strategy and its emphasis on the social dimension and increased public through the recognition of children as societal

actors in their own right. At the following link you will find five videos which can be downloaded and were produced in partnership with SiS Catalyst and are now hosted on the EUCU.net website.

SIS CATALYST

- ★ Coordinated by the University of Liverpool in the United Kingdom.
- ★ Funded under FP7-SIS.
- ★ http://cordis.europa.eu/result/rcn/150615_en.html
- ★ Project website: <http://www.siscatalyst.eu/>
- ★ <http://bit.ly/1hTx89B>



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INTERPRETING ANCIENT SICILIAN INSCRIPTIONS

EU-funded researchers focused on interpretation and evaluation of Sicilian inscriptions under the Roman Empire.

The W&S (Writing & Statues: Palaeographic analysis and historical perspectives on Greek and Latin honorary inscriptions from ancient Sicily (I BC - VII AD)) project collected Greek and Latin epigraphic documents carved on stone in Sicily in post-27 BC to 650 AD. The work represents a complete and exhaustive examination of the epigraphic material and its original context.

Although Greek and Roman stone inscriptions from Sicily have already been published, what sets this work apart from the rest is that it does not focus exclusively on historical aspects. Instead, the interdisciplinary approach used included an analysis of the documents whereby the focus was on palaeographic, stylistic and historical aspects. Additionally, the relationship between words and images as a means to convey messages and values was examined.

Only inscriptions that come from statue bases were used. It was found that they come primarily from the north-western

part of Sicily and that the occurrences decrease during the 2nd and the 3rd centuries AD. This demonstrates that overcoming the separation of different areas of knowledge is crucial in reconstructing a more reliable framework of ancient Sicily.

The results have been disseminated through publications and participation in seminars and workshops in Europe. Such an interdisciplinary approach gives way to a clearer and more reliable picture of the collection of Greek and Roman inscriptions from Sicily.

"What sets this work apart from the rest is that it does not focus exclusively on historical aspects."

W&S

- ★ Coordinated by in the United Kingdom.
- ★ Funded FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169490_en.html

ENERGY AND TRANSPORT

NEW BIOCOMPOSITE-BASED MATERIALS REDUCE BUILDINGS' EMBODIED ENERGY BY 50%

The BIOBUILD project has created new biocomposite structures that require less energy for their production when compared to commonly used alternatives. The new material boasts a 40-year lifespan and no extra cost for manufacturers.

The energy efficiency of buildings commonly entails reduced energy consumption in the use phase — one of the key targets under the EU's climate and energy package. However the energy required for the production of these buildings, also known as embodied energy, is equally important to the assessment of their environmental impact. In fact it is responsible for approximately 35% of a building's carbon footprint.

Reducing this energy use from mining to processing of resources, manufacturing and transport was the main concern of BIOBUILD (High Performance, Economical and Sustainable Biocomposite Building Materials). Completed in May 2015, the project developed new biocomposite materials to reduce the embodied energy of the building façade, supporting structure and internal partition systems by at least 50% compared to state-of-the-art materials — all this without increasing cost.

The project's results were praised at this year's JEC Europe Innovation Awards, where the new BIOBUILD façade won the prize for most innovative product in the construction sector.

'This product pushes the boundaries of both façade and materials engineering towards new targets by using

bio-composites in an extremely demanding sector of construction. The design freedom of biocomposites can generate a strong impact on the appearance of buildings,' said Guglielmo Carra, BIOBUILD design manager at Arup Berlin — one of the 13 project partners working under the coordination of NetComposites in the UK.

The façade panels, which can be used to replace conventional construction materials, including aluminium, steel, brick and concrete, are composed of two biocomposite laminates produced thanks to open-mould process. The two laminates are made from bio-polyester-impregnated twill (diagonal-ribbed) Biotex flax fabrics and have a distinctive appearance: the external laminate has a clear coating that makes the natural fabric visible, whereas the internal laminate is painted white. The project team points out that a number of coating colours and finishes can be chosen for the surface, depending on the architect's requirements.

Between the two laminates is a material improving the acoustic and physical insulation characteristics of the panel.

"The design freedom of biocomposites can generate a strong impact on the appearance of buildings."

The thickness is variable and the panels can be used in both residential and commercial buildings, just like other BIOBUILD-developed products such as internal partition and suspended ceiling kits.

A life-cycle approach

The project team notes that their new biocomposite materials allow for higher environmental sustainability when compared to benchmark materials solutions like traditional glass and carbon fibre composites, while also featuring an outstanding lifespan of 40 years. The BIOBUILD products were designed while following a 'cradle-to-cradle' approach for all their parts, which can be easily separated from

others at the end of their life cycle to be either recycled or reused.

BIOBUILD was funded by the EU to the tune of EUR 7.5 million. Although it has now come to an end, some dissemination activities are still planned and will be advertised on the project website.

BIOBUILD

- ★ Coordinated by NetComposites in the United Kingdom.
- ★ Funded under FP7-NMP.
- ★ http://cordis.europa.eu/news/rcn/123244_en.html
- ★ Project website: <http://biobuildproject.eu/>

PLANNING FUTURE TRANSPORTATION

An EU team assessed Europe's future transport requirements and the prospects of the transport sector. Doing so helped develop strategic options for European transport research and policy.

The transportation sector is known to be vital to Europe's economy, and the sector's future will depend on contemporary decisions concerning innovation and research. Hence, research must be targeted to future challenges, though they are difficult to predict.

Funded by the EU, the FUTRE (Future prospects on transport evolution and innovation challenges for the competitiveness of Europe) project aimed to provide such foresight.

Specifically, the five-member consortium identified future challenges, demand drivers and upcoming innovations, which can have a considerable impact on the global demand patterns for passenger and freight transport and which may affect the competitiveness of related industries and service providers.

Researchers developed plans to reconcile various future prediction studies with the issues of competitiveness and the support required from targeted research strategies. The two-year undertaking wound up in September 2014.

Work took both demand- and supply-oriented perspectives. The former addressed behaviour, affected by market drivers and other factors, while the latter examined upcoming technologies and innovations. The two analyses were merged, yielding scenarios consisting of qualitative framings and model-based quantification. Together, the work illustrates how the scenarios may help to achieve various European policy targets.

Researchers delivered options for EU research and transportation policies, including the design of future research

and development strategies. The project's key findings were published electronically for a public audience. Other dissemination work included additional materials and a series of workshops.

Data produced on private investment in transport research and development were used in the EU Transport Scoreboard.

FUTRE

- ★ Coordinated by the Centre for Research and Technology Hellas in Greece.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/148966_en.html
- ★ Project website: <http://www.futre.eu/>



SAVING SOLAR ENERGY FOR A RAINY DAY THROUGH HYDROGEN CONVERSION

A simple, cost-effective way of storing solar energy as hydrogen could help EU Member States meet their renewable energy targets.

While solar energy is renewable and abundant enough to meet Europe's growing energy demand, sunny days are not always guaranteed. Finding a cost-effective means of storing solar energy for a 'rainy day' would go some way to solving this problem. This was the challenge addressed by the COCHALPEC project, part-funded through an EU Marie-Curie Intra-European

Fellowship (IEF) grant, which officially ended in May 2015.

The project's success could help Member States in their obligations to fulfil the

"The team behind the innovation are confident that the new method can be scaled up to a commercial level."

Renewable Energy Directive, which requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020. The Directive specifies national renewable energy targets for each country, ranging from a low of 10% in Malta to a high of 49% in Sweden.

The COCHALPEC (Development of electrodes based on copper chalcogenide nanocrystals for photo-electrochemical energy conversion) project's starting point was to develop — in an efficient and cost-effective manner — solar panels capable of generating an electrical current to split water molecules into oxygen and hydrogen (hydrogen has been shown to be a viable form of solar fuel). While the concept is simple, the cost of water-splitting technologies has — until now — been too expensive to commercialise.

In response to this challenge, the COCHALPEC team found a way of making efficient, low-cost solar panels that are capable of directly producing solar hydrogen. The key to this solution was the adoption of so-called 2-D materials — sometimes referred to as single-layer materials — which consist of a single layer of atoms. Perhaps the best-known 2-D material is graphene, a single layer of graphite that, like other potential 2-D materials, offers extraordinary electronic properties.

Manufacturing the graphene required to cover an area large enough to harvest usable amounts of solar energy is not cheap. The team therefore developed a new cost-effective manufacturing method using tungsten diselenide. Recent research has suggested that this 2-D material offers conducting properties similar to graphene, and could have potential as an efficient material to convert solar energy directly into hydrogen fuel.

The project team next turned to finding a way of cost-effectively manufacturing these tungsten diselenide-based solar panels. This was achieved by mixing tungsten diselenide powder with a liquid solvent, which turned the material into thin 2-D flakes. These flakes were then spread evenly to produce a high-quality thin film, which was then transferred to a newly designed plastic support panel.

Final testing successfully demonstrated that this cost-effective method could achieve high solar-to-hydrogen conversion efficiency rates. Most promisingly, the team behind the innovation are confident that the new method can be scaled up to a commercial level.

The success of the project underlines the effectiveness of EU Marie-Curie IEF funding, which helps researchers willing to develop their career in Europe outside their home country. In addition to bringing key expertise together to work on a specific project — in this case the COCHALPEC project — the funding also enables European scientists to broaden their horizons and improve their career prospects.

COCHALPEC

- ★ Coordinated by the Swiss Federal Institute of Technology in Lausanne in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/news/rcn/123401_en.html

FIRST OF ITS KIND FUEL CELL TRI-GENERATOR PROMISES TO REDUCE ENERGY LOSS, COSTS AND EMISSIONS

TRISOFC coordinator Dr Mark Worall speaks about the project's unique fuel cell tri-generator which has the potential to increase the utilisation of available energy, reduce costs, add value, and decrease primary energy use and emissions.

Almost half of the world's primary energy consumption is in the form of electricity, heating and cooling. Most of this energy comes from centralised power stations where up to 70% of available energy is wasted. The inefficiency of this model is unacceptably high, leading to considerable CO₂ emissions and unnecessarily high running costs. These problems could be addressed if we moved from conventional centralised

power generation systems to efficient onsite micro-generation technology, and one promising possibility in this area is the solid oxide fuel cell (SOFC).

SOFC technology combines hydrogen and oxygen in an electro-chemical reaction to generate electricity, with the only by-products being water vapour, heat and a modest amount of carbon dioxide. Hydrogen can be supplied from hydrocarbon fuels such as natural gas, which

is widely available for domestic and public buildings. For three years, the TRISOFC (Durable Solid Oxide Fuel Cell Tri-generation System for Low Carbon Buildings) project team worked to advance this type of technology by developing a low-cost durable low temperature (LT) SOFC tri-generation (cooling, heating and power) prototype.

TRISOFC coordinator Dr Mark Worall from the University of Nottingham



© TRISOFC

provided more specific details on the outcomes of the project, which officially concluded at the end of July: 'The team designed, optimised and built an LT-SOFC tri-generation prototype, based on the integration of a novel LT-SOFC stack and a desiccant cooling unit.' Additional components of the system are a fuel processor to generate reformat gas and other equipment for the electrical, mechanical and control balance of plant (BoP).

TRISOFC unique features

The TRISOFC's system boasts a number of unique features that set it apart from anything that has been done before. In particular, the operating temperature of the TRISOFC system is between 500 and 600 degrees Celsius, in comparison with normal SOFCs of 800 to 1000 degrees Celsius. 'This is important,' Dr Worall notes, 'because it enables BoP and other temperature-dependent components to be manufactured from relatively low-cost materials, such as stainless steel, and so it has the potential to substantially reduce the cost of materials and components.' Additionally, the LT-SOFC is based on a single component nanocomposite material, the invention of a team led by Professor Binzhu Zhu of KTH, one of the consortium partners, which is unique in that it can act as an anode, a cathode and an electrolyte. Dr Worall adds, 'Again, this has the potential to reduce costs and complexity and increase reliability and durability.' Finally, the system has been

integrated with an open-cycle desiccant dehumidification and cooling system to provide heating, cooling and thermal storage. This has not been used before in fuel cells and has the advantage of potentially increasing the utilisation of the waste heat (currently 40% to 50% of total energy input is wasted).

Dr Worall notes, 'In our system, the waste heat from the SOFC is used to re-concentrate the solution. This is a form of thermal storage, which allows us to operate the fuel cell when we don't need cooling and use it when we do. Our system has three main advantages: firstly, it increases the conversion efficiency of the SOFC from 45% to 55% to potentially 85% to 95%; secondly, it reduces the demand for the electrical energy that would be needed to provide comfort cooling (and by reducing electrical energy use, we are also reducing primary energy consumption and carbon dioxide emissions); and thirdly, it reduces the cooling provided by vapour-compression refrigeration systems, which currently rely on working fluids that have a global warming potential (GWP) when released.'

Putting the LT-SOFC tri-generation system to the test

The team has successfully proved the concept of a LT-SOFC tri-generation system. Dr Worall draws attention to two particularly significant test results: 'Tests of two-cell 6 cm x 6 cm

LT-planar type SOFCs have shown power densities of up to 1100mW/cm² with a power output of 22W, at 530 degrees Celsius. Researchers are in the process of developing 200We stacks and we should be able to demonstrate large-scale, low-temperature electrical output.'

'Additionally, tests on the desiccant dehumidification system showed that a coefficient of performance (COP) of above 1.0 was achieved. COP is the ratio of the cooling output to the total energy input, and so represents a key performance parameter. In overall conversion terms, our heat-powered cooler is competitive with other systems.'

TRISOFC impact

Now that the concept has been proven, the next steps will be to prove long-term durability, scale up production and further reduce costs. Dr Worall and the team expect the system developed under TRISOFC to have a significant impact on a number of levels: 'This system is a first-of-its-kind fuel cell tri-generator and has great potential to increase the utilisation of the available energy, reduce costs, add value, reduce primary energy use and emissions and promote distributed energy production.'

One group that could feel the benefits the most is consumers, as Dr Worall explains: 'Most buildings use primary energy for heating, cooling and electricity, so by generating electricity at domestic level, consumers can potentially benefit from the sale of excess electricity production (depending on local energy costs, incentives and tariffs), and reduce demand for heat for the provision of hot water and heating, and the provision of electricity for cooling. As we are getting three for the price of one, consumers should benefit financially and in terms of reducing their impact on the environment.'

The team is confident that both as an integrated system and as individual components, the LT-SOFC tri-generation system has potential for commercialisation. 'We are actively engaged with industry and end users to develop user-friendly, reliable and economical systems and subsystems,' Dr Worall concludes.

TRISOFC

- ★ Coordinated by the University of Nottingham in the United Kingdom.
- ★ Funded under FP7-JTI.
- ★ http://cordis.europa.eu/news/rcn/123805_en.html
- ★ Project website: <https://triso.fc.wordpress.com/>

ENVIRONMENT AND SOCIETY

DISCOVERING UNTAPPED VALUE IN EUROPE'S FORESTS

EU-funded researchers with the STARTREE project recently showed a global gathering of ecologists how sustainably exploiting non-wood products can boost rural communities.

Non-wood forest products can help boost the economies of remote mountainous areas of Europe, maintain local traditions and preserve unique landscapes for generations to come. Exploitation of a variety of non-wood products also means that rural communities are less dependent on just one cash crop.

These key findings from the EU-funded STARTREE (Multipurpose trees and non-wood forest products, a challenge and opportunity) project were discussed at the recent annual International Association for Landscape Ecology (IALE) World Congress. STARTREE partners from the University of Padova, Italy, told the congress that products such as forest fruits, mushrooms,

nuts and essential oils present an untapped opportunity for many rural communities.

Since 40% of the EU's land-mass consists of forests, better use of their products and services has the potential to benefit both rural communi-

ties and forest-based businesses. The critical question is how to sustainably exploit this potential in a manner that produces both economic and ecological benefits.

The EU-funded STARTREE project began in November 2012 by providing a clear overview of all non-wood forest product resources at Europe's disposal. Until now, research into non-wood forest products has been fragmented and only implemented at the regional or country level.

STARTREE therefore sought to provide a truly European perspective for the first time and to make much more explicit the potential of these products. The project has focused on 14 European regions stretching from Portugal to Finland. In Alentejo, Portugal, for example, work has been carried out to

support forest management in the production of cork, pine nuts and mushrooms.

Building on the knowledge gained from the case studies and working throughout with forest owners, resource managers and other public/private entities, the STARTREE project has developed management and marketing strategies for specific non-wood products.

Another key element of the project has been to improve the commercialisation of non-wood products. Rural communities are often unaware of urban demands, and therefore miss potential new market openings. Identifying and servicing urban markets with new products can be economically beneficial, and can also lead to a greater appreciation among city dwellers of the value of sustainable rural communities. Diversification into non-wood products also means that the forestry sector and related business activities are better prepared to deal with economic crises that may hit the commercial value of a particular product.

In addition, a wealth of new information and spin-off projects has resulted from the project. Consortium partners from 12 countries met for the Sixth STARTREE General Assembly in May 2015 to discuss progress and exchange ideas, with interesting new discoveries on bees, bluebells, mushrooms, lichens and black cherries shared. New research into medicinal benefits, apps and label certification was also discussed.

The STARTREE project is due for completion in October 2016.

STARTREE

- ★ Coordinated by the European Forest Institute in Finland.
- ★ Funded under FP7-KBBE.
- ★ http://cordis.europa.eu/news/rcn/123566_en.html
- ★ Project website:
- ★ <http://star-tree.eu/>

NANOREM: EARLY RESULTS CONFIRM THE POTENTIAL OF NANOPARTICLES FOR SOIL AND WATER REMEDIATION

A team of EU scientists is investigating the use of nanoparticles to remediate polluted soil and water. The first phase, which consists of evaluating the toxicity of various candidates, is well under way and has already yielded encouraging results.

Despite its positive impact on quality of life, industrialisation has left many polluted sites in its wake. Every year EUR 6 billion is spent to manage these sites in Europe. In the meantime, the surface area of polluted soils is expected to increase by 50% by 2025 according to a report issued by the European Environment Agency in 2012. Additionally, the EU estimates that 20% of European water is seriously threatened by pollution.

Whereas most countries currently rely on 'pump and treat' and/or removal to landfill (*ex situ* techniques) to remediate polluted soil and water, the excavation of contaminated material can sometimes be undesirable or unfeasible. This is where *in situ* technologies — biological, chemical, physical and/or thermal processes to treat soil and/or groundwater at sub-surface level — come into play: they can be undertaken with minimal disruption in site operations, they minimise worker exposure and they have a much smaller footprint than *ex situ* methods.

Aiming to bring *in situ* techniques to the next level, the NANOREM (Taking Nanotechnological Remediation Processes from Lab Scale to End User

Applications for the Restoration of a Clean Environment) project trusts in the use of small particle size and high reactivity nanoparticles. Nano-scale zero valent iron (nZVI), for example, is expected to deliver a substantial improvement in remediation performance for a wide range of problems. The use of these nanoparticles, however, is limited due to uncertainties surrounding their environmental impact.

Encouraging results

The project has five core objectives, one of which is increased knowledge and confidence among stakeholders. To achieve this, the team has been measuring the toxicity of potentially interesting nanoparticles, assessing their ecotoxicity when in contact with soil and pollutants, measuring how this toxicity changes with time, and describing how they interact with indigenous microorganisms during and after remediation treatment.

Recently, the NANOREM team announced the initial results of ecotoxicological tests for a range of nanoparticles that could be good candidates for remediation projects: NanoFer 255, Carbo-Iron, Fe-Oxide,

Fe-Zeolites and Bionanomagnetite. The nanoparticles were tested on a range of organisms including earthworms, crustaceans, green algae and bacteria, and the team found no significant toxicological effects on any of them.

The team has also announced two other positive findings. First, while looking at how nanoparticles' reactivity and toxicity change with time, they confirmed that they actually become less reactive as they interact with soil matrices.

The team then investigated whether nanoparticles being used to treat pollutants were able to fully degrade them and not turn them into more toxic compounds — a widespread concern among stakeholders. Although this work is still under way, initial results seem to indicate no increase in pollutant toxicity even within a few metres of the injection wells shortly after the injection is performed. On the contrary, groundwater samples from one of the field sites were found to be highly toxic prior to injection of Fe-Oxide nanoparticles, but this toxicity was significantly reduced within three weeks following injection.

The project will continue until January 2017, when the team hopes to have low-cost production techniques ready for use in large-scale commercial applications. The next steps will be to pursue ecotoxicity testing, whilst the monitoring of injected field sites will continue for several months and assays on microbial functioning are scheduled for the second half of the project. The researchers are optimistic and consider the results obtained thus far as extremely promising.



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NANOREM

- ★ Coordinated by in Germany.
- ★ Funded under FP7-NMP.
- ★ http://cordis.europa.eu/news/rcn/123249_en.html
- ★ Project website: <http://www.nanorem.eu/>

IMPROVING EUROPE'S AIR QUALITY

An EU project has improved on measures of air pollution associated with transport, allowing a more in-depth understanding of its effects on human health.



A large part of air pollution is made up of particulate matter (PM), which is associated with a range of human health problems. Despite this, the tools and information needed to quantify airborne PM and its effects on the population are sorely lacking.

For this reason, the EU funded the TRANSPHORM (Transport-related Air Pollution and Health Impacts – Integrated Methodologies for Assessing Particulate Matter) project that looked specifically at airborne PM from urban traffic, road, shipping, rail and aviation sources. TRANSPHORM used targeted measurements in Thessaloniki (Greece), Rotterdam (the Netherlands) and Helsinki (Finland) to improve European air pollution policies.

The research team collected data on traffic activity and shipping emissions to model and develop new emission factors. This culminated in the development of baseline European emission inventories for the present (2005) and future (2020 and 2030).

Another model was also developed that accounts for the effect of buildings on particle size distribution and mass concentrations. Researchers integrated this model with a particle size-specific human respiratory tract model in order to estimate the accumulation of PM in human lungs.

Using all of the models created and data collected by the project, TRANSPHORM developed a way to estimate population exposure and human health impacts from airborne PM. This approach yielded a quantified health impact for various particles, including elemental carbon and benzo(a)pyrene.

Ultimately, TRANSPHORM efforts will support urban planning that encourages reduced emissions and better human health. The project results will also aid in the establishment of emission reduction targets for shipping and aviation.

“TRANSPHORM efforts will support urban planning that encourages reduced emissions and better human health.”

TRANSPHORM

- ★ Coordinated by the University of Hertfordshire in the United Kingdom.
- ★ Funded under FP7-ENVIRONMENT.
- ★ http://cordis.europa.eu/result/rcn/91403_en.html
- ★ Project website: <http://www.transphorm.eu/>

THE IMPACT OF FLOODING ON PLANT ROOTS

Scientists have investigated how the roots of crops respond to periods of flooding in order to ensure good harvests.

Plants can suffer from oxygen deprivation during flooding and the resulting drop in energy production can have a significant impact on crop production. Plants respond to oxygen deprivation in several ways, which involve changes in their form

and structure and alterations to gene expression and metabolism.

Although extensive research has been conducted into the mechanisms that enable plants to sense and respond to oxygen deprivation, they are still not well understood. However, it is known that oxygen deprivation in roots results in a significant increase in nitric oxide (NO). This small lipophilic free radical is synthesised in almost all organisms and acts as a signalling molecule.

Nitrate reductase and plant mitochondrial pathways are the most likely

sources for NO during hypoxia (oxygen deficiency). Furthermore, class 1 haemoglobins play an important role in scavenging NO levels during hypoxia. Therefore, the TRNOILOS (The role of nitric oxide in survival of low oxygen stress in plants) project was established to investigate how NO contributes to the regulation of plant metabolism.

Researchers investigated the role of NO in barley roots under aerobic conditions, comparing wild-type (WT) plants with plants that over expressed non-symbiotic haemoglobin 1 (Hb+). The work showed that NO is important

“It was revealed that nitrite reduction to NO protects mitochondrial structure and functionality in low-oxygen conditions.”

for the homeostasis of oxygen and reactive oxygen species (ROS) under aerobic conditions. This established a regulatory role for NO beyond that which was identified under hypoxic conditions.

Plants that have experienced a period of flooding must pass through a potentially damaging reoxygenation phase, during which levels of ROS can be raised. Project partners therefore studied the impact of NO produced under low-oxygen conditions on this process using seedlings from *Arabidopsis*, a model organism.

Results indicated that NO generated under transient hypoxic conditions protects plants during the subsequent reoxygenation phase through antioxidant mechanisms. In addition, an investigation into the impact of mitochondrial NO production on mitochondria under hypoxia

was carried out. It revealed that nitrite reduction to NO protects mitochondrial structure and functionality in low-oxygen conditions.

The TRNOILOS project successfully provided new insights into the regulatory role of NO in aerobic and hypoxic plant metabolism. Growing evidence for the protective role of NO suggests that it may be possible to protect crops using the controlled release of nitrite or NO into affected plant tissue.

TRNOILOS

- ★ Coordinated by the University of Oxford in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169467_en.html



WHY TRANSFERRING SUSTAINABLE TRANSPORT IDEAS IS A WINNING CONCEPT

The award-winning TIDE project has brought cities and regions together in order to share sustainable mobility solutions.

The EU-funded TIDE project, which aims to introduce cities to new sustainable transport technologies, recently won the 2015 European Platform on Mobility Management Award for best international policy transfer. Special recognition was given to the towns of Groningen, the Netherlands, and Donostia/San Sebastian, Spain, for their cooperation in promoting parking for cyclists.

“The project consortium hopes that local authorities and urban transport professionals will continue to access the toolbox and think seriously about adopting sustainable transport technologies.”

While Donostia/San Sebastian has a growing cycling culture, the city has suffered for years from a lack of parking infrastructure. Residents have been forced to leave their bikes on the street, generating clutter and reducing space in the tightly congested old town.

The TIDE (Transport innovation deployment for Europe) project was able to identify Groningen as an example of good practice in this respect, and set about arranging a transfer of ideas. Meetings between the two towns were organised, with city officials from Donostia/San

Sebastian visiting Groningen and participating in training sessions.

This is one example of how the three-year project, due for completion in September 2015, has helped to transform urban transport through the sharing of best practices and technologies. The project began in 2012 by selecting mobility concepts deemed most promising, and then set about developing and publishing implementation guidelines and a transferability methodology.

The project then issued an open call for proposals, which led to the selection of 10 cities interested in developing some of these innovations. TIDE researchers advised the cities about costs and benefits as well as impact issues. Roadmaps for these cities have now been prepared, while 50 more cities will receive training in the use of TIDE methodologies.

Reading in the UK is the TIDE project's leading city when it comes to advanced network and traffic management to support traveller information. Reading Borough Council launched a two-week challenge to find app developers interested in creating travel apps that would allow people living in and around the borough to get instant travel and transport information on their phones. The winning entry was a local team who came up with a concept that provides information tailored to individual needs and interests.

In order to ensure that TIDE achieves a sustainable impact long after it is completed, an innovation toolbox containing 15 transport measures has been developed. The project consortium hopes that local authorities and urban transport professionals will continue to access the toolbox and think seriously about adopting sustainable transport technologies.

The toolbox is organised into five themes: financial models, non-motorised transportation, network management, electric vehicles and public transportation organisation. The project has also refined existing transfer methodologies and integrated them into a handbook.

The TIDE consortium consists of 14 partners from nine countries. Moreover, through the member cities and regions of two partner organisations — Polis and EUROCITIES — the project has been able to cover not only the EU but also several accession and neighbouring countries as well. Each partner is an expert or leader in innovative urban mobility policy.

TIDE

- ★ Coordinated by POLIS in Belgium.
- ★ Funded under FP7-TRANSPORT.
- ★ http://cordis.europa.eu/news/rcn/123524_en.html
- ★ Project website: <http://www.tide-innovation.eu>

IT AND TELECOMMUNICATIONS

TECHNOLOGY THAT LEAPS OUT OF THE SCREEN

Exciting new technologies, which allow users to change the shape of displays with their hands, promise to revolutionise the way we interact with smartphones, laptops and computers. Imagine pulling objects and data out of the screen and playing with these in mid-air.

Today we live in a world of flat-screen displays, which we use all day — whether it's the computer in the office, a smartphone on the train home, the TV or iPad on the couch in the evening. The world we live in is not flat though; it's made of hills and valleys, people and objects. Imagine if we could use our fingertips to manipulate the display and drag features out of it into our 3D world.

Such a vision led to the launch in January 2013 of GHOST (Generic, Highly-Organic Shape-Changing Interfaces), an EU-supported research project designed to tap humans' ability to reason about and manipulate physical objects through the interfaces of computers and mobile devices.

'This will have all sorts of implications for the future, from everyday interaction with mobile phones to learning with computers and design work,' explained GHOST coordinator Professor Kasper Hornbæk of the University of Copenhagen. 'It's not only about deforming the shape of the screen, but also the digital object you want to manipulate, maybe even in mid-air. Through ultrasound levitation technology, for example, we can project the display out of the flat screen. And thanks to deformable screens we can plunge our fingers into it.'

Shape-changing displays you can touch and feel

This breakthrough in user interaction with technology allows us to handle objects, and even data, in a completely new way. A surgeon, for instance, will be able to work on a virtual brain physically, with the full tactile experience, before performing a real-life operation. Designers and artists using physical proxies such as clay can mould and remould objects and store them in the computer as they work. GHOST researchers are also working with deformable interfaces such as pads and sponges for musicians to flex to control timbre, speed and other parameters in electronic music.

Indeed, GHOST has produced an assembly line of prototypes to showcase shape-changing applications. 'Emerge' is one that allows data in bar charts to be pulled out of the screen using one's fingertips. The information, whether it's election results or rainfall patterns, can then be re-ordered and broken down by column, row or individually, in order to better visualise it. The researchers have also been working with 'morphes', flexible mobile devices with lycra or alloy displays which bend and stretch according to use. These can change shape automatically, for example, to form screens to shield your fingers when you type in a pin-code or to move the display to the twists and turns of

a game. And such devices can be enlarged in the hand to examine data closer and shrunk again for storing away in a case or pocket.

Tactile technology reaching the market

One of the GHOST partners, the University of Bristol, has spun off a startup, now employing 12 people, called UltraHaptics, to develop technology being studied in GHOST that uses ultrasound to create feeling in mid-air. The company has attracted seed investment in the UK and

further funding from the Horizon 2020 programme.

'GHOST has made a lot of progress simply by bringing the partners together and allowing us to share our discoveries,' commented Prof Hornbæk. 'Displays which change shape as you are using them are probably only five years off now. If you want your smartphone to project the landscape of a terrain 20 or 30 cm out of the display, that's a little further off — but we're working on it!'

GHOST, which finishes at the end of this year, involves four partners in the

United Kingdom, Netherlands and Denmark, and is receiving EUR 1.93 million from the EU's Future and Emerging Technologies programme.

GHOST

- ★ Coordinated by the University of Copenhagen in Denmark.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/result/rcn/167038_en.html
- ★ Project website: <http://www.ghost-fet.com/>
- ★ <http://bit.ly/1LOxrGE>

STRANDS' COMPANION ROBOT FEATURED ON GADGET MAN TV SERIES

Airing on the UK's Channel 4, Gadget Man's fourth season features TV presenter Richard Ayoade showcasing new technologies designed to make our lives easier. In June, the show featured a companion robot named Linda which was developed under the STRANDS project.

'My final, personal, "pièce de résistance" is Linda, an intelligent robot programmed to autonomously patrol the house and make sure no one tries to jack my shiz,' Ayoade explains as the robot enters the screen in his fictional, security gadget testing 'crib'.

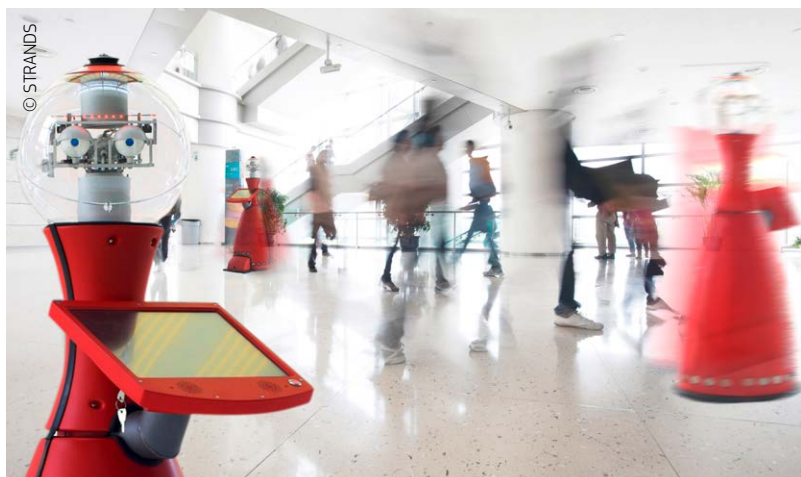
Thanks to its laser scanner, Linda can move around while building up a map of her environment, identifying intruders and supporting security staff in their duties. She can run autonomously for weeks, gather data about her surroundings and adapt her behaviour accordingly.

Last year, Linda was tested at the Natural History Museum of London where she was tasked with guiding visitors to exhibitions on the occasion of European Robotics Week. 'We are trying to enable robots to learn from their long-term experience and their perception of how the environment unfolds in time. It will have many possible applications and taking Linda to the Natural History Museum is a fantastic opportunity for people to see how robots like this will, one day, be able to aid and assist humans in a variety of roles,' Dr Marc Hanheide from the University of Lincoln had explained at the time.

Linda is one of six robots developed by the STRANDS (Spatio-Temporal Representations and Activities For Cognitive Control in Long-Term Scenarios) team that also includes Bob, Henry, Karl, Werner and Lucie. Where state-of-the-art robots would generally read spatio-temporal dynamics as anomalous readings, piling up errors that eventually prevent them from running more than a few hours, Linda and co are expected to be able to run for at least 120 hours by the end of the project, while being capable of adapting to highly demanding, real-world security and care scenarios.

While STRANDS is only due for completion in May 2017, its robots have already been tested in various situations. Bob, for instance, has been enrolled for three weeks by G4S — the leading global integrated security company — to patrol a working office environment.

The latest project achievement was the publication of a research paper in March 2015. In the document, the team proposes a probabilistic sequential model of Human-Robot



Spatial Interaction (HRSI) relying on a Qualitative Trajectory Calculus (QTC) embedding the concept of proxemics to facilitate richer models.

'For mobile robots to be used in populated environments, they have to understand how humans behave and be able to move when encountering each other in a corridor for example. In such situations, the robot's movement not only has to be safe but the robot has to be able to convey its intention on where and how to move, how to react to the human's movements, and how the human will react to it. Current research mainly focuses on how the robot has to avoid a human, but not on how their movement might influence each other,' lead author Christian Dondrup of Lincoln's School of Computer Science explained.

STRANDS

- ★ Coordinated by the University of Birmingham in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/news/rcn/123241_en.html
- ★ Project website: <http://strands.acin.tuwien.ac.at/>
- ★ <http://bit.ly/1K79SLV>

A SOCIAL NETWORK FOR ONLINE MUSIC LEARNING

Community feedback and advanced analytics combined with lesson planning and monitoring tools for teachers make this social learning platform, PRAISE, a step forward in collaborative online learning.



© PRAISE

‘Feedback is essential for learning,’ says Carles Sierra, Research Professor at the Spanish National Research Council and coordinator of the PRAISE (Practice and performance Analysis Inspiring Social Education) project. The project aims at filling a gap in online learning by creating a social network for music education with tools for giving and receiving feedback.

Using PRAISE’s Music Circle platform, music students can upload recordings of their playing and receive detailed feedback from other members of the community. Advanced tools let reviewers place their comments as annotations at exactly the right place in the audio signal representation.

‘Students’ peers can say “this crescendo is very nice” or “this passage is very expressive,”’ explains Professor Sierra. ‘This timeline of structured comments and this level of granularity have been lacking in online approaches to giving feedback on music.’

A social network of learners

As PRAISE is a web-based social media platform, a single comment can spawn multiple comments. These discussion threads help to create a community of people giving and receiving feedback that becomes a social network of learners.

Aside from human feedback, PRAISE’s sophisticated tools also provide automatic

feedback. Students can play a particular piece, for example, and the software will tell the student whether they played the right notes at the right time. Moreover, if the student submits a new recording, areas of improvement or retrogression are similarly flagged.

A teaching tool with marks generation

PRAISE is actually more than just a platform for giving and receiving feedback. Its tools also allow music teachers to create lesson plans and track their students’ progress online.

In addition, PRAISE tackles a problem faced by many Massive Open Online Courses (MOOC). Since it’s physically impossible for a single teacher to mark the thousands or tens of thousands of students who may follow an online offering, many MOOCs rely on peer assessment. This approach is unsatisfactory, however, because students may not give marks in the same way that the teacher would give them.

To solve this problem, a teacher marks just a few students while students each mark several of their peers. PRAISE then uses an algorithm to identify the student assessments that most closely resemble those made by the teacher and these are given more weight. In this way, the teacher’s approach to giving marks ripples throughout the community of students.

‘With MOOCs, marks typically reflect an average of what students think of each other,’ says Professor Sierra. ‘We instead compute a trust network that emphasises the views of the teacher.’

A crescendo of activity

PRAISE’s Music Circle platform has already been used by over 20000 students who finished a course in jazz piano on Coursera and it is being used by about 150 music students at Goldsmiths College of the University of London and several more at ESMUC in Barcelona.

‘One of the advantages of Music Circle is zero cost. Paying a tutor is astronomically expensive,’ notes Professor Sierra.

The project’s tools have also been applied to other domains such as to English learning.

“Students can play a particular piece, for example, and the software will tell the student whether they played the right notes at the right time.”

PRAISE involves researchers from Institut d’Investigació en Intel·ligència Artificial in Barcelona, Goldsmiths College of the University of London, the Vrije Universiteit Brussel and Sony’s Computer Science Lab in Paris. Part of what makes the project unique and has made the collaboration so fruitful is that PRAISE’s researchers share not only a strong interest in artificial intelligence, but also a love of music. Many of PRAISE’s researchers are gifted musicians in their own right.

PRAISE received EUR 2.3 million in EU funding and ran from 2013 to 2015.

PRAISE

- ★ Coordinated by the National Research Council in Spain.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/result/rcn/166239_en.html
- ★ Project website: <http://www.iiia.csic.es/praise/>
- ★ <http://bit.ly/1MaHv65>

ANTICIPATING THE MOBILE TRAFFIC BOOM

Mobile data traffic is expected to grow a hundred- or thousand-fold by 2020, when the new 5G telecom standards are due to enter the market. As the race is on to come up with new solutions for telecom networks to accommodate this massive growth, one EU research project has already developed an ultra-fast solution using optical transmission technology.

LIGHTNESS (Low latency and high throughput dynamic network infrastructures for high performance datacentre interconnects), an industry-driven EU research project that started back in 2012, was set up to strengthen European technology for connecting data centres and anticipate the growing traffic between them. It is doing this by harnessing the improved power, speed and cost-efficiency of optical (over electrical) transmission.

'The infrastructure we develop must scale upwards for 5G in a way that current grouped Ethernet switches won't be able to,' explained Matteo Biancani of Interoute, the telecoms and cloud services provider leading the project. 'Scalability of the project is really the key word if we are to meet increased future demand.'

Data transmission at the speed of light

Even today's 4G and 3G networks are seeing great demand for high data throughput and fast response times, due to the increasing use of high-performance computing, as well as cloud and server-side storage applications. This makes the work of the LIGHTNESS project immediately relevant, in addition to anticipating the advent of 5G technologies.

The main aim of LIGHTNESS has been to design innovative photonic switching and transmission techniques to establish high-performance, low-cost interconnects between and inside data centres. Specifically, universities and research facilities participating in the project in the UK, the Netherlands and Spain, have trialled Optical Circuit Switching (OCS) and Optical Packet Switching (OPS) in special test beds. The test beds simulate intra-data centre network environments and test the technology to see if it can fulfil the requirements of emerging applications in terms of ultra-high bandwidth and low network latency.

With scalability in mind, they have carried out a lot of studies and simulations to evaluate the benefits of LIGHTNESS

architecture in very large deployments, using more than 100 different wavelength channels at the same time, resulting in bandwidth capacities of multiple terabits/

second per fibre link. The use of OCS and OPS technologies together forms the most promising solution to switching huge data flows, literally at the speed of light.

Rates of 40 to 100 gigabits per second

In the test beds, the LIGHTNESS researchers developed an Optical Packet Switch (OPS), which indeed does provide the nanosecond latency that networks will need to respond to

the demands of mobile users in the future. They have also trialled a 'Top-of-Rack (ToR)' switch, used for linking racks of storage equipment to the OPS/OCS data centre network, aggregating traffic in both long-lived and short-lived data flows. LIGHTNESS has successfully tested these operations at speeds that have never before been seen in networks, ranging between 40 and 100 gigabits per second.

Deployment in data centre networks by 2018

Preliminary prototypes from the project were showcased at the European Conference on Networks and Communications in Paris last year, where LIGHTNESS won the Best Booth Award in demonstrating its new software-defined Optical Data Centre Network (ODCN).

'The full implementation of the LIGHTNESS hardware and software prototypes is now ready and is under experimental evaluation and validation in the project testbed. We are building equipment for deployment in our data centre networks and production will peak in two to three years' time,' said Matteo.

LIGHTNESS is a Specific Targeted Research Project receiving EUR 2.44 million investment from the EU's 7th Framework Programme. It involves seven partners in Italy, the Netherlands, Spain and the United Kingdom, and ends in October this year.

LIGHTNESS

- ★ Coordinated by Interoute in Italy.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/result/rcn/167059_en.html
- ★ Project website: <http://www.ict-lightness.eu/>

"We are building equipment for deployment in our data centre networks and production will peak in two to three years' time."



MONT-BLANC SUCCESSFULLY TESTS ITS SOFTWARE ON HIGH-PERFORMANCE ARM-BASED SERVERS

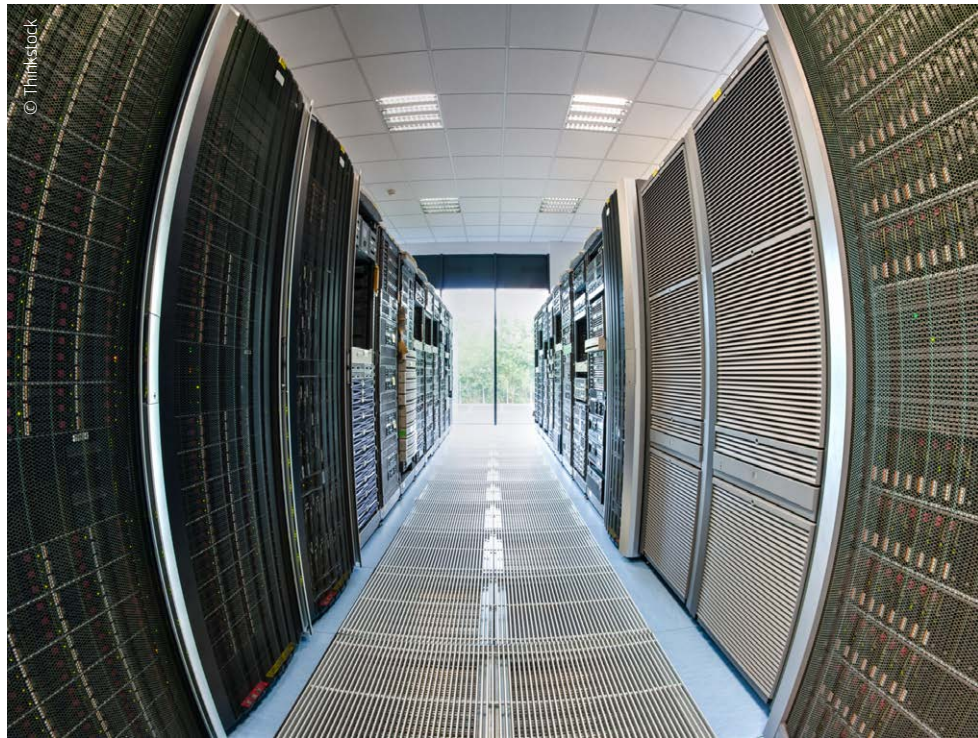
The MONT-BLANC team has taken another key step in their quest for low consumption Exascale systems, by proving the portability of their software stack on new high-performance ARM-based server platforms.

This new success comes a little over a month after the MONT-BLANC (Mont-Blanc, European scalable and power-efficient HPC platform based on low-power embedded technology) prototype was successfully deployed by the Barcelona Supercomputing Center (BSC). The tests were run by BSC with support from E4 Computer Engineering, which has already helped the project to develop its first prototype of ARM+GPU cluster.

'We have been following with interest the activity of E4 in developing ARM-based platforms since the early days,' explained Filippo Mantovani, technical coordinator of the MONT-BLANC project and senior researcher at BSC. 'We wanted to show that our HPC system software is also able to run on standard production machines and not only in the MONT-BLANC prototypes, and we finally managed it.'

While Mantovani says that the team can still extract a significant amount of information from the server prototype it developed, exploring performance with commercially available ARM 64-bit platforms is a must if MONT-BLANC is to achieve its core aim of setting future global HPC standards based on energy-efficient solutions already used in embedded and mobile devices. These platforms are available to both the server and mobile markets. The latest smartphones now come equipped with ARMv8 64-bit processors and their host of speed improvements, and there is little doubt that these will quickly take over the market.

The MONT-BLANC project builds on the observation that current high-performance computing (HPC) challenges related to energy consumption can be solved by learning from energy-efficient ARM processors powering our mobile devices. While ARM processors were not originally designed for HPC, Mantovani and his team believe that a unified software support for all available ARM



platforms would make the technology more widely accepted on the server market. Making this a reality is one of MONT-BLANC's main objectives.

According to E4, the ThunderX ARMv8 SoCs are good candidates for a potential success among server market players. Its 48 custom cores are uniquely suited to drive performance for operations as demanding as data processing of CERN's Large Hadron Collider, and combining these with MONT-BLANC's software stacks provided both companies with precious information about memory bandwidth, floating point performance and energy efficiency. The benchmarks showed 'extremely satisfactory results and perfect stability' in the new architecture.

Originally planned to run from 2011 to 2015, MONT-BLANC benefitted from a parallel three-year extension under the MONT-BLANC 2 project to pursue efforts on its system software stack, define its Exascale architecture, track evolution of ARM-based

"According to E4, the ThunderX ARMv8 SoCs are good candidates for a potential success among server market players."

systems and keep supporting both the operations of the MONT-BLANC prototype and application developers. A third project, MONT-BLANC 3, has already been granted EU support under Horizon 2020.

MONT-BLANC

- ★ Coordinated by in Spain.
- ★ Funded under FP7-ICT.
- ★ http://cordis.europa.eu/news/rcn/123644_en.html
- ★ Project website: <http://www.montblanc-project.eu/>
- ★ <http://bit.ly/1Q0FGqe>

H2020 RESEARCHERS ANNOUNCE ANOTHER 5G BREAKTHROUGH

The POINT project successfully demonstrated the first IP-over-ICN-over-SDN implementation – a new architecture that promises a more content-centric approach for the future Internet.

This breakthrough is very exciting for us. In just six months we have developed a truly unique demonstration which is able to use standard IP end-points and translate the IP flow into an IP-over-ICN abstraction (publish/subscribe model), where a single hop within the ICN network used SDN switches with pre-installed forwarding rules for the ICN flows,' says Dirk Trossen, Principal Scientist at InterDigital and POINT's Technical Manager. The POINT (iP Over ICN - the betTer ip) project kicked off in January 2015 and is supported by the EU to the tune of EUR 3.5 million.

ICN, which stands for Information Centric Network, has been the focus of many research teams since 2006 for its potential to replace the IP-based Internet as we know it. ICN notably allows for content to be fetched from multiple servers and caches, for savings in the synchronous and quasi-synchronous delivery of popular content, for securing the content rather than the endpoint, and for allowing operators to apply traffic engineering rules.

However, the requirements of such a switch — including heavy standardisation, strong stakeholder support and the fact that viable methods to create a truly scalable internetworking of individual ICN highlands has not yet been found — have cast doubt on its feasibility.

The best of both worlds

To overcome this obstacle, POINT tries another approach. Instead of seeking to replace Internet Protocol (IP)-based networks, the project aims to harness the innovation potential of IP-based applications and solutions, while benefitting from specific ICN solutions in terms of their potential for better performance compared to their IP-based counterparts. At its core is the fundamental question: is an IP-over-ICN system a better solution for IP-based services than pure IP-based networks?

A customer use case in the project's presentation flyer helps to illustrate the POINT approach: John, a London

priest wanting to reach out to older parishioners whose health doesn't allow them to attend services in person, would like to set up a live video streaming service to fulfil this need. Unfortunately his bandwidth is not high enough, and paid streaming services are too expensive. He reluctantly chooses to use YouTube despite his fear of losing his content rights and sends over the data, thereby enabling a high number of users to view the video simultaneously. With the POINT software, John could have created a unicast stream received by users as a multicast stream, meaning he wouldn't have to worry about his bandwidth anymore, and could do without both paid and free streaming services.

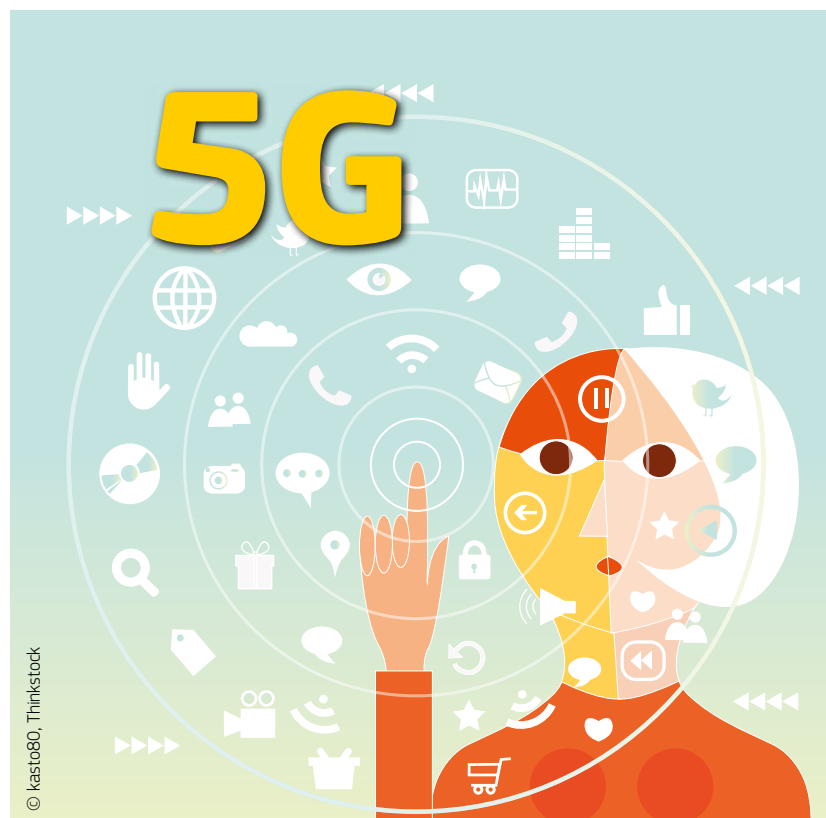
While the project still has much to do to prove that IP-over-ICN surpasses IP-based networks, the demonstration made in July at the Rhine-Westphalia Institute of Technology in Aachen is already a great achievement. Thanks to Blackadder, an ICN core implementation developed by the award-winning,

FP7-funded PURSUIT project, participants were able to connect to a Network Attachment Point (NAP) — a system performing the IP-to-ICN translation via an IP-over-ICN abstraction and offering standard IP access via Ethernet (server) and Wi-Fi (clients) — via Wi-Fi using devices like smartphones, tablets and laptops.

POINT will end in January 2018, a couple of years before the expected launch of 5G services in Europe. By then, the team intends to perform a large-scale trial of its IP-over-ICN model on an operational network in Cyprus.

POINT

- ★ Coordinated by the Aalto University in Finland.
- ★ Funded under H2020 Future Internet.
- ★ http://cordis.europa.eu/news/rcn/123613_en.html
- ★ Project website: <http://www.point-h2020.eu>



INDUSTRIAL TECHNOLOGIES

START-UP IDENTIFIES MARKET POTENTIAL FOR FLEXIBLE PRINTED ELECTRONICS

EU funding has enabled a Portuguese start-up to better position itself to take full advantage of the coming flexible printed electronics revolution.

EU funding has enabled Portuguese printed electronics start-up Ynvisible to fully assess the potential of applying flexible printed electronics to consumer objects. The six-month feasibility study completed at the beginning of August 2015 involved carrying out tests on the new platform — called PRINTOO (Flexible, thin, printed electronics prototyping kit) — which enabled the company to better understand the needs of various end users.

‘The study enabled us to take the time and effort to better understand our clients, and identify who they are and how best to address their needs,’ explains Manuel Câmara, new product manager at Ynvisible.

One key potential end-user segment has been identified as education and learning. Schools have expressed interest in printed electronics as a tool to develop creativity and do-it-yourself technical skills in students at different levels.

‘Thanks to our market research, we intend to create products that fit the needs of the educational sector,’ says Câmara. ‘Schools and universities around the world yearn for new tools that will allow their students to learn while creating and exploring new ideas.’

Another potential untapped market segment is health. Ynvisible recently partnered

with another innovative tech company, BITalino, to develop a smart wearable device that enables users to track various measurements such as body temperature and heart rate. BITalino is revolutionising DIY health tracking by making physiological sensors capable of measuring the body’s bio-signals accessible to all.

‘We’re now considering whether PRINTOO should be spun off its original company,’ adds Câmara. ‘We know much more about our business, our market and our clients.’

Following completion of the feasibility study, Ynvisible’s next priority is to bring its range of flexible printed electronics to market. Each printable PRINTOO component contains at its core a high performance, low power microcontroller — basically a tiny computer fitted onto a single integrated circuit board — below which is a list of various modules that customers may choose from to suit their needs.

Businesses can apply these very thin electronic ‘labels’ to items — anything from balloons and clothing to 3D printed objects, making them intelligent and interactive.

This is the essence of the Internet of Things (IoT), where objects, animals and people are provided with unique identifiers

and are able to transfer data over a network without requiring computer interaction. By adding internet capabilities to their products, businesses can enable end users to control their devices remotely via apps on their smartphone. The unique selling point of PRINTOO is that the modular printable electronics being developed are flexible and very affordable, opening up a whole new range of potential users.

‘Since all board designs are open-source, you can change them up and customise them to your needs, just like other modular building kits, with the addition of having printable, completely flexible components at your disposal,’ says Câmara. ‘We intend to push the boundaries of innovation by bringing to market new flexible print technologies that have not previously been available.’

PRINTOO

- ★ Coordinated by Ynvisible in Portugal.
- ★ Funded under H2020 SME Instrument.
- ★ http://cordis.europa.eu/news/rcn/123746_en.html
- ★ Project website: <http://www.printoo.pt/>
- ★ <http://bit.ly/1K7yYua>

SMART WELDING CLAMP DESIGN

Clamping is a critical first assembly step in welding and plays a critical role in the quality of the final part. An automated decision-support system (DSS) for intelligent welding clamp design will make sure small and medium-sized enterprises (SMEs) achieve high-precision assembly.

The very high temperatures and forces during welding can cause deformation and distortion of the work piece. This in turn leads to increased manufacturing costs, material waste and lost time that puts increasing pressure on SMEs in the welding business. At the same time, the drive to create custom clamping devices that cannot be adapted to other assembly tasks supports the need for faster and better clamping assembly design.

“CLAMPIT’s DSS enables SMEs to automatically choose the optimal clamping design and process parameters for welding a new workpiece.”

With the support of EU funding, the CLAMPIT

(Intelligent Welding Clamp Design Software Using Computer-Aided Optimisation For SMEs To Achieve High Precision Assembly) project developed a high-end DSS to automate clamping design calculations. The system exploits computer-aided design to determine the optimal distribution of clamping points and clamping forces for a given weldment configuration. Further, it includes a fast and efficient distortion prediction module incorporating low-stress, no-distortion technology.

The newly customised clamping fixture can be saved in the knowledge base, helping the system to learn with each iteration. Two project videos highlight the technology and the website hosts a number of documents for download, including leaflets, newsletters, posters and press releases.

CLAMPIT’s DSS enables SMEs to automatically choose the optimal clamping design and process parameters for welding a new workpiece. By simulating predicted distortion before welding, CLAMPIT will help SMEs cut costs and time while increasing the performance of their welding fixtures and product quality, putting EU metal-working SMEs back in the driver’s seat.

CLAMPIT

- ★ Coordinated in Hungary.
- ★ Funded under FP7-SME.
- ★ http://cordis.europa.eu/result/rcn/151403_en.html
- ★ Project website: <http://clampit.eu>
- ★ <http://bit.ly/1K7zrMM>

ADAPTIVE SYSTEM FOR REPAIR AND MANUFACTURING

An EU-funded project developed an automated laser cladding system with variable spot sizes that is particularly suitable for advanced repair and coating applications.

An often unsung hero, laser cladding has been saving damaged parts from the salvage yard and fortifying new components. A laser beam melts the material on the workpiece surface and the powder nozzle moves over the workpiece surface to deposit single tracks or complete layers. Lack of control over this process can raise temperatures leading to damage of the laser-cladded piece.

Currently, processing a cladding track with complex geometry requires programming of several paths. The ALAS (Adaptive laser cladding system with variable spot sizes) project developed a new fully automated user-friendly adaptive solution that adjusts the track width.

The ALAS prototype includes a modular cladding head with a zoom module that can be adapted to different parts such as fibre connectors, collimators and beam splitters. Thanks to track width variation, the head can adapt to complex geometries, eliminating human intervention.

A real-time monitoring system based on a coaxial machine-vision system controls heat accumulation in the part to be processed. A closed-loop control system modifies the laser beam power according to the melt pool width that is measured using a camera based on CMOS (complementary metal-oxide semiconductor) image sensors.

Another important element of the ALAS concept is a high-level control system (HLCS) that enables setting important parameters in the ALAS optical system and controller. These are the track width at every position of the tool path, the laser process speed, the optical system positioning and the required laser power at different positions. The HLCS interpolates laser beam widths at any point of a tool path and sends the time-based table to the field-programmable gate array controller.

ALAS should lead to significant advances in several areas of the materials processing field, especially in repairing complex geometries and re-manufacturing or fabricating complex 3D structures. Repairing metal components for power generation, industrial equipment, transport, petrochemical and aerospace industries are some of



the potential applications benefitting from the newly developed laser cladding system. A project video is available online.

ALAS

- ★ Coordinated by in Spain.
- ★ Funded under FP7-SME.
- ★ http://cordis.europa.eu/result/rcn/150937_en.html
- ★ Project website: <http://www.alasproject.eu>
- ★ <http://bit.ly/1EUKld1>

NEW COLLISION AVOIDANCE SYSTEM PROMISES TO INCREASE MINING SAFETY

A novel Collision Avoidance System (CAS) will be made available to mine operators and machine producers within the next one to two years. The system, which is more reliable and effective than existing technologies, will help industry cope with more stringent regulations.



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Mining sites are considered to be some of the most dangerous workplaces in the world. The operation of large machines with limited visibility poses a constant threat to both miners and their machines, to the point where, in the USA, it is responsible for 22% of all coal mining-related fatalities. Industry and government officials increasingly agree that CAS could help curb this trend, and some legislative changes are already paving the way for their wider adoption in the US, India and South Africa.

To help the sector comply with upcoming regulations, the FEATUREFACE project has developed a new concept of CAS that uses various technologies to exceed the accuracy and reliability of available systems. This initiative was funded under the European Commission's Research Fund for Coal and Steel (RFCS).

'The emergence of new legal regulations concerning mining safety has made it clear that this is an area which will play an important part in mechatronics development in the future,' project leader Dr Clemens Hesch recalls about the decision to go ahead with the project. 'So with our expertise in signal processing we developed the necessary algorithms and technologies to enable safe working conditions in noisy environments.'

The FEATUREFACE technology builds on current CAS — which are mainly based on electro-magnetism — by coupling them with sensors utilising the different propagation speeds of radio signals and sound to precisely determine the position of obstacles. Tests performed on actual machines have demonstrated the accuracy and reliability of the concept, enabling miners to be precisely located in the vicinity of a machine. When a miner approaches in

an unsafe manner, the machine shuts down immediately.

'The potentially hazardous mining machine emits audible sound signals over a number of loudspeakers and a radio trigger signal. A small microphone placed on the miner's helmet detects these signals, calculates the run time (which is proportional to the distance) from the various loudspeakers and gets a precise overview of the position of all workers,' Dr Hesch explains. The prototype can provide a 2D-localisation of miners within a range of 10 m with an accuracy of 10 cm, as well as determine a miner's distance within a range of 50 m.

Making this work in a real-life scenario was undoubtedly the most difficult part of the process, as the high level of background noise found in mines and the movement of the involved parties — which causes Doppler shifts — can render the signals illegible. LCM, one of the project partners, was able to overcome this issue with special signal-processing algorithms which even allow the level of the measurement signals to be under that of ambient noise.

The next step for the FEATUREFACE consortium will be to obtain the ATEX certification required for operation in coal mines along with various safety certificates. Thanks to the diversity of consortium partners, including sensor developers, producers of mining machines and operators of mines, commercialisation is virtually guaranteed: Dr Hesch says mining machine manufacturers will include the final system exclusively in their machines within the next one to two years.

FEATUREFACE

- ★ Coordinated by RWTH Aachen, IMR in Germany.
- ★ Funded under the Research Fund for Coal and Steel.
- ★ http://cordis.europa.eu/news/rcn/123845_en.html
- ★ Project website: http://www.imr.rwth-aachen.de/index.php/featureface_en.html

MULTISCALE MODELS OF NANOCOMPOSITES

To realise the full potential of polymer nanocomposites, researchers need to relate microscopic, mesoscopic and macroscopic properties and processing parameters to product function. Novel multiscale simulation software will address this urgent need.

Nanofilled polymer matrix composites are replacing conventional polymers in many industries because they can offer tailor-made functionality. A consortium of Russian and European research groups developed simulation software to speed development with EU funding of the COMPANOCOMP (Multiscale computational approach to the design of polymer-matrix nanocomposites) project.

Scientists developed and validated the methodology and software against two main categories of systems: soft silica-filled natural and synthetic rubbers (thermoplastic elastomers) and carbon nanotube (CNT)-filled thermoset resins.

To understand the effects of reinforcement of polymer-matrix nanocomposites by filler particles, the team integrated three interconnected levels of representation with a special focus on silica-filled natural-rubber 'green tyre' materials. The first level was a detailed atomistic representation of both polymer chains and nanoparticles. Their behaviour was tracked with molecular dynamics. The intermediate scale modelled the polymers as freely-jointed chains and the nanoparticles as single spheres using Field Theory-inspired Monte Carlo.

The coarsest level represented the polymer in terms of chain ends, crosslink, entanglement, adsorption and grafting points using coarse-grained Brownian dynamics coupled with kinetic Monte Carlo simulations. They also developed a method to estimate the rates of adsorption and desorption of end-constrained chains (by cross-links or entanglements) from a polymer melt onto a solid substrate for use in the coarse representation.

Another approach modelled elastic and dissipative properties of reinforced elastomers. Comparisons to experimental data showed very good qualitative agreement.

A multiscale strategy, which combines on-the-fly mapping/reverse mapping schemes, the network building procedure based on reactive dissipative particle dynamics and the fully atomistic molecular dynamics, was used to simulate highly cross-linked epoxy resins filled with both single-wall and multiwall CNTs. These simulations elucidated important properties of the CNT-epoxy systems as well as their relationships to processing parameters.

Through simulation work supported by experimental optimisation, the team produced nanofilled matrices, using CNTs for aerospace applications and silica for wind energy applications. They enhanced the performance of carbon fibre-reinforced composites.

COMPANOCOMP multiscale models of nanofilled thermoplastic and thermoset polymers promise to speed development of high-performance tailored nanocomposites for many industries including transport and energy. Training workshops and research exchanges organised to impart knowledge about the software to students and researchers will enhance uptake and maximise impact.

COMPANOCOMP

- ★ Coordinated by in the Netherlands.
- ★ Funded under FP7-NMP.
- ★ http://cordis.europa.eu/result/rcn/147158_en.html
- ★ Project website:
<http://www.compnanocomp.eu>



"Particle transfer efficiency as high as 90% has been realised and the ejected particles form a very narrow particle beam for well-controlled placement."

PHYSICS AND MATHEMATICS

GAS-PHASE ANALYSIS OF INDIVIDUAL NANOPARTICLES

Micrometre- and nanometre-sized particles are ubiquitous in the air, affecting working conditions, pollution levels, and even weather patterns and global climate. A newly developed apparatus could make their detection and identification much easier.

Knowing the identity and origin of atmospheric particles impacts the health of people and the planet. The detection of neutral particles is particularly challenging as many techniques rely on ionisation that can damage fragile samples. Blister-based laser-induced forward transfer (LIFT) is a relatively new femtosecond laser ablation technique that is mild enough to accommodate such samples.

A material is transferred to a metal substrate and irradiated from behind by a short laser pulse, causing a blister to form. Rapid movement of the metal substrate facilitates efficient material transfer and effective isolation. Scientists have improved on a matrix-free blister-based LIFT technique, producing an apparatus for gas-phase analysis of small particles through EU support of the DECIMA (Detection and characterisation of individual micro- and nanoparticles) project.

In particular, DECIMA developed a new LIFT technique to introduce nanoparticles into high vacuum for ionisation and analysis. Particle transfer efficiency as high as 90% has been realised and the ejected particles form a very narrow particle beam for well-controlled placement. The average particle velocity is about 50 m/s, slow enough to allow investigation of particle composition and morphology with depth resolution. Scientists have integrated the LIFT technology with time-of-flight mass spectrometry (TOFMS) of both positive and negative ions.

Researchers fully characterised the operation of the new apparatus using atomic force microscopy and theoretical studies to optimise laser characteristics and prevent sample materials damage. The technology is simple to realise and compatible with any sample, including carbon nanostructures, aerosol particles and biological objects. It has been successfully used to transfer fullerene C60 molecules from a metal-coated substrate into the extraction region for TOFMS. Further, it effectively isolates the transferred materials from other ablation materials and minimises laser heating so that the particles are delivered to the analytical instrumentation unaltered.

DECIMA progress will be important in getting the nanoparticle detection and characterisation set-up closer to proof-of-principle in the laboratory and eventual prototype development. Commercialisation of the integrated LIFT-TOFMS apparatus could have a significant positive impact on health, environmental safety, and the understanding of weather patterns and global climate change.

DECIMA

- ★ Coordinated by the University of Edinburgh in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169440_en.html

A NANO-SCALE TEST BED OF QUANTUM BEHAVIOURS

Although it may seem simpler to study the quantum world through theory rather than experimentation, computing power can be limiting. Scientists have created an experimental quantum simulator that will enable practical tests of predictions and hypotheses.

Amazing advances in both experimental and theoretical methods have opened a window on to a brave new world, the quantum world. Here, the behaviours of matter defy the descriptions of classical mechanics and almost anything seems possible. However, when dealing with all these atomic and subatomic interactions, the computational load of the many-body problems can become problematic.

Scientists have created an experimental set-up, a quantum simulator, to help form and test hypotheses when it comes to the complicated behaviours of quantum systems. With EU support of the MOQUASIMS (Memory-enabled optical quantum simulators) project, the pioneering researchers have also constructed and implemented a quantum system to capture flying photons and hold them in stationary atomic excitations. In other words, they have created the foundations of the first-ever programmable quantum simulator capable of optical memory storage to be realised by integration of the two.

The quantum memory set-up stores broadband light in room-temperature caesium vapour. Enabling room-temperature operation is a big victory for most technologies. Anything that can be done without fancy cooling or heating minimises complexity, maximising the likelihood of success. It also maximises the likelihood of subsequent uptake because it lowers investment costs and operating difficulties.

Solutions to observed noise issues have now resulted in the ability to store and retrieve gigahertz broadband flying photons in a programmable way in a very low-noise environment. In particular, the system can reliably transport a single photon with a sub-nanosecond period or cycle time.

Next, the team created an all-optical integrated network, a photonic chip of very high complexity that can simulate a multitude of interesting quantum physics phenomena. They have already used this simplified model to perform a variety of quantum experiments, including simulation of a

quantum analogue of a photosynthetic system.

“The system can reliably transport a single photon with a sub-nanosecond period or cycle time.”

The final step will be to integrate the two. This is expected to enable experiments not previously possible, as well as to have practical uses in areas such as the development of unconditional secure communication, super-fast computation and very precise measurement. MOQUASIMS has delivered a powerful new tool with the potential to change the way we interact with each other and the world around us.

MOQUASIMS

- ★ Coordinated by the University of Oxford in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169449_en.html

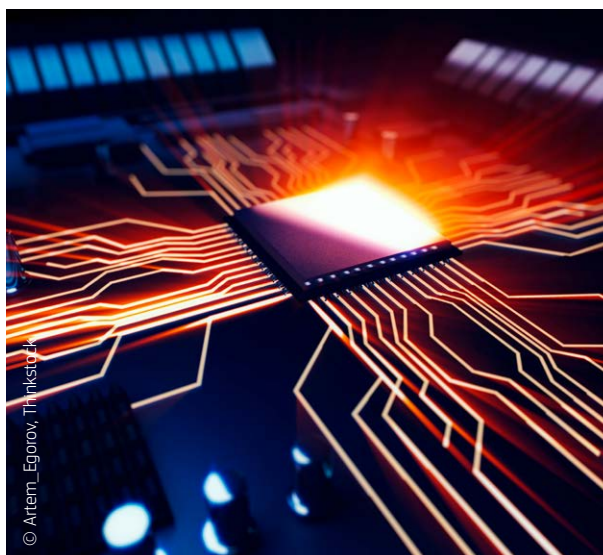
CHARGE TRANSPORT IN TRANSITION METAL OXIDES

Two main drivers of global innovation and economic growth are the semiconductor/integrated chip (IC) market and renewable energy. Deeper understanding of the mechanisms of charge transport in advanced materials could advance both fields substantially.

Many of the functional oxide materials important to the IC industry are also critical for the energy storage systems necessary if intermittent sources such as wind and the sun are to be effective. Despite this overlap, research on the properties of materials related to the two fields has generally been carried out separately.

The EU-funded ELIOT (Electronic and ionic transport in functional oxides) project has formed a bridge, investigating how material production and physical properties affect charge transport in these oxides.

Scientists have chosen to study transition metal oxides, their electrochemical and physicochemical properties, and the effects of material deposition techniques and conditions on charge transport. They have targeted applications in non-volatile memory and energy storage with a focus on electronic and ionic mobility respectively. Establishing mechanisms could lead to the engineering of better materials for both fields.



One promising alternative to flash memory devices which overcomes inherent barriers in capacity and speed exploits metal oxides that exhibit resistive switching. The first objective of the project was to identify materials for which the large scalable change in resistance to applied pulsed voltages is due to correlated electron effects.

Transition metal oxides with high ionic mobility but low electrical conductivity are interesting as solid electrolytes for fuel cell applications. Materials with high lithium storage capacity (low mobility) and good electrical conductivity are potential candidates for electrode applications.

Studies covered simple binary oxides such as vanadium or titanium dioxide (VO₂ and TiO₂ respectively). They also evaluated more complex oxides such as samarium nickelate (SmNiO₃) and lithium manganese oxide (LiMn₂O₄).

VO₂ and SmNiO₃ showed a metal to insulator transition, from good charge conductivity to low conductivity, with temperature. TiO₂ and LiMn₂O₄ were identified as promising electrode materials for batteries, while a lithium magnesium oxide showed potential for use as a solid electrolyte.

Enhanced knowledge about the factors affecting electronic and ionic mobility of transition metal oxides could lead to important breakthroughs in socioeconomically important areas such as volatile memory and energy storage. ELIOT has pointed the way to rational engineering of advanced materials for these and other applications.

ELIOT

- ★ Coordinated by imec in Belgium.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169456_en.html

NOISY TIME EVOLUTION AND QUANTUM MEMORY

The marriage of information theory and quantum mechanics gave rise to the field of quantum computing. Now, scientists have advanced a mathematical formalism that promises to make practical implementation possible.

Several years ago, a concept called dissipative quantum computing was proposed as a robust way to implement quantum algorithms. Dissipation refers to the process of irreversible energy loss. Since quantum mechanics is typically described using a mathematical formalism (Hamiltonian) in which total system energy is conserved, a new formalism was required.

Scientists launched the EU-funded QUINTYL (Quantum information theory with Liouvillians) project to advance the mathematical framework underlying quantum dissipative (noisy) time evolutions. The main objective was to incorporate controllable dissipative time

evolution into key components of quantum information theory. Establishing the feasibility of dissipative approaches for the processing of quantum information could be a giant leap toward the realisation of a quantum computer.

Researchers achieved all initial goals, beginning with introduction of Fourier-based analysis methods into the mathematical frameworks describing quantum and classical stochastic (specifically, Markov) processes to control their convergence behaviours.

A new mathematical framework supports quantification of the storage capacity of noisy quantum memories. It was successfully applied to several

control operations that could be applied during the storage time in the context of controllable dissipative time evolution and quantum computing. In addition, the analytical output will be useful for comparison to observations of experimental quantum memory implementations.

In other work, the team established bounds in the quantum domain that define fundamental energy restrictions on future implementations of quantum computers. The bounds also represent a trade-off between process time and energy efficiency. Other novel algorithms enable robust operation even in a poorly defined noisy environment. Implementation resulted in a significant acceleration in computation time for an unstructured search even compared to noiseless classical algorithms.

The mathematical foundations for quantum computing have been strengthened significantly, and results were widely disseminated within the scientific community. Outcomes are likely to have profound ramifications for the size and nature of problems that can be addressed in fields from cosmology to particle physics to biomedicine.



QUINTYL

- ★ Coordinated by TUM in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ http://cordis.europa.eu/result/rcn/169451_en.html

EVENTS

EVENTS

For more forthcoming events:
<http://cordis.europa.eu/events>

NOVEMBER
02 ▶ 27

Geneva, SWITZERLAND

CONFERENCE

WORLD RADIO-COMMUNICATION CONFERENCE 2015

The World Radiocommunication Conference 2015 (WRC-15) will be held from 2 to 27 November 2015 in Geneva, Switzerland.

The conference will review, and, if necessary, revise the international treaty governing the use of the radio-frequency spectrum and the geostationary-satellite and non-geostationary-satellite orbits. Revisions are made on the basis of an agenda determined by the ITU Council, which takes into account recommendations made by previous world radiocommunication conferences.

The outcome of the conference will be decisive for the future development of mobile communications. The possible reallocation of frequency ranges to mobile broadband services will be high on the agenda of this key ITU event.

For further information, please visit:

<http://www.itu.int/en/ITU-R/conferences/wrc/2015/Pages/default.aspx>

NOVEMBER
04 ▶ 06

Malaga, SPAIN

CONFERENCE

SECOND TRANSATLANTIC CONFERENCE ON PERSONALIZED MEDICINE

The Second Transatlantic Conference on Personalized Medicine will take place from 8 to 9 October in Rotterdam, the Netherlands.

Organised by six FP7-funded projects (ENANOMAPPER, MOD-ENP-TOX, MODERN, PRENANOTOX, MEMBRANENANOPART and NANOPUZZLES) and MODENA COST ACTION, the conference aims to disseminate and integrate outputs on computational methods for toxicological risk assessment of engineered nanoparticles. The organisers hope that the event will also provide an opportunity to discuss further the needs and perspectives in the area.

The format of the event is open. Modellers, as well as researchers from all areas of nanoscience and nanotoxicology, are invited to participate. The deadline for registration is 25 September 2015.

For further information, please visit:

<http://www.compnanotox2015.eu/>

NOVEMBER
09 ▶ 10

Potsdam, GERMANY

CONFERENCE

GRACE FINAL CONFERENCE

The final conference of the GRACE (GMO risk assessment and communication of evidence) project will take place on 9 and 10 November in Potsdam, Germany.

The conference will provide an overview of conclusions and recommendations drawn from the GRACE studies in the course of a multistep stakeholder engagement process. It will also offer opportunities to discuss the broader perspectives and future implications of GRACE and related research projects for the refinement of GMO impact assessment and policy making. In this context, the organisers also aim to address the role of society in fostering the design of research and innovation in order to better align them with the values, needs and expectations of society.

This conference is open to all stakeholders interested in GMO impact assessment. This includes, but is not limited to, GMO risk assessors, risk managers and policy makers as well as representatives of all relevant sectors (competent authorities, industry, professional organisations, civil society organisations and academia). Online registration is open until 30 September. The registration fee is EUR 80.

For further information, please visit:

<http://www.grace-fp7.eu/en/content/final-conference-registration-now-open>

NOV.
14

Milan, ITALY

CONFERENCE

2BFUNTEX FINAL CONFERENCE

The 2BFUNTEX Final Conference on Technology Transfer of Functional Textile Innovations will take place on 14 November in Milan, Italy.

2BFUNTEX is an FP7 Coordination Action aimed at exploiting the untapped potential in functional textile structures and textile-related materials. The 2BFUNTEX Final Conference will showcase successful cases of effective technology transfer on functional textiles between research and industry. There will be a special focus on antimicrobial textiles, smart textiles, nanotechnologies, flame retardancy, biotechnology, electrospinning, plasma, sustainable textiles and other functional textiles for technical applications. The winners of 2BFUNTEX's free technology competition (open until 30 September) will have the opportunity to give a presentation at the conference.

The conference takes place during ITMA 2015. Although registration is free, conference participants need to have a valid ITMA 2015 badge to enter the venue.

For further information, please visit:

<http://www.itma.com/conferences/concurrent-events/2bfuntex-final-conference>



THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION

HORIZON 2020

PROJECT INFORMATION NOW AVAILABLE ON CORDIS

Almost 4 000 project factsheets from Horizon 2020 — the first wave of the EU's biggest ever research and innovation framework programme — can now be browsed and searched on CORDIS.

CORDIS is continuing its role as the European Commission's primary public repository, containing over 100 000 EU-funded research projects and results stretching back 25 years, and now extending its services to Horizon 2020 projects.

The first Horizon 2020 grants were signed in 2014 and hundreds of new projects are being added every month. CORDIS retrieves its information from the grant agreements, publishing for each project its acronym, costs, topic, funding scheme, objectives, coordinating and participating organisations, and the EC contributions for each beneficiary. Horizon 2020 projects can currently be found through their programme area and topic but further information is planned to be added, such as project websites, contact people and cross-cutting domains. A more thematic approach to information will also be explored.

H2020 projects' publishable reports will also be made available on CORDIS in the future, alongside the thousands of Report Summaries currently being provided by FP7 projects. The publication of these reports will later be followed with multilingual Results in Brief for each project and coverage in the free *research*eu results magazine* — making it easier to identify exploitable results and opportunities for innovation.

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