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SPECIAL FEATURE

FISH OR SEAFOOD FEEDING HUMANITY WHILE MAINTAINING NATURE'S BALANCE



BIOLOGY & MEDICINE

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OFFER HOPE TO
PANCREATIC CANCER
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EDITORIAL

by the editorial team

SUSTAINABLY SATISFYING THE WORLD'S HUNGER FOR FISH

Humanity's tendency to overuse available resources is one of the biggest problems it has ever had to face. Marine ecosystems are no exception: according to the WWF, the global fishing fleet is two to three times larger than what our oceans can sustainably support. Various studies indicate that around 85% of global fish stocks are over-exploited, depleted, fully exploited or recovering from depletion. In 2006, a study led by Dalhousie University in Canada even predicted that stocks of all species currently fished for food would collapse by 2048.

Whether this gloomy perspective is an inexorable part of our future is, luckily, still open for debate. What is certain is that, if we are to maintain our lifestyle while preserving marine ecosystems, concrete measures are needed to prevent overfishing, and alternative solutions should be made available to sustain the world's growing need for seafood without compromising delicate ecosystems.

'A study led by Dalhousie University in Canada even predicted that stocks of all species currently fished for food would collapse by 2048.'

In Europe, the new Common Fisheries Policy (CFP) aims to achieve just that by making sure that EU citizens are provided with a stable, secure and healthy food supply over the long term with a prosperous fishing sector. Tackling overfishing and promoting aquaculture are two cornerstones of this vision — also supported by investment under FP7 and Horizon 2020.

For EU-funded researchers, priorities include competitive and environmentally-friendly fisheries and aquaculture, cross-cutting marine research, animal welfare and the preservation of marine biodiversity. This edition of the *research*eu results magazine* puts some of the most recent and representative projects under the spotlight, with one main underlying question: are we any closer to striking a sustainable balance between fish preservation and easy access to seafood?

This special feature is followed by the usual eight sections providing insights into biology and medicine, social sciences and humanities, energy and transport, the environment, IT and telecommunications, industrial technologies, food and agriculture, and physics and mathematics, along with a list of upcoming events hosted by or involving EU-funded research projects.

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



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Focus on
The path to life
beyond Earth

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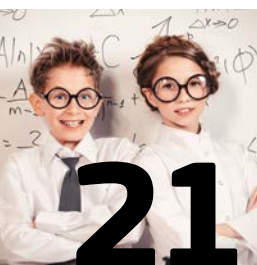


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SPECIAL FEATURE

FISH OR SEAFOOD: FEEDING HUMANITY WHILE MAINTAINING NATURE'S BALANCE

INTERVIEW

A MULTISPECIES APPROACH TO FISH MANAGEMENT IN THE NORTH SEA

As fish overexploitation becomes more and more of a concern, stakeholders are constantly looking for novel resource management strategies and more accurate forecasting techniques. The GADCAP project has made an important contribution by test-driving the multispecies approach to fisheries management in the Flemish Cap.

Piointed by the likes of the Food and Agriculture Organisation (FAO) of the United Nations, the limitations of a single-species approach to fisheries management have resulted in attempts to replace it with a wider ecosystem approach to fisheries assessment and management.

The main shortcoming of the single-species approach to fisheries management lies in the fact that it considers species in isolation from their ecosystem and uses the resulting data to establish management procedures. The effects of interactions with other species on population dynamics are disregarded, which is where a multispecies approach can prove useful.

The EU-funded GADCAP (Implementation of a multispecies model GADGET to the ecosystem of Flemish Cap and incorporation to the fisheries stock assessment of NAFO; a case study) team, led by Prof. Dr Perez-Rodriguez Alfonso, spent the past two years applying such an approach to the Flemish Cap. The relative simplicity of this area — where 85% of the total biomass is made up of cod, redfish and shrimp, its relatively high level of isolation, the strong connections between species and the vast amount of quality data available from commercial and scientific surveys conducted made it an ideal test environment.

In this exclusive interview with the *research*eu results magazine*, Prof. Dr Rodriguez expands on the results of the project and how it will eventually contribute to disentangling the interconnected drivers determining the dynamic of cod, redfish and shrimp stocks in the Flemish Cap.

★ **What are, according to you, the main shortcomings of the single-species approach to fisheries management?**

Prof. Dr Perez-Rodriguez Alfonso: Well, this approach can be valid for commercial species that are not preyed upon (or not so much in comparison to other causes of mortality) and feed on ecosystem components that are not currently commercially exploited (like zooplankton or phytoplankton). However, these are in fact rare cases and most commercial species are subjected to strong species interactions which include not just predation, but also competition for food resources. In these cases, disregarding species interaction may lead to an overestimation of population productivity and eventually to short- and long-term forecasts of stock biomass that are way above real values. This may in turn result in the overexploitation of resources, and if this failure is maintained in the long term it may favour declines and even a collapse in exploited populations.



Prof. Dr Perez-Rodriguez Alfonso

★ **How can the multispecies approach lead to better results?**

The multispecies approach, as opposed to the single-species approach, takes into consideration the main interactions with other commercial species in the ecosystem. While the description and modelling of past time (hindcast) is not necessarily better in the multispecies than in the single-species approach, the short and long-term forecast is expected to be more reliable in the multispecies approach. The reason is that when running projections, the trophic interactions and the complex interactions resulting from predation and competition can be explicitly considered to predict the dynamics of commercial population.

In some areas, the evaluations of predation-related mortality coming from multispecies models are considered in single-species models. Although this is already progress, it is not enough: single-species models cannot properly represent the complex feedbacks resulting from predatory interactions, and this is especially important in the evaluation of management strategies.

★ **Why did you choose the GADGET tool for your project?**

The intention of GADCAP was to develop a model that was simple enough to be of use for scientific advice in the Northwest Atlantic Fisheries Organisation (NAFO) area, but still with the highest level of information related to species interactions and other elements related to population productivity.

GADGET meets these requirements. It is a flexible tool that allows the user to create everything from the simplest to the most complex models, taking into account various characteristics of the ecosystem: one or more species, each of which may be split into multiple components; multiple areas with migration between areas; predation between and within species; growth; maturation; reproduction and recruitment; and multiple commercial and survey fleets taking samples from the populations. It is a process-based model and it allows for modelling different biological and ecological processes for each population, setting the parameters for sub-models of predation, growth, maturation, length-weight relationship or change of sex. It has been recognised by the FAO as one of the ecosystem

models with the best performance for practical scientific advice in fisheries management. It is currently utilised in different areas like Icelandic seas, the Barents Sea and the Gulf of Biscay.

★ **What have you learned from your research on the dynamics of Flemish Cap cod, redfish and shrimp populations?**

Overfishing, predation and cannibalism, as well as variable recruitment success, were found to be the main drivers behind strong swings in the biomass of all three stocks over the study period. In shrimp, both predation by redfish and fishing have worked together to cause the stock collapse, along with predation by cod. The proportion of large cod in the stock, especially since 2010, raised predation-related mortality in redfish and seems to be the main factor inducing their decline. The model has also made it clear that cannibalism has been the main source of mortality in both juvenile cod and redfish, and has significantly jeopardised the chances of increasing the stock. Additionally, it has revealed the relevance of external prey groups like hyperiids and eupausoids for immature, small mature cod and redfish, the genus *Anarhichas sp* for large mature cod, and copepods for redfish. These results suggest that the potential decline of some of these alternative prey groups may have important consequences for the dynamics of the commercial species by changing predatory (and cannibalism) interactions.

For the long-term forecast, the overall values of biomass and the estimated 'Maximum sustainable yield' (MSY) for each species obtained with different fishing pressure levels showed marked patterns resulting from the negative effect of fishing mortality on prey or predator stocks. In this regard, the expected patterns of decrease in biomass as a result of increasing fishing pressure were observed in all three stocks. But other than these trivial fishing-stock reactions, which can also be estimated with single-species models, more interesting secondary feedback was only observable with multispecies models. Among these was the negative effect on total production and MSY for cod as a result of higher fishing mortality among redfish and shrimp. This negative impact was the result of the increased cannibalism in cod, as their main prey became more difficult to find. It was also of interest to observe the positive effect on redfish biomass and MSY of increasing cod fishing mortality as a result of the released predation mortality. The same is observed in shrimp biomass and MSY in relation to redfish and cod fishing pressure.

★ **What would you say are GADCAP's main contributions to the development of the multispecies approach?**

GADCAP's main contribution so far is the fact that it provides a clear example of the usefulness of considering trophic interactions when trying to explain and forecast population dynamics. However, soon we expect to be able to expand the scope of the multispecies approach by applying the GADCAP model in multispecies management strategy evaluation.

★ **How do you think your project results will help to better manage fisheries in the Flemish Cap area?**

GADCAP is the first multispecies model that has been developed for the NAFO area. The results clearly indicate that disregarding species interactions in the assessment of the Flemish Cap cod, redfish and shrimp would lead to serious underestimations of both the magnitude and the variability of natural mortality. This would entail an

overestimation of the exploitable biomass in the short-term projections supporting management decisions, due to excessive positivism.

Meanwhile, it has also been shown that, due to the prey-predator size relationship and the dynamic of prey-predator stock populations induced by variable recruitment, trophic interactions have a high degree of plasticity and are beyond being only species interactions; they are also size-modulated specific interactions. This should be seriously considered when evaluating the effect of a predator on a prey stock, otherwise the assessment of predation mortality could be misleading. Hence, GADCAP is representing the first step towards the implementation of a multispecies and ecosystem approach to fisheries management in the NAFO area.

★ **What are your plans now that the project has been completed?**

The development of GADCAP has been a breakthrough in my expertise in matters related to modelling of population dynamics, stock assessment and management aspects. This has added to my background as a biologist and marine ecologist. Now I am ready to take on projects and integrative tasks in terms of their environmental content and management, where knowledge about the marine ecosystem and its modelling are of great importance.

Therefore, I am particularly interested in continuing with projects applying knowledge of ecosystem management of fisheries resources. One possibility would be the continuation

of the work initiated in the Flemish Cap with the development of a Management Strategy Evaluation framework where the multispecies models developed in GADCAP would be a central element of the operative model.

★ **What about other fishing grounds? Do you have any plans to pursue your work elsewhere in Europe?**

Yes, the multispecies approach to fisheries management is relatively new and has only been applied to a small number of systems. As mentioned above, in those systems where the interactions between species are important, especially predatory interactions, the multispecies approach provides an insight into the dynamics of the community which the single-species approach lacks. This can lead to serious errors in management decisions. Therefore, in those systems with suitable databases, it will always be interesting to develop this approach and I will be glad to contribute, both directly and indirectly. These ecosystems might be located both within European waters as well as in international areas where the EU, as a contracting party, is highly interested and has an outstanding role in defining management approaches and decisions (as is the case for NAFO).

GADCAP

- ★ Coordinated by the Institute of Marine Research in Norway.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/110232>

NEW BLUEPRINTS FOR MANAGING EUROPE'S FISHERIES

The EU-funded MYFISH project has created economically, socially and environmentally sustainable multiannual management plans for Europe's fisheries.



The EU's Common Fisheries Policy pledges to provide EU citizens with a long-term, sustainable, secure and healthy food supply. But managing Europe's fisheries is a complex task that must meet the challenge of making fishing environmentally, economically and socially sustainable.

MYFISH (Maximising Yield of Fisheries while Balancing Ecosystem, Economic and Social Concerns) is one EU project that has helped tackle this challenge by

defining the required measurements and setting out plans that can be used in effectively managing Europe's fisheries.

The project worked on the concept of the 'Maximum sustainable yield' (MSY) of fisheries, which has been used to manage fisheries for 50 years. MSY refers to the largest average catch that can be captured from a fish stock under existing environmental conditions.

MYFISH addressed the lack of agreement on the terms 'sustainable' and

'yield'. It also tackled concerns on how achieving a sustainable approach — or MSY — for one stock may affect other stocks and the broader socio-economic and ecological system.

New MSY indicators

The project has developed new MSY indicators that can ensure high levels of fishery yield whilst respecting ecological, economic and social sustainability. These indicators subsequently inform its new multiannual implementation plans.

MYFISH has also created new, user-friendly guides to help fisheries stakeholders make decisions on how much fish can be caught whilst taking economic, ecological and social aspects into account.

The new indicators were defined with the involvement of a wide range of stakeholders from across industry. MSY now encompasses both maximum economic yield and sustainability criteria, such as the desire to maintain and



preserve sensitive species, as well as support employment.

In particular, MYFISH found that the principle of MSY can be expanded from an approach focussed on just one species of fish, to multiple interacting species and fisheries.

Meanwhile, the project concluded that management strategies focusing purely on boosting yield when they might compromise ecosystem or social sustainability should be avoided. MYFISH also argues that the implementation of management plans must be flexible. Variations in ecosystems and in economic and social aspects must be taken into account. So too must the specific characteristics of individual fisheries. Moreover, management plans need to outline choices and explain the trade-offs in a way that is easily

understandable to users. Plans should ideally allow users to experiment with different choices, the project said.

One other finding of the project was that decreasing fishing pressures for spawning fish stocks would increase catches and income.

MYFISH concentrated on the five main areas of European fisheries: the North Sea, the Baltic Sea, the Mediterranean Sea, western waters (Celtic Sea, Irish Sea, Bay of Biscay and Iberian Sea) and widely ranging fish.

Next steps

With the end of the project in February 2016, the MYFISH consortium has noted that more work will be needed to further develop different MSY ranges.

In particular, the project advocates more consideration over creating the concept

of a 'Pretty good yield' (PGY). A PGY is defined as a sustainable yield of at least 80% of the maximum sustainable yield. Such yields are generally obtained across a broad range of stock sizes (20-50% of unfished stock abundance), and this range is not sensitive to the population's basic life history parameters, such as natural mortality rate, somatic growth rate, or age at maturity.

MYFISH received nearly EUR 5 000 000 of EU funding.

MYFISH

- ★ Coordinated by the Technical University of Denmark.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/news/rcn/124905>
- ★ Project website: <http://www.myfishproject.eu/>

HUMAN ACTIVITIES TRIGGER CHANGE IN MARINE ECOSYSTEMS

The EU-backed BIOWEB project finds that human and environmental factors are causing significant changes to marine ecosystems.

Marine ecosystems are constantly subject to anthropogenic and environmental factors that cause them to change. From fishing and pollution, to climate change and invasions of non-native species, these factors have existed since prehistoric times but little is known about their cumulative impact.

In order to get a better understanding of these processes, the BIOWEB (Towards an Ecosystem-based Approach of Marine Resources: Linking Biodiversity, Food WEBS, Ecosystem Services and Drivers) project has examined the web of influence over time on marine environments. It has delved into what this might mean for the services that marine ecosystems provide, such as food production and tourism.

Cumulative impacts on marine ecosystems

'BIOWEB has found that cumulative impacts on marine ecosystems are essential to explaining the past and current dynamics of changes seen in marine resources,' says Marta Coll, BIOWEB project coordinator. 'In general, marine ecosystems today have fewer large organisms like marine mammals, large fish and sharks and more small fish and invertebrates like small crustaceans and pelagic cnidarians like jellyfish. These organisms tend to be less commercial. There are also more invasive species. In some cases they can have a commercial value, but in others they can be poisonous and dangerous for humans.'

Another trend the project has observed is fluctuations in marine productivity. Productivity levels are rising in coastal zones due to organic pollution from sewage and agricultural run-off, which can cause eutrophication. In some cases, these areas have seen a decrease in oxygen and even anoxic conditions closer to the seabed.



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Meanwhile, productivity levels in open ocean systems may be decreasing. 'This may be due to higher stratification of the water column and a reduction in mixing of nutrients in the bottom of the ocean due to an increase in sea surface temperatures. Weaker surface winds and a reduction in water coming from river run-off may also contribute to these phenomena,' Coll explains.

More vulnerable ecosystems

These changes have significant impacts, making marine ecosystems more variable, less resilient to change and more prone to unpredictable shifts. This could lead to a drop in the productivity of commercial marine species, as well as a failure of conservation measures for non-commercial species, the project found.

And it's not just fishing and conservation that could be affected. 'When species like jellyfish and exotic fish — which can be toxic — become more abundant, tourism might be affected,' Coll adds.

BIOWEB also found that changes can run deeper in certain marine environments. Fishing has a large impact on marine resources worldwide, but its impact is especially marked in areas with poor resource management such as the Mediterranean Sea. Around 90% of fish stocks in this area are over-exploited.

Habitat loss and change in coastal land zones can disturb marine ecosystems and will continue to increase, the project found. The exploration and mining of mineral resources in the sea, such as underwater oil fields, as well as deep sea fishing, may also provoke changes in the future.

BIOWEB also discovered that climate change is having a substantial effect. 'It is already very influential on some species and areas where sea temperatures and acidity levels have risen. This will certainly increase in the future with uncertain outcomes,' Coll explains. 'Finally, enclosed regions like the Baltic Sea and Mediterranean Sea are even more vulnerable to invasions of non-native species — and this threat will continue to rise in the future.'

BIOWEB

- ★ Coordinated by the French Research Institute for Development in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/news/rcn/125061>

INTERVIEW

HOW FISHERIES IMPACT BEHAVIOURAL EVOLUTION IN ATLANTIC COD

As seen in other animal species, fish individuals tend to react differently to a new situation. In the case of human harvest, the boldest and more active individuals tend to be more likely caught, leaving only the fearful and cautious ones to breed. But does it mean that future generations of fish will become harder to catch? This is one of the questions the BE-FISH project tried to answer.



Fish personality — consistent individual behaviour which is maintained over time and across contexts — is known to result from adaptive processes involving life-history trade-offs or physiological constraints. Concretely, a population from a single species can include individuals of the same sex, size or age which feature different behavioural traits, these traits being grouped in five major categories: shyness-boldness, exploration-avoidance, activity, sociability and aggressiveness. Various studies have demonstrated that this personality variation is heritable. This means that they can be subject to evolutionary processes.

Scientists in the BE-FISH (Pace of life syndromes in fish: harvesting effects and the role of marine reserves) project have long suspected that fisheries may contribute to such evolutionary impacts in marine resources by selectively removing specific behavioural traits.

Dr David Villegas-Ríos, Marie Curie Postdoctoral fellow at the Flødevigen Research Station (IMR) and coordinator of the project, discusses the project results. According to him, they provide a unique link between fisheries, behavioural ecology and evolutionary biology sciences, and as such will lead the way to various national and EU projects in the coming years.

★ How is fish personality affected by fishing practices?

Dr David Villegas-Ríos: Human harvesting is a non-random activity. It often removes individuals because they are more desirable (e.g. trophy hunting) or because they are more vulnerable, as is the case for fishing. For instance, bolder individuals will enter a fishing trap more easily than shier ones. Similarly, more active fish find the nets faster than less active individuals. This means that behaviour can determine fitness.

By consistently removing individuals with certain behavioural properties, fishing practices can entail evolutionary consequences in the harvested populations. For instance, by favouring evolution towards less active phenotypes. The ecological consequences of such practices are still largely unknown but they can be maladaptive, reducing the potential for future adaptations along with the productivity of the populations.

★ Why do you think it is important to consider these evolutionary changes in fisheries?

Maladaptive evolutionary changes in behaviour can make the remaining individuals less and less catchable (because the more vulnerable individuals are consistently removed), which will reduce fisheries productivity.

Moreover, behavioural variation has been postulated (and sometimes proven) to co-vary with differences in life history traits. This is known as the pace of life hypothesis. It means that for instance, if we select against more active fish because they find the fishing gears more easily, and those individuals are the ones that grow faster (i.e. there is a genetic correlation between been active and growing fast), then populations may decline faster than expected. In summary, the maladaptive consequences of fisheries-induced evolution on behavioural traits can be extended to other traits that are of more interest to fisheries productivity.



If we select more active fish because they find the fishing gear more easily, and those individuals are the ones that grow faster (i.e. there is a genetic correlation between been active and growing fast), then populations may decline faster than expected.

★ **Can you tell us more about the techniques you used to gather telemetric data?**

The BE-FISH project used acoustic telemetry to record wild behaviour of cod. Acoustic telemetry is a widely-used technique to understand the spatial ecology and movements of aquatic organisms. We make a small incision in the abdomen of the fish, place an acoustic transmitter in the body cavity and close it with two or three stitches using surgical thread. To facilitate this process, the fish is first anaesthetised with clove oil which keeps it motionless for a few minutes. When the fish recovers and displays normal behaviour (typically in 5-10 minutes), it is released into the wild again. It will transmit a unique code that reveals its individual identity as well as a depth measure.

The system is completed with a set of underwater receivers which are distributed along the study system (in our case a coastal fjord) at a 3-4 metre depth, forming a dense array that records the signals from the transmitters. Basically, if the fish is close enough to a particular receiver, it will register its presence and the depth at which the fish was at that particular moment. By placing the receivers close enough to each other, we can get an accurate estimate of the true location and depth of the fish. In our study, we recorded one position every 1.5 minutes on average. The data is downloaded from the receivers and analysed twice a year.

★ **What kind of tests did you conduct on fish and why?**

In BE-FISH we investigated behaviour in the wild and in captivity. Behaviour in the wild was investigated using acoustic telemetry as discussed above. Then, in captivity, we conducted three standard tests in order to investigate animal behaviour. First, we used an open-field test to score exploration tendency. For that, fish were allowed to swim in an open 600-litre tank of saltwater and several parameters were recorded that would reflect their individual exploratory behaviour (e.g. latency to first movement).

Boldness was assessed with a novel object test. In this case, the fish, habituated to the tank from the previous test, was presented with a novel object in the centre of the tank. The reaction towards this object (latency to approach it, time in its

proximity, etc.) was scored as a measure of boldness. Lastly, aggressiveness was measured by letting the fish interact with its own image reflected in a mirror. The number of approaches and the time spent close to the mirror were amongst the variables recorded in this case. By using these three tests we were able to score three of the five axes of behaviour normally recorded in animal personality studies.

★ **What are the main conclusions from your research so far?**

We are now involved in the last analyses of the project. So far we have found that individual variation in behavioural traits of Atlantic cod is large both in the wild and in captivity, and that both recorded behavioural traits are repeatable at the individual level — which means that they can be termed personality traits. This alone means that behavioural traits of cod are likely to be heritable and fishing or other human activities can have a role in the population's eco-evolutionary dynamics.

We also found that behavioural traits of cod displayed in the wild are correlated at the individual level. These correlations are called behavioural syndromes and are recognised as a source of constraint in evolutionary change: traits do not evolve independently anymore, but rather they depend on the evolution of correlated traits. In other words, we found that the possibility of cod behavioural traits evolving is reduced by 25% on average.

★ **What else would you like to achieve by the end of the project?**

We haven't finished all the analyses but we aim to know, within the next couple of months, whether behaviour measured in captivity is correlated with behaviour measured in the wild — something that has never been done for a marine organism. This is important because researchers normally assess behaviour in captivity and make evolutionary conclusions based on this. However, captivity assays may not be representative of wild behaviour which is the one subject to selection and to evolutionary change. Testing the hypothesis that behavioural traits measured in captivity are ecologically relevant is therefore crucial.

The last analyses will also tell us if behavioural traits are linked to life history traits such as growth. This will enable us to understand if the evolutionary consequences of fishing include evolutionary change in correlated traits that reflect the productivity of the population.

★ **What do you hope will be the project's impact over the months and years to come?**

In practical terms some results have already been sent for publication to



DR DAVID VILLEGAS-RIOS

international journals and presented in international conferences. More generally, this project will set a landmark in how we see and how we analyse telemetry data. It expands the range of possible applications and its potential since we showed how it can be used to understand eco-evolutionary processes in marine organisms. Our project also demonstrates empirically that marine organisms display animal personalities and behavioural syndromes in the wild. It provides hard evidence: now we know that fisheries-induced evolution of behavioural traits is not only possible but likely common, and that it will depend on the correlation structure of the traits.

More generally, this project will set a landmark in how we see and how we analyse telemetry data. It expands the range of possible applications and its potential since we showed how it can be used to understand eco-evolutionary processes in marine organisms. Our project also demonstrates empirically that marine organisms display animal personalities and behavioural syndromes in the wild. It provides hard evidence: now we know that fisheries-induced evolution of behavioural traits is not only possible but likely common, and that it will depend on the correlation structure of the traits.

A future challenge emerging from this project will be to understand if the patterns observed in our model species (Atlantic cod) can be generalised for most marine creatures.

BE-FISH

- ★ Coordinated by the Institute of Marine Research in Norway.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/188220>
- ★ Project website: <https://befishproject.wordpress.com>
- ★  <http://bit.ly/1U8XWTM>

SUSTAINABLE, FASTER AND MORE PRODUCTIVE AQUACULTURE OF CATFISH

With 57 % of EU consumption being imported from China and Southeast Asia, European producers are facing fierce competition only aggravated by depleting fish stocks. Catfish production for instance is overrun by pangasius imports, and more efficient production techniques for aquaculture are desperately needed. The SILGEN project promises just that.



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In the face of stagnating fisheries production and health and environmental concerns raised by aquaculture, demand for sustainable aquaculture systems providing fresh, high-quality, local supply of healthy products which follows strict rules to protect the consumer, the fish and the environment has never been so high.

Aranypony Zrt., a Hungarian company producing freshwater and running a full-scale fish farm system of over 1500 hectares at Retimajor, hopes to meet this demand with a sustainable farming technique for European catfish (*Silurus glanis*). Their technology is resource-efficient, eco-friendly, faster and more productive than existing alternatives, and it has received EU funding through the SME Instrument under the SILGEN (Sustainable farming of European catfish (*Silurus glanis*) for innovative, resource efficient and eco-friendly pond farm production) project.

Ferenc Lévai, coordinator of SILGEN, details the main innovations of the project and the results of the feasibility study ahead of its end on 31 May.

★ How does your aquaculture solution differ from existing practices?

Ferenc Lévai: With traditional pond aquaculture, high quality (and high value) predatory fishes are cultured only in polyculture with cyprinids. The ratio is about 3-4% of the total production. It means not more than 30-40 kg/ha, even in traditional fish farms that would qualify as 'good'.

Our target fish, the European catfish, is also a high value predatory species. Up to now this fish was mainly farmed in earthen ponds with very low density, feeding on cyprinids, or in closed systems fed by artificial pellets. Both techniques run on the borderline between loss and profit, which is why the production was so low in comparison to carp or trout cultured in Middle and Eastern Europe.

With our project we combine the technique of using closed systems with water recirculation and pond culture. A closed system is excellent for the production of yearlings, but table size catfish production can compete with Asian dumping of pangasius only if using pond culture. By combining yearling production in 'Recirculating aquaculture systems' (RAS) and table fish production in ponds we can reduce the production time to two years — instead of the three needed with the old method — and increase the yield from 30 kg/ha to 3000 kg/ha of catfish. In this case the fish is fed by pelleted feed, but can also consume a lot of natural food organisms grown in pond water. This completes the nutrients in the feed. Another difference between our new technique and the old one is that we apply pond recirculation in a special way. We use a water-saving technology where the polluted water of the intensive pond is cleaned in a low density 'non-fed polyculture' pond.

★ Why did you decide to focus on European catfish?

European catfish is the second largest fresh water fish (after the great sturgeon). It is a fast growing, tasty predatory species having no intermuscular bones. It tolerates low winter temperatures well (in contrast to African catfish) and can be cultured in our large carp ponds.

★ What have you learned so far from your feasibility study under H2020 Phase 1?

The chance to carry out a feasibility study under SME Instrument Phase 1 has been a great opportunity to strengthen our business strategy. The good news is that our



© Ferenc Lévai

FERENC LÉVAI



project has a seller's market, and because it is our native species there is no danger that some individuals would escape from the culture pond into the natural rivers or lakes.

We also learned that our bestselling product will be the 'fillet fresh on ice'. It can compete well with pangasius. Freshness and short transport are the most important factors, and that is why using native fish will be a great advantage.

★ **What are the main guarantees you provide to consumers?**

The aim of the current project under SME Instrument Phase 1 is to carry out a feasibility study. However, during the Phase 2 project, we plan to carry out a widespread pilot project in our 1 500 hectare fish farm that will demonstrate the technology in a real environment and give guarantees to the customer.

★ **So you are planning to apply for Phase 2 funding after the end of the project in May? What else will you try to achieve with this additional funding?**

Certainly we plan to apply for Phase 2. The funding — hopefully awarded — will be used mainly for technological

purposes and for the commercialisation of SILGEN. We plan to modify our carp ponds for catfish culture, and to carry out selection work using 'Marker assisted selection' (MAS) for developing an even faster growing and resistant catfish variety.

The latter work is planned with close cooperation from geneticists at the University of Pannonia in Hungary. Improving our fish processing plant will also be part of the project to aid its development.

★ **Where do you see your company 5 years from now?**

In our own fish farm (roughly 1 500 ha) we would like to achieve circa 2 000 tons of catfish, and with other cooperating farms which account for about 5 000 ha we would like to reach another 2-3 000 tons of catfish 5 years from now. We would also like to be the main supplier of fingerlings for our partner farms.

SILGEN

★ Coordinated by Aranypony Zrt in Hungary.

★ Funded under H2020-SME-1.

★ <http://cordis.europa.eu/project/rcn/199404>

HEALTHIER SALMON BENEFITS HUMAN WELL-BEING AND BOOSTS AQUACULTURE'S COMPETITIVENESS

Backed by EU funding, scientists have been studying fish and fish feed with the aim of maximising the health-giving properties of farmed Atlantic salmon.

It is widely known that regularly eating oily fish like salmon sourced from the Atlantic is beneficial to human health. It's packed with protein and is good for the heart. But at the same time Europe's seas are suffering from severely depleted fish stocks.

So it's not surprising that farmed fish — or aquaculture — is on the rise. Today, farmed fish account for around half of all fish consumed in the world.

One EU-funded project has delved into how to make farmed fish even healthier via the food the fish eat, potentially boosting the global competitiveness of EU salmon.

The project, OMEGA3MAX (Maximizing marine omega-3 retention in farmed fish: sustainable production of healthy food), has produced novel scientific knowledge on the use of antioxidants, including polyphenols, in Atlantic salmon diets. Polyphenols are a type of chemical found naturally in many healthy foodstuffs, including fruit, vegetables, green tea, spices and olive oil. It is believed that eating them can help prevent degenerative diseases such as cancer and cardiovascular diseases.



In its project results, OMEGA3MAX conceded that much remains to be done to fully implement the use of new antioxidant sources in Atlantic salmon. However, the project has created a knowledge base which paves the way for the use of some natural antioxidants, including polyphenols.

'In this project, we have shown that we can enrich salmon fillet with antioxidants such as gamma tocopherol — a vitamin E isomer with important antioxidant and anti-inflammatory properties,' says Dr David Menoyo Luque, OMEGA3MAX project coordinator.

SPECIAL FEATURE

Boosting the aquaculture industry

OMEGA3MAX is also hoping that its findings will have practical applications in the aquaculture industry. 'If farmed fish have optimal husbandry conditions, good health and adequate feed which is well-suited to the physiological needs of the farmed animals, then growth and production levels will be boosted to the benefit of the industry,' Dr Menoyo explains.

The project set out to discover ways to boost the health and health-giving properties specifically of farmed salmon. 'Farmed fish such as Atlantic salmon are a rich source of healthy long chain polyunsaturated fatty acids, including the marine "eicosapentaenoic acid" (EPA) and "docosahexaenoic acid" (DHA), high-quality protein, vitamin A,

B12, D and E and minerals like iodine and selenium,' continued Dr Menoyo.

Whilst these health properties are established, scientific advances are showing how to enrich the particularly good nutrients and diminish ones that have been raised as a concern.

'The scientific community has been trying to identify important health-promoting compounds found in food. Recent advances in animal production technologies and practices, such as those used in our project, have shown that it is possible to increase the concentration of these compounds in animal tissue to boost the nutritional value for the consumer,' he adds.

OMEGA3MAX tested 12 different antioxidant substances on farmed Atlantic salmon. Of these, one was found to

enhance the omega3 fatty acid — EPA and DHA — concentrations in fish fillets compared to fish not fed with the antioxidant supplement.

Ultimately, the project hopes it has provided practical recommendations for improving fish performance and meat quality. 'Our project can help the industry develop novel, cost-effective feeding strategies that can support the sustainable development of the EU's aquaculture industry,' Dr Menoyo concludes.

OMEGA3MAX

- ★ Coordinated by the Technical University of Madrid in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/101602>

INTERVIEW

NOVEL METHODS TO EVALUATE FISH RESPONSE TO STRESS

Farmed fish are subjected to many stressors that have an important impact on their health and can even lead to their death. The COPEWELL project tried to help fish farmers to cope with this issue by developing methods that will allow them to better understand how fish experience their world.

The EU-funded COPEWELL (A new integrative framework for the study of fish welfare based on the concepts of allostasis, appraisal and coping styles) project was completed in December 2015, although the project team intends to keep publishing papers in 2016. Their main objective, which consisted in providing a better understanding of the physiology, biology and behaviour of fish, their underpinning mechanisms and the way in which coping styles emerge, has largely been achieved.

Dr Tore Kristiansen coordinated the project for the Institute of Marine Research in Norway. He elaborates on how its results deepen our knowledge of the development of the brain function, behaviour and stress response in farmed fish, and how it provides tools for a better assessment of fish welfare and, last but not least, hints at solutions to improve this welfare.

★ Why is it important to know more about how fish experience their world?

Dr Tore Kristiansen: Because this is what fish welfare is about! We want to study quality of life as experienced by the fish. Was it a nice experience or not? How good or bad was it? There is still a debate on whether fish have conscious experiences, and this is something we wanted to investigate.

★ What was the methodology you used in this investigation?

The challenge was to develop methods that could answer our questions. Especially for farmed species, the sizes needed and number of experimental arenas were demanding. We developed several methods and used the small zebrafish as



DR TORE KRISTIENSEN

a model organism, and then scaled some of these methods up to European seabass, Gilthead seabream and Atlantic salmon.

An example of a method used under COPEWELL is the Conditioned Place Preference Test, where the fish are exposed to rewarding or aversive conditions in different areas of a fish tank. The areas where they experienced the assumed good or bad stimuli were marked with different



background patterns. If the fish experience the conditions as aversive, they will later associate this pattern with the aversive experience and avoid this area and thereby show their subjective experience. The opposite will happen if the stimuli were experienced as positive. In addition to fish behaviour, we also looked at gene expression of so-called immediate early genes and monoamines in the brain, in order to study which areas of the brain were affected.

★ **Why did you choose to extend this research to different species?**

It is important to recognise that a fish is not just a fish. We have around 30 000 species of fish in the world, and there is probably a much larger difference between various fish species than between a bat and an elephant. Comparing salmon and sea bass is like comparing a tiger and a dog, or a pig and horse. Even within the same species we found different coping styles or 'personalities': fish behaved differently and had different neurophysiological and genomic responses to the same experiences.

★ **What have you learned with regards to the consequences of poor fish welfare?**

In many of the experiments we could see that the fish had a remarkable ability to adapt to stressful conditions as long as they could cope with the given challenges. A central concept in the project has been that of 'allostasis' as an alternative model to the old homeostasis model.

Instead of conditions with as few stressors as possible, the fish should be submitted to stressors it can successfully cope with. The brain will reward successful behaviour and such reward is what creates pleasurable experiences and good welfare. Of course, all organisms have limited resources: too many challenges and stressors will lead to wear and tear of the body, and finally a breakdown of the physiological functioning.

★ **Other than that, what would you say are the most important outcomes of the project?**

In the COPEWELL project we have maybe for the first time in aquaculture studied how experiences early in life affect later development, behaviour, brain neurochemistry and stress responses. We have shown that we can modify how fish react to stressors by creating predictable conditions.

According to the allostasis model the fish (or humans) regulate their bodily functions according to predicted demand. If the conditions are predictable — meaning that the fish has experienced a similar situation before and can estimate what is coming, it will give more appropriate stress responses instead of overreacting to the stimuli and spending more resources than necessary on stress handling.

"A central concept in the project has been that of 'allostasis' as an alternative model to the old homeostasis model."

At last we now have a better understanding of the underpinning mechanisms in the brain, but here most of the map is filled with blank areas. We are still in the early stages of fish brain neuroscience.

★ **How can aquaculture benefit from your findings?**

Handling stress is a large source of mortality in farmed fish. If we train the fish to handle stressors like for example crowding or pumping in a better way, this should lead to better growth and a higher survival rate. Also fish need training and education!

Our results have shown that fish have different coping styles and personalities that are more or less fit for aquaculture conditions. This should be further studied and implemented in the breeding programmes.

★ **The project has already come to an end but you have already said that more papers would be coming in 2016. Can you tell us more about this ongoing work?**

By now I think we have published 25 papers related to the project, and more than 20 papers are in the pipeline. We hope most of them will be accepted. I must also mention that we have four PhDs who have already defended their thesis and a few more who will finish it this year.

COPEWELL

★ Coordinated by the Institute of Marine Research in Norway.

★ Funded under FP7-KBBE.

★ <http://cordis.europa.eu/project/rcn/99347>

FERMENTATION TECHNOLOGIES FOR CHEAPER, GREENER FISH PRODUCTS

An EU-funded initiative has designed a fermentation process for low-value fish raw materials to produce new food products with improved shelf life and a high level of consumer acceptance.



Fermentation of fish is a traditional technique used in Asian countries to extend the shelf life of fish products and increase the value of low-value raw fish. In Western fisheries, almost a third of high-value fish is lost during the processing of fillets — an unacceptable situation in the face of drastic overfishing and the need for greater sustainability.

The FISHFERMPLUS (Added-value bioprocessing for fish raw materials via low-cost fermentation technologies delivering a plus in the sustainable production, consumer safety and quality of highly sensitive fish products) project developed fermentation methods for utilising by-products of fish processing. Fermentation has the potential to improve shelf life and customer approval of low-quality fish products.

Project partners completed a market analysis, which indicated that improved shelf life is the most important way for the industry to add value to their products. This was coupled with a literature review of fish fermentation practices in Asian countries.

This information resulted in specifications for new fermented fish products. Two approaches were investigated: fermentation of fish mince for antimicrobial properties, and fermentation of good-quality off-cuts to improve taste and texture.

Suitable raw materials and cultures were tested to establish an effective bioprocess, and optimal fermentation parameters were identified. This helped to ensure that value added products would be produced in an economically-efficient way.

The fermented products were further processed in order to obtain stable, marketable products. The stabilisation steps included texturing processes, the addition of antioxidants, salting, and drying and heating treatments.

The stabilised intermediate products were finally incorporated into marketable convenience products such as spreads, burgers and filled puff pastry. However, it was shown that the products could also be used as ingredients, for example as pizza toppings.

Researchers also developed models for predicting pH, lactic acid concentration and the growth of pathogens during fermentation. Sensory and chemical tests revealed that no off-flavours from fat oxidation occurred and that peroxide value and thiobarbituric acid reactive substance values did not increase during storage.

FISHFERMPLUS outcomes will mean cost-efficient processing and greater value for underexploited raw materials in the European fishing industry. They will enable groundbreaking physical processing and natural ingredients that increase the shelf life and safety of fish and seafood products and significantly improve competitiveness with other fish exporting countries.

FISHFERMPLUS

- ★ Coordinated by ISI Food Protection in Denmark.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/result/rcn/151597>
- ★ Project website: <http://www.fishfermplus.eu>

BIOLOGY AND MEDICINE

NOVEL MOLECULES OFFER HOPE TO PANCREATIC CANCER PATIENTS

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EU-funded researchers have identified and evaluated novel molecules that could eventually lead to life-saving cancer-fighting drugs.

The EU researchers have made significant progress along the road to delivering novel drugs that improve life expectancy and the quality of life of pancreatic cancer patients. Following a systematic screening of natural and chemically synthesised compounds, the PANACREAS (Integrating chemical approaches to treat pancreatic cancer: making new leads for a cure) project team has been able to identify a number of molecular targets that have shown promise in halting cancer progression.

The confirmation of strong anti-cancer activity could lead to further testing and evaluation of these molecules, and hopefully to the eventual clinical application of new cancer-fighting drugs.

Cancer of the pancreas, or 'Pancreatic ductal adenocarcinomas' (PDACs), constitutes one of the most aggressive forms of human cancer, causing 34 000 deaths annually in the EU alone. Despite considerable research efforts over the past few decades, conventional treatment approaches — including surgery, radiation, chemotherapy and combinations of these — have close to no impact on the course of this aggressive cancer, which rapidly metastasises and induces death in nearly all patients.

New treatments for PDACs are therefore urgently needed to significantly improve the physical and psychological status of patients and also help reduce the burden of healthcare costs on the EU. Furthermore, potential new drug molecules identified by PANACREAS could spur further technological innovation, create new opportunities for European pharmaceutical firms and boost Europe's research reputation for finding treatments for diseases traditionally regarded as incurable.

The search for new drugs to combat PDAC progression and thus increase patient life expectancy and achieve healthcare cost efficiencies has been an EU priority.

The PANACREAS project brought together clinicians, translational cancer researchers, chemists and two pharmaceutical enterprises in an integrated effort to synthesise and test new

PDAC drugs. Assays, models and *in silico* research was conducted to identify inhibitors of various known tumour suppressors. The team suspected that certain proteins and enzymes might be implicated in the spread of PDACs.

The project's work programme sought to specifically address the clinical issues and challenges that researchers have encountered in developing viable PDAC therapies. These include resistance to conventional therapeutics and the high propensity of the cancer to metastasise. These issues were taken into account when selecting possible molecular targets.

The project team synthesised new molecules, assessed their capacity to effectively block precise cancer-associated mechanisms and determined their anti-cancer activity *in vivo*. Molecules that demonstrated promising anti-cancer activity in PDAC cells were then investigated in more depth. Chemical genetic screenings were also carried out in order to identify compounds with synthetic lethal activity in PDACs.

The most promising compounds have been sent for validation for therapeutic potential at the Centre for Integrated Oncology (CIO) Cologne-Bonn. The CIO Cologne-Bonn is certified as one of initially five German centres of excellence for haematology and clinical oncology by the German Cancer Foundation (Deutsche Krebshilfe).

The PANACREAS project was officially completed at the end of February 2016.

PANACREAS

- ★ Coordinated by the University Hospital Bonn in Germany.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/news/rcn/124891>
- ★ Project website: <http://www.panacreas.eu/>

THE CLINICAL RELEVANCE OF TUMOUR HETEROGENEITY

Gastrointestinal cancer is a morphologically heterogeneous disease. The identification of clinically relevant tumour subpopulations could aid a more positive outcome of cancer therapy.

The evolution of cancer and the clinical management of patients heavily depend on the intra-tumour molecular and phenotypic heterogeneity. However, the identification of tumour cell subpopulations has proved challenging.

The EU-funded SITH (Proteomic segmentation of intratumour heterogeneity for identifying clinically relevant tumour subpopulations in gastrointestinal cancers) project set out to identify clinically relevant tumour cell subpopulations and characterise their properties using omics technologies. Work focused on intestinal-type gastric cancer and invasive ductal breast carcinoma. The goal was to evaluate the impact of intratumour heterogeneity on patient survival and lymph node metastases.

Researchers utilised 'Imaging mass spectrometry' (IMS), a method that combines mass spectrometry with microscopy of tissue sections. IMS allows the imaging of different molecules such as proteins, peptides, lipids or metabolites in their histological

context. The alignment of mass spectral data with histology revealed molecular heterogeneity between individual tumour samples, and also molecularly common tumour subpopulations across several samples.

Association of the generated data with the clinical data of patients with gastric cancer indicated that the presence of different tumour subpopulations was linked with a different overall survival. With respect to breast cancer, less molecular heterogeneity was observed, but still one subpopulation was found to be significantly associated with the presence of local metastases.

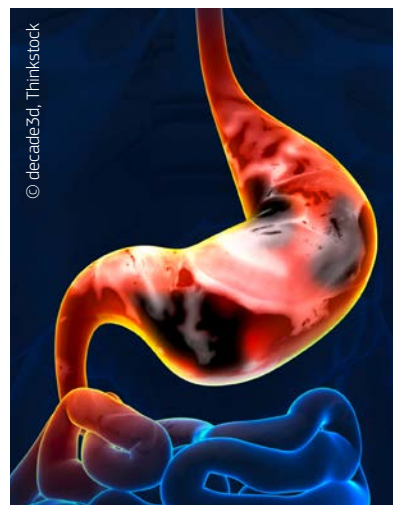
Researchers next introduced proteomic and metabolomics analysis of these tumour subpopulations to verify the IMS data. Gene expression analyses unveiled further alterations in several signalling and metabolic pathways.

Overall, the SITH approach provided a novel angle on the existence of microscopically indistinct tumour subpopulations that have an adverse impact

on clinical outcome. Elucidation of intratumour heterogeneity is anticipated to accelerate the way we treat cancer.

SITH

- ★ Coordinated by the Leiden University Medical Center in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180877>



MECHANISMS OF CANCER-RELATED DRUG RESISTANCE

Through manipulation of epigenetic modifications, scientists hope to establish a new line of anti-cancer therapies. However, the emergence of therapy resistance necessitates investigation into the underlying mechanism.

Accumulating evidence indicates that apart from genetic mutations, cancers harbour complex aberrations of the epigenetic landscape. Pharmacological targeting of chromatin regulators can reverse these aberrations, and promising results have emerged from clinical trials.

Recent evidence on the targeting of the 'Bromodomain and extraterminal domain' (BET) containing protein 4 (BRD4) — a reader of histone-acetyl marks — indicates the therapeutic value of this approach. However, pre-clinical data from 'Acute myeloid leukaemia' (AML) indicate the emergence of resistance against BRD4 through as yet unknown mechanisms.

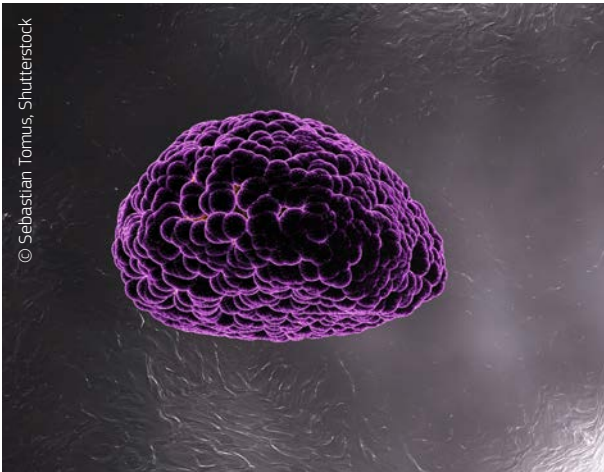
The EU-funded BET(TER) TARGETS (Targeting BET bromodomains in cancer — mechanisms of sensitivity and resistance) project set out to investigate the mechanism underlying the observed resistance to BET inhibition. For this purpose, they combined advanced RNAi technologies, experimentally tractable AML mouse models, and comprehensive profiling (proteomic, transcriptional, epigenetic) of sensitive and resistant cells. The ultimate goal was to

identify and characterise the molecular determinants of the sensitivity and resistance to BET inhibition.

Scientists analysed the composition of BRD4 complexes via quantitative mass spectrometry in sensitive and resistant AML cells. They identified a plethora of nuclear proteins that clearly illustrated the complexity of the pathway. Through an alternative approach, they performed dynamic RNA sequencing in sensitive and resistant leukaemia cells with or without BET inhibition. Significantly, they discovered a gene set that is differentially expressed between sensitive and resistant cells.

Project findings suggested that BET inhibition triggers acute repression of MYC in human leukaemia regardless of their sensitivity profile. Resistant cells restore MYC transcription through the activation of the Wnt pathway, rapidly overcoming the effect of BET inhibition.

Further work on the mechanism of BRD4-dependent transcription in sensitive and resistant AML cells unveiled a role for histone-modifying proteins in chromatin remodelling



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around the regulatory pathways that restore the transcription of key BRD4 targets.

Overall, the BET(TER) TARGETS study validated Wnt signaling as a driver and candidate biomarker of BET inhibitor resistance in leukaemia. Apart from therapeutic implications, the results of the project highlight the heterogeneity and plasticity of transcriptional machinery in determining the outcome of chromatin-targeted therapies.

BET(TER) TARGETS

- ★ Coordinated by the Research Institute of Molecular Pathology in Austria.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/175283>

ROADMAP TO FOSTER AND ENCOURAGE VACCINE INNOVATION IN EUROPE

The EU-funded IPROVE project has unveiled a comprehensive roadmap for vaccine research and innovation in Europe for the next 20 years.

Launched at the European Parliament on 16 March, the roadmap is the first of its kind and will inform strategic decisions on the priorities for future vaccine investment in innovation and technological development at EU and Member State level. The launch event was hosted by three prominent 'Members of the European Parliament' (MEPs) — French MEP Francoise Grossetete, Romanian MEP Cristian Silviu-Busoi and German MEP Markus Ferber.

“The roadmap highlights that there is a clear necessity for Europe to continue investing in the basic and fundamental science underpinning vaccine research.”

Maintaining Europe's vaccine leadership

The IPROVE (Innovation Partnership for a Roadmap on Vaccines in Europe) was formed with the mission of establishing a clear vision of how to maintain Europe's preeminent position as a global leader in vaccine and vaccinology technologies and its capacity to tackle unmet medical needs. Currently 80% of vaccines from the major research manufacturers are produced in Europe and exported worldwide. Additional aims of the project included favouring a more structured vaccine innovation agenda, tackling changing medical needs and

supporting healthcare systems during a time of strained public budgets.

The project consortium, coordinated by the European Federation of Pharmaceutical Industries and Associations (EFPIA) and Vaccines Europe, a specialised group within EFPIA, began the process through a detailed consultation process. This involved experts from public health and regulatory bodies, SMEs, large industry actors, academia, research organisations, civil society organisations and funding bodies. This was to help the project analyse the entire vaccine innovation chain, from needs identification and conceptualisation, to discovery and development, including interventions necessary to improve education curricula, and vaccine perception and awareness among the public.

Roadmap conclusions

The roadmap highlights that there is a clear necessity for Europe to continue investing in the basic and fundamental science underpinning vaccine research. This research needs to be multidisciplinary and connected across microbiology, immunology, structural biology systems and bioinformatics.

A more rational approach to antigen selection and vaccine design should be prioritised. Recommendations should also be made on the need to support and accelerate research into novel adjuvants, the development of vaccine vectors and prime-boost

strategies, as well as investigations into novel routes for immunisation.

From a development perspective, goals include the simplification and a more evidence-based and less empirical approach to the design of clinical studies, and better tools and approaches for data collection, extraction, analysis and interpretation so that innovation can be translated into practice more efficiently.

Furthermore, the project calls for more attention to be paid to ensuring that there is innovation in the manufacturing, regulatory and quality control cycle, to enable more affordable, faster, more flexible and less wasteful production. The project critically pointed out the need for more funding



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and partnership across sectors to support the networks and multidisciplinary infrastructures that are essential to R&D innovation for vaccines.

The project's far reaching consultation also reinforced the fact that vaccines are only as good as their vaccine implementation programmes, and that more must be done to understand and address vaccination hesitancy on the part of both the general public and healthcare professionals. The roadmap points out that there is great potential for more pan-European cooperation and collaboration in

this area, and for helping develop physical European Research Clusters for vaccines that bring science, entrepreneurs, investors and the most innovative vaccine producers together.

Ruxandra Draghia-Akli, Director of the Health Directorate at the European Commission's DG Research and Innovation (RTD), commented: 'The FP7-funded IPROVE project is an important contributor to building a strategic vision for future European activities in the entire innovation chain for vaccines, and to maintaining Europe's leading position in this important area of research, which

is close to the hearts of European citizens.'

The IPROVE project finished at the end of March 2016 and received around EUR 500 000 in EU funding.

IPROVE

- ★ Coordinated by the European Federation of Pharmaceutical Industries and Associations in Belgium.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/news/rcn/124902>
- ★ Project website: <http://iprove-roadmap.eu/>

NATURE-INSPIRED 'GLUE' TO FIX BROKEN BONES

Surgical glue that mimics adhesives produced by mussels to anchor them to rocks may soon replace plates, nails and wires for repairing broken bones.

Marine organisms like mussels produce glues that can withstand wet, turbulent environments to anchor them strongly to surfaces. This makes them a great place to look for inspiration when it comes to bonding agents for surgery.

While such marine-inspired bioadhesives are currently used for soft tissues (to repair wounds, for example), they need further tweaking for hard tissues like bones. The EU-funded DIADOM (Marine inspired biosilica-filled hydrogels) project combined a bioadhesive from mussels with marine silica to enhance bone mineralisation and hence growth.

"To combine the hydrogel with biosilica, they used nature-inspired chemical reactions that link amino acids together to form proteins."

combine the hydrogel with biosilica, they used nature-inspired chemical reactions that link amino acids together to form proteins.

When the team tested the mechanical properties of the adhesive hydrogel, they found that gels cross-linked with biosilica could resist greater mechanical forces than hydrogels alone. In addition, the hydrogel-biosilica system gelled in less than three minutes, suggesting it is suitable for gluing bone fragments and closing wounds rapidly during surgery.

Since DIADOM used natural silica from marine organisms, researchers needed to make sure it was not toxic to human cells. Biosilica extracted from algae in the Mississippi River was first tested for toxicity using mice cells. Researchers then tested the biosilica-hydrogel system in mice to see if it induced inflammation, and checked its effect on kidney, spleen and liver organs.

Having confirmed the system is not toxic in mice, researchers used human cells to look at bone cell response. Although they found no evidence of toxicity, the cells attached poorly to the hydrogel and they could not test the system any further.

DIADOM has demonstrated the important benefits of nature-inspired glue forming strong bone-to-bone bonds quickly. While it has promising biomedical applications, its ability to bond to surfaces and withstand mechanical forces needs improvement before patients can benefit from this exciting development.

DIADOM

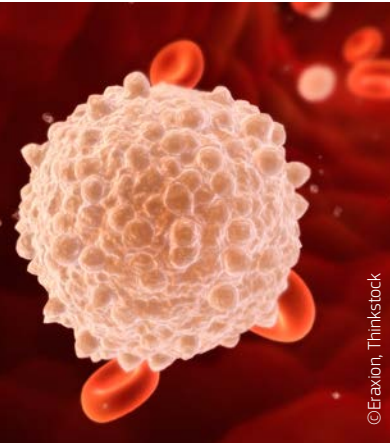
- ★ Coordinated by Queen's University Belfast in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/158482>



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THE ROLE OF IMMUNOGLOBULIN D IN AUTOIMMUNITY

'Systemic lupus erythematosus' (SLE) is an inflammatory autoimmune disease associated with increased levels of 'immunoglobulin D' (IgD). Understanding the connection between the two will lead to improved therapies for SLE.



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Immunoglobulins, or antibodies, are used by the immune system to recognise and neutralise pathogens such as bacteria and viruses. Over the years, we have come to characterise the five classes of antibodies (IgA, IgD, IgG, IgE and IgM) secreted by B cells and their function in health and disease.

However, despite the evolutionary perpetuation of IgD antibodies, it remains unclear how they work.

Recent evidence shows that IgD orchestrates an ancestral surveillance system at the interface between immunity and inflammation. To shed light on the function of IgD antibodies, scientists in the EU-funded ACIGDSLE (Regulation and function of IgD in systemic lupus erythematosus) project investigated their role in autoimmunity and in SLE in particular.

As a first step, they characterised the regulation of IgD by B cells, and discovered a functional connection with vitamin D (VD3). VD3 was shown to negatively regulate IgD induction by interfering with the IgM to IgD class switching at the DNA level. This finding was supported by the observation that SLE patients have high levels of IgD antibodies and VD3 insufficiency.

Preclinical data in a mouse model showed that IgD enhances primary Th2 responses by interacting with basophils and perhaps other effector cells of the innate immune system. Furthermore, researchers saw that IgD interacts with the transmembrane protein CD44, a process that may become deregulated in autoimmune disorders.

Collectively, the results of the ACIGDSLE study indicate that IgD antibodies are high in autoimmunity and may exacerbate the inflammatory process. The functional association with VD3 suggests novel ways to attenuate inflammation in SLE.

ACIGDSLE

- ★ Coordinated by IMIM in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/91800>

HUMAN STEM CELL DESTINY DETERMINATION

EU researchers have devised a microchip-scale environment to look at the mechanisms and components that regulate how each stem cell develops and arrives at its ultimate fate.

Somatic stem cells only retain their unique functions when in contact with instructive signals in their environment. In this so-called stem cell niche, stem cells integrate a fantastic number of molecular signals with their own regulatory networks. The result is a specialised cell with a specific function and frequency that will be able to respond to physiological demands within the body.

The EU-backed S.CE.N.E. (Deconstructing the stem cell niche in human interfollicular epidermis *in vitro*) project devised an ingenious experiment to investigate how stem cell fate

is determined. A microchip contains two sorts of islands, each of which can capture tens of thousands of stem cells. One traps the cells and

forces them to differentiate within 24 hours. In the other, larger-diameter island, the cells are able to spread and can therefore remain undifferentiated.

Researchers used high-content imaging analysis to monitor the fate of hundreds of thousands of outer skin-layer stem cells. They also harnessed fluorescent reporters to study the effect of receptor-ligand interactions on stem cell

differentiation. The sheer volume of data has generated data sets with a high significance level.

'Yes-associated protein' (YAP) was found to have a significant effect on stem cell development. As a transcription coactivator, YAP plays a critical role in organ size and is implicated in the development of human cancer. The team found that YAP is in part regulated by the physical properties of the substrate. Moreover, YAP overexpression can override niche signals.

The scientists then went on to look at the impact of Notch ligands expressed in the human interfollicular epidermis on stem cell fate. Some Notch ligands induced strong receptor activation and induced terminal differentiation in large-diameter islands whereas others partly blocked differentiation in smaller microchip islands.

S.CE.N.E. research results have established an *in vitro* platform with potential development application in stem cell niche interactions and drug discovery. Importantly, the platform provides an alternative to animal testing in toxicology.

S.CE.N.E.

- ★ Coordinated by King's College London in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180868>

"The sheer volume of data has generated data sets with a high significance level."

NOW ON CORDIS

Quantum technologies and supercomputers SPOTLIGHT ON THE FUTURE OF EUROPEAN ICT

Over the past 20 years, advances in computing have been mostly incremental. Manufacturers have had to stretch their imagination in order to appeal to customers, and evolutions focused mostly on software, interface and human-computer interaction. Computer architecture has remained largely unchanged. The true computing revolution is taking place behind the scenes, with quantum and High Performance Computing (HPC).

There is surging demand in Europe for a world-class High Performance Computing (HPC) infrastructure to process data in science and engineering. Supercomputers may be composed of thousands of processors working in parallel, but we must go further. The response to some challenges such as climate modelling, understanding the human brain or linking genome to health lies in the ability to understand the complexity of a huge amount of information coming from many sources. For this, exascale computing is crucial.

Taking a longer perspective, engineers from across the world are contemplating quantum computing as a way to completely replace the current binary digit system (bits) with quantum bits (qubits), in which each qubit can be in a superposition of states. Concretely, quantum computers would be able to solve certain problems much more quickly than any traditional computers using even the best known algorithms. But the ability of quantum technologies to transform our lives is not just limited to computing. Engineers and physicists across Europe are making exciting quantum advances in fields as diverse as metrology, medical technology, simulation mapping and geophysics.

The European Cloud Initiative, part of the Digitising European Industry Package, supports the development of both technologies. They will be the cornerstones of the future high-tech and digital economy, helping strengthen Europe's position in data-driven innovation, and supporting the creation of a Digital Single Market in Europe.

To keep an eye on breakthroughs enabled by EU-funded research, CORDIS is proud to announce the launch of two new Results Packs focusing respectively on HPC and quantum technologies.

NEW FRONTIERS FOR EUROPE WITH QUANTUM TECHNOLOGIES

Mastering quantum technologies is of strategic importance for Europe's enterprises, governments and citizens. By increasing their ability to manipulate quantum effects and materials, scientists and engineers can create devices with fundamentally superior performance and capabilities for communication, metrology, sensing, simulation, data security and computing.

The EU, which has invested around EUR 550 million in novel quantum technologies and their applications, is leading the way with an ambitious, long-term and large-scale flagship initiative.

SUPERCOMPUTING: A KEY CORNERSTONE OF THE DATA-DRIVEN EUROPEAN ECONOMY

The nature of computing is changing with an increasing number of data-intensive applications: by 2020, 25 billion devices will be connected and will generate over two zettabytes of traffic every year. In the face of these growing needs, the EU aims to see a supercomputer based on homegrown technology among the world top three by 2022. More than EUR 700 million have already been committed for HPC-related activities, and EU researchers are taking huge steps to bridge the gap between technical capacity and industry needs.

About CORDIS ResultsPacks

CORDIS ResultsPacks are a new set of products grouping EU-funded project results per topic and target audience. The aim is to disseminate information about new studies, scientific findings and technologies to the relevant target audience, in order to facilitate their exploitation across Europe.

SOCIAL SCIENCES AND HUMANITIES

STEM RESOURCES REPOSITORY HELPS IMPROVE TEACHING ACROSS EUROPE

European students are less and less interested in science, technology, engineering and mathematics (STEM). In fact, the EU is already running short of STEM professionals. To help Member States solve this problem, the EU-funded SCIENTIX 2 project provides strategies for the wide uptake and dissemination of 'Inquiry-based science and maths education' (IBSME), along with other methodologies known to improve the quality of science education.

'Recent evidence from a SCIENTIX comparative analysis on STEM education, published in January 2016, shows that countries across Europe are struggling to get students interested in STEM studies and careers. And to top it off, underachievement in STEM subjects is still above the 15% benchmark set by the strategic framework for European cooperation in education and training (ET 2020),' Dr Águeda Gras-Velázquez, Project Manager of Scientix and Science Programme Manager at European Schoolnet, says.

This trend is already what convinced her and her team to launch the SCIENTIX project back in 2010. The project, which set the stage for SCIENTIX 2, resulted in the first-ever online portal collecting and

presenting information from European projects in STEM education. The SCIENTIX resource repository currently contains over 1400 teaching materials, 700 research reports and 60 training courses which are used by over 3500 science teachers to enhance their courses. Those resources are produced by the 400 EU-, Member State- and locally-funded projects on STEM education that are part of the SCIENTIX online portal.

'For the past three years we have experienced a significant growth of registered online users and face-to-face participants. SCIENTIX organised 29 national conferences, a European one in Brussels, more than 20 webinars, online discussion forums, nine science workshops, 11 networking events, and much

more. More than 6000 people have joined our events and 6400 registered on our online portal,' Dr Velázquez adds enthusiastically.

SCIENTIX 2 picks up where its predecessor SCIENTIX left off, but it was also inspired by the report '*Science Education Now; A Renewed Pedagogy for the Future of Europe*' (Rocard – 2007) of which it aims to implement the first and fifth recommendations. These recommendations call for more active involvement of Member States in the renewal of science education as well as a better articulation between national activities and those taking place at the European level. In other words, while SCIENTIX defined the needs of the STEM education community in Europe, SCIENTIX 2 expands to the

national level through an active collaboration with National Contact Points.

'We now collaborate with 30 countries across Europe,' Dr Velázquez explains. 'More strategic outreach activities were carried out, and the cooperation with National Contact Points and teachers helped SCIENTIX get the word out to the European general education community.'

A long-term undertaking

Since SCIENTIX was completed in 2013, various improvements have been made to the portal and the translation service of resources in STEM education — which has been instrumental in the success of SCIENTIX so far. Registered users can now request translations of lesson plans, science exercises, research reports and all other resources available in 30 languages as long as they are published under a Creative

Commons License which allows for derivatives. 'We now receive hundreds of requests for translations of documents every year,' Dr Velázquez says.

The SCIENTIX strategy at the national level is already paying off, as outlined in the SCIENTIX comparative analysis: 'Examples from Belgium, Estonia and Austria show that they have already benefitted from the exchange of best practices. They were able to better incorporate innovative pedagogies and resources into existing teacher training programmes, and build networks for the professional development of teachers,' Dr Velázquez says. 'More countries are moving away from the traditional form of teaching and learning, in which the teacher is the centre of attention, to an inquiry-based learning and to teaching the socio-economic aspects of science.'

Of course, this shift from traditional forms of learning to a student-centred one, in which discovery is crucial, needs constant financial and political support which Dr Velázquez is happy to witness. SCIENTIX has already been granted another three years of funding. 'We will continue our activities by collecting resources and making them available, and by maintaining this

lively community which combines face-to-face activities, online training and communication. We also want to become more visible to teachers in training and training institutions, so that SCIENTIX becomes a reference point for all people interested in entering the teaching profession.'

Another key aspect SCIENTIX might have to keep focusing on in the future is gender equality: the project's comparative analysis reveals that initial and in-service teacher training did not address gender-specific interests and attitudes towards STEM education in 80% of the countries observed. 'By preparing teachers and making them more aware of how gender may affect people's attitudes towards STEM, we may attract more girls towards such subjects,' Dr Velázquez concludes.

SCIENTIX 2

- ★ Coordinated by European Schoolnet in Belgium.
- ★ Funded under FP7-SIS.
- ★ <http://cordis.europa.eu/project/rcn/110349>
- ★ Project website: <http://www.scientix.eu>
- ★  <http://bit.ly/1WlakA2>

"Registered users can now request translations of lesson plans, science exercises, research reports and all other resources available in 30 languages."

MORE EFFECTIVE TEACHING OF IRISH READING

Obtaining a clearer understanding of the challenges in teaching Irish reading and formulating an analysis of the Irish writing system can lead to a solid foundation for more effective teaching.



Developing literacy skills is a challenge for language learners across all levels. In Ireland, the first official language is Irish, a language which uses the same alphabetic system as English. However, the different sound-symbol correspondences between the two languages have proven to be a challenge for English-speaking learners of Irish. This can present a problem for children in schools in Ireland who are required to learn to read in both languages, but who evidence difficulty in achieving literacy skills in Irish. Adult *ab initio* learners of Irish (internationally as well

as in Ireland) also struggle with Irish orthography and experience negative transfer from English.

An EU-funded project, IRISH ORTHOGRAPHY (A psycholinguistic investigation of Irish orthography and reading), consisted of a collaborative study between a linguist and a psychologist. The main aims were to develop a better understanding of the problems encountered among learners acquiring Irish reading skills, and to produce a comprehensive analysis of Irish orthography that can be used in promoting interdisciplinary scientific discourse and pedagogical enhancement.

"Results include an analysis of teachers' perceptions of the challenges they face when teaching Irish reading as well as their approach."

Researchers initially conducted a needs assessment based on interviews with primary teachers in different school types, as well as other experts. This was followed by a detailed analysis of Irish orthography and a review and evaluation of existing materials. An eye tracking study followed that used a range of Irish texts of varying difficulty

to explore Irish reading among bilingual participants with different levels of proficiency in Irish.

Results include an analysis of teachers' perceptions of the challenges they face when teaching Irish reading as well as their approach (published in articles and chapters in national and international publications). A linguistic analysis of Irish spelling patterns in terms of the most frequently used words in children's books was also produced and will be published in 2016. Finally, a manual for teachers and adult learners was developed to address the needs identified by teachers and experts, and this manual is currently being prepared for publication.

Potential impact of the study results will span beyond the educational sphere to include socioeconomic implications, policymaking and civil society.

IRISH ORTHOGRAPHY

- ★ Coordinated by University College Dublin in Ireland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180898>

INNOVATIVE MODEL FOR UNDERSTANDING RISK TRADING AND GLOBAL MARKETS

Most of the largest reinsurance companies are based in Europe, accounting for about one third of the world market share. An EU initiative has provided better insight into trading practices and risks in order to make Europe an authority in the sector.

Europe is a major player in global reinsurance, but it is not necessarily recognised as the foremost authority whose expertise is sought after.

To help achieve this, the EU-funded ETHNOGRAPHYOFRISK (Interdisciplinary advances on behavioural theories of financial risk-taking: Innovative insights from a video-ethnography of live trading in global reinsurance markets) project sought to investigate how people relate to tools and technologies in reinsurance trading, and the implications of such interactions for financial risk-taking and assessment.

Several peer-reviewed papers were published in high-profile American and European industry and academic journals and drew heavily on the fields of economic sociology, technology and

ethnography. Additional papers on how different risk-trading procedures influence financial markets around the world were also published.

To complement the papers, a book was published with a leading university press and was primarily aimed at academics and practitioners interested in financial markets, risk, insurance, reinsurance and the technologies associated with risk trading. As the first worldwide ethnography of the finance industry, it looks into the custom of trading risk in the reinsurance industry worldwide by taking a novel approach to the coordination and functioning of global markets.

Four academic workshops attracted leading scholars to study existing theoretical standpoints and emerging

research on different fields related to the research focus. The objective was to find links among approaches and call attention to future research domains.

A set of tools and frameworks were developed to diagnose industry change and enable companies to act. These outcomes also revealed the possible dangers of systemic risk.

Research findings were presented at various key industry events, and at European and North American universities. Seven training masterclasses and two professional workshops supplemented industry reports, media articles, conference presentations and talks.

ETHNOGRAPHYOFRISK introduced novel behavioural approaches to financial risk management, and is well on its way to producing European thought leaders among major global reinsurers.

ETHNOGRAPHYOFRISK

- ★ Coordinated by City University in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/159683>

“A book was published with a leading university press and was primarily aimed at academics and practitioners interested in financial markets, risk, insurance, reinsurance and the technologies associated with risk trading.”



LOWER RISK FACTORS FOR BETTER LEARNING

A study has examined the effects of maltreatment and neglect on children's pre-academic skills, as well as the role of 'executive functions' (EFs) as mediators here. This innovative approach can shed light on the relationship between risk and protective factors and the pre-academic and EF skills of at-risk preschoolers.

Studies show that early exposure to contextual risk factors can lead to detrimental consequences for children's cognitive skills. **AT-RISK PRESCHOOLERS** (The Future of preschoolers at risk: The mediational role of executive functions on effects of maltreatment and neglect on pre-academic skills, and the moderation of family SES and classroom quality) was an EU-funded project focused on Portuguese preschoolers.

EFs that include working memory, inhibitory control and attention shifting had not been previously examined as mediators of the effects of these risks on pre-academic skills. The development of EFs has shown to be impaired in children who have been maltreated. Additionally, the study examined the moderating effects of the socioeconomic status of the family as well as classroom quality as related to risk factors and pre-academic skills.

Propensity score matching with a comparison sample of 68 school children from 31 public school classrooms or subsidised preschools was used. The neighbourhoods selected were from four of Portugal's largest cities. Additionally, a sample of 24 at-risk preschoolers was taken along with a random sample of 44 who were not under the care of Child and Youth Protection Committees (CPCJ); together they comprised the comparison group.

Results showed considerably lower skills in mathematics, literacy and EF in the at-risk group as opposed to the comparison group. Moderating effects of classroom quality regarding the relationship between risk factors and pre-academic skills were also included.

Practical implications of the study will be useful in the child protection, education and social security sectors. It can be used to inform policy and practice in child protection and ways to intervene, as well as how to change settings to better serve at-risk children.

"EFs that include working memory, inhibitory control and attention shifting had not been previously examined as mediators of the effects of these risks on pre-academic skills."

AT-RISK PRESCHOOLERS

- ★ Coordinated by the University Institute of Lisbon in Portugal.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180902>

IMMIGRANT POPULATIONS IN FOCUS

A large number of Europe's immigrant populations come from North Africa. Studying the impact of migration on health is vital in helping to improve their living conditions.

An EU-funded project, **EUNAM** (EU and North African migrants: Health and health systems), was unique because it looked at health conditions in both host countries and countries of origin. Participating countries from North Africa included Egypt, Morocco and Tunisia, and EU partner countries were Germany, France, Italy and Sweden.

Team members accessed a variety of survey and register materials relating to population migration health, disease patterns and healthcare systems. This information was useful for completing the overview of the participating countries.

The team successfully collected health information from France and Italy. They also examined the disease panorama of immigrants in Sweden in terms of many variables, including: cardiovascular diseases related to lifestyle, migration, heredity and environment; mental illness with interactions between genes, home environment and area of residence; pre-term births; and frequency of hospitalisation for type 2 diabetes in first- and second-generation immigrants.

Other areas under study included: healthcare utilisation by immigrants in

France; surveys of population well-being and healthcare in Morocco and Tunisia; and an overview of the disease spectrum in Egypt, with topics studied including cancer, obesity and cardiovascular diseases. Project members conducted workshops to discuss the documents and draft policy statements.

This work has the potential to help researchers and policy-makers better understand disease trends, with the goal of developing prevention strategies. By sharing information, countries in Europe can work together to combat disease, especially infectious diseases like AIDS and malaria.

Scientifically valid state-of-the-art evaluations and appropriate recommendations for scientific and health policy measures have been developed. These recommendations have been designed to improve the conditions for immigrants living in Europe.

EUNAM

- ★ Coordinated by the German Cancer Research Center in Germany.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/result/rcn/158644>
- ★ Project website: <https://www.dkfz.de/en/molgen/epidemiology/EUNAM/EUNAM.html>



ENERGY AND TRANSPORT

FLEXIBLE, COST-EFFECTIVE AND EFFICIENT LED LIGHTING PANELS AND SOLAR CELLS

An EU-funded project has created flexible lighting foils produced using a roll-to-roll method that could hold the potential for large-scale production of low-cost LED lighting panels and solar cells.

The TREASORES (Transparent Electrodes for Large Area, Large Scale Production of Organic Optoelectronic Devices) project set out to find innovative solutions and develop new technologies to reduce the manufacturing costs of LED lighting panels, solar cells and other organic electronic devices. Its most important contribution is the development and scaling-up of manufacturing processes for new barrier materials and transparent electrodes that are used in advanced flexible optoelectronics.

Transparent electrodes to reduce cost and improve efficiency

Three electrodes on flexible substrates, using thin silver, metal fibres, or carbon nanotubes, are either expected to start production this year or are already being developed on a commercial scale. Tests were carried out on the new electrodes with different types of optoelectronic devices, using rolls measuring 100 metres in length. The use of such 'Roll-to-roll' (R2R) processing is comparable to the methods used for newspaper printing. The new electrodes produced through this method have demonstrated that they are suitable for complex solar cells and light sources.

Crucially the innovative processing methods hold the potential to make solar cells and light sources less expensive in the future. This would bring benefits to consumers but would also facilitate the growth of more environmentally friendly lighting solutions, thus contributing to the European Union's ambitious climate change objectives.

The electrodes developed by the project are technically as good as the electrodes currently used by the lighting industry that are made from indium tin oxide. However, they are cheaper to produce and do not depend on the use of indium. Importantly, this does not compromise effectiveness, as the new electrodes are able to support a stable light source over a wide area and attain an efficiency of 25 lumens/W. This is comparable to the relatively slower sheet-to-sheet manufacturing process used to produce similar devices.

Additionally, the project consortium also devised new techniques to ensure that the new electrodes are able to operate even when they are bent repeatedly, a test that has the potential to become an industry standard.

Novel transparent barrier foils

The project also had another exciting outcome — the testing, development and scale-up of new manufacturing methods to create transparent barrier foils. Low-cost and high-performance barriers were created and are now being further advanced and commercially developed by Swiss-based consortium partner Flexibles Kreuzlingen.

These types of barriers are required to maximise the lifetime and efficiency of the device, a factor discovered by the project to be a crucial element when ensuring the economic and environmental viability of solar cells.

Overall, by integrating the production of electrodes and barriers, rather than using two separate plastic substrates, the project has demonstrated that manufacturing costs for the production of such devices can be significantly reduced, at the same time allowing for thinner and more flexible device designs.

Challenges and next steps

However, despite their great success, the project team has also faced the challenge of producing extremely flat, clean and smooth electrode and barrier foils. Optoelectronic devices feature active layers that measure several hundred nanometres, which means that even minuscule dust particles or slight surface irregularities can affect the device yield, or could result in a shorter lifetime and inconsistent, less effective illumination.

Even with the formal end of the TREASORES project in October 2015, the project partners have been continuing to address these challenges, preparing patents for the technology and moving towards full commercialisation of their novel devices. In total, the project received just over EUR 9 million in EU funding.

TREASORES

- ★ Coordinated by the Swiss Federal Laboratories for Materials Science and Technology in Switzerland.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/news/rcn/124884>
- ★ Project website: <http://treasures.eu>

NEW INSIGHT INTO SOLAR CELL FUNCTION

Using light to produce either electricity or hydrogen, 'Dye-sensitised solar cells' (DSSCs) are currently the most efficient third-generation solar technology. Increases in their conversion efficiency through better understanding of how light-absorption materials function will make them attractive for large-scale deployment.

DSSCs have attracted a great deal of attention as promising alternatives to traditional silicon-based solar cells, especially because they contain less expensive materials and require relatively simple manufacturing processes. Such cells consist of a photosensitised 'titanium oxide' (TiO₂) anode (covered with a molecular dye that absorbs sunlight), a liquid electrolyte and a metal cathode.

Given that the photocurrent depends on the dye nanomaterials, elucidation and control of their interfacial activity are indispensable for increasing the photoelectric conversion efficiency. Within the EU-backed POLYMAP (Mapping and manipulating interfacial charge transfer in polymer nanostructures for photovoltaic applications) project, scientists elucidated a relationship between the electrochemical or electrocatalytic activity of materials and changes in their morphology occurring at electrode interfaces in DSSCs.

By using a new high-resolution electrochemical scanning probe technique, 'Scanning electrochemical cell microscopy' (SECCM), scientists overcame challenges associated with studying nanostructured electrode materials. By

illuminating electrodes and using SECCM, they successfully mapped with sub-micrometre resolution variations in the photoelectrochemical activity of TiO₂ aggregates coated with a dye. Modulating the light intensity enabled the team to study loss processes that limit conversion efficiencies.

Given their fundamental role in charge-transport mechanisms, work was also geared towards preparing and conducting electrochemical characterisation of conjugated polymers that ranged in thickness from 5 to 500 nm. After putting them under the microscope, they observed variations in the electrochemical activity mainly because the electroactive films were heterogeneous. By also combining SECCM with atomic force microscopy and Raman microspectroscopy, the team found a relationship between the structure and reactivity of the electrodeposited organic films.

Other materials such as carbon nanotubes increased the chemical reaction rate and were found to be electroactive along their entire length. However, their morphology impacts on their reactivity.



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Scientists also demonstrated that pristine, defect-free carbon nanotubes are as effective electrocatalysts as gold. This has important implications especially for producing hydrogen peroxide for use as a fuel.

Lastly, iridium oxide nanoparticles were extensively investigated as water-splitting photocatalysts and demonstrated notable variations in their electrocatalytic activity as a function of the electrode potential.

Project results provide a new view of photovoltaic devices at the nanoscale, ultimately allowing for the design of improved DSSCs.

POLYMAP

- ★ Coordinated by the University of Warwick in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180880>

PROMISING NEW WING CONCEPTS FOR MORE EFFICIENT AIR TRANSPORT

An EU initiative has advanced aircraft lifting technology beyond the state-of-the-art. Modelling and design tools, novel configurations and wind tunnel test procedures should speed up commercialisation of greener aircraft.

Novel wing designs that reduce drag not only support lift but can also reduce fuel consumption and associated costs and emissions. With this in mind, the EU-funded NOVEMOR (Novel air vehicles configurations: From fluttering wings to morphing flight) project set out to improve performance by investigating a novel joined-wing configuration and the use of wings that change their shape.

Project partners examined the benefits and application of morphing technology in aircraft. They proposed morphing wing solutions such as span and camber strategies and wing tip devices to enhance lift capabilities and manoeuvring. Software tools were developed for the design of the morphing concepts and mechanisms.

A reference aircraft was defined to serve as a benchmark for assessing the potential performance benefits of morphing devices and the joined-wing configuration. The morphing mechanisms and concepts were then applied to the newly developed aircraft configurations.

Team members analysed the stability, flight mechanics and aerodynamic performance of all the concepts applied to the regional jet and joined-wing aircraft. No issues were reported.

The morphing concepts and joined-wing configuration were successfully validated through wind tunnel tests.

The overall benefits of the concepts were assessed by considering elements such as weight fluctuations and lift and drag.

NOVEMOR outcomes should significantly decrease the costs of design and development as well as aeroplane operation costs and emissions. Perhaps equally important, it will help put the EU in a leadership position regarding efficient and environment-friendly air transport.

"The morphing concepts and joined-wing configuration were successfully validated through wind tunnel tests."

NOVEMOR

- ★ Coordinated by Instituto Superior Técnico in Portugal.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/result/rcn/91601>
- ★ Project website: <http://www.novemor.eu/>

HYBRID PROPULSION SYSTEM PROMISES TO SHAKE UP AVIATION INDUSTRY

An EU-funded project has developed an electric hybrid propulsion system for small aircraft that will not only lower emissions but also significantly reduce fuel costs.

The HYPSTAIR (Development and validation of hybrid propulsion system components and sub-systems for electrical aircraft) project, which began in September 2013 and officially ended in February 2016, has designed a serial hybrid propulsion system for small aircraft that uses an electric motor to drive the propeller. The electrical power can be sourced either from a battery pack, that can be recharged during the flight, or from an on-board fuel powered generator.

Project researchers have designed the hybrid propulsion system's components from the conceptual stage. The components have been sized and designed considering the performance and energy efficiency of the complete airframe-propulsion system, and the finished prototype engine has recently been tested for the first time in Ajdovscina, Slovenia.

The plane chosen for the first test flight was provided by Pipistrel, the Slovenian light aircraft manufacturer that coordinated the project. All of the powertrain components were developed by fellow project consortium member Siemens, a global leader in electric propulsion.

New hybrid specifications

For the initial testing, a five-blade, low-rpm propeller was attached to the motor. The first power-up tested all power modes at low and high power settings. Additionally, all of the components were

designed with all existing aviation safety and certification regulations in mind.

The HYPSTAIR project's 200 kW motor is the most powerful hybrid electric powertrain developed for aviation to date, providing an equivalent amount of power as typical aviation engines. The HYPSTAIR drive motor is designed to deliver 200 kW for takeoff and 150 kW in cruise mode. The motor can run in electric-only mode, using battery power, generator-only mode or hybrid mode combining the two.

Whilst the HYPSTAIR tests have been highly promising, the current limitations of electric energy storage technology make an electric-only propulsion system unsuitable for long distance flying. Consequently, an on-board generator provides a weight-efficient, if somewhat less energy-efficient, power generation solution.

To realise a highly capable hybrid propulsion system, the electric motor and generator have been designed with special emphasis on high power densities to reduce the weight of the propulsion system. This therefore maximises the airplane's payload. Special attention was also given to the component's efficiencies in order to realise the potential for increased energy efficiency.

Tailored 'Graphic user interface' (GUI)

The project has also developed a tailored GUI for hybrid drives following extensive

tests and simulations. They comply with customs and regulations for the display of information in aeronautics, but bring innovations through the use of systems and regulations from other fields (automotive and marine).

The new GUI has been designed in a way that is familiar to professional pilots in a layout similar to the analogue instrumentation. This type of representation and layout can particularly help pilots from older generation aircraft (that have lower levels of computerisation) or those with poor training on digital systems.

As such, the design of the human-machine interface has emphasised simplicity and a high level of automation that will reduce the pilot's workload. The design places emphasis on the pilot being able to receive important information on the state of the hybrid system through visual and haptic cues. Overall, the project hopes that its innovative interface system will be adopted as standard by the aviation industry.

Next steps

With the end of the project, the aim is to begin installation of the components developed into a flying airframe that will pave the way for the commercialisation of a hybrid drive airplane.

Furthermore, the components developed during the project, as well as obtaining the necessary certification standards, would also allow other airframe and electrical component manufacturers to enter the market of hybrid and electric propulsion aircraft.

The success of the project would therefore help to open a completely new aviation market. The EU could have a clear market advantage by not only defining the standards but also pioneering the first designs specifically tailored for this market.



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HYPSTAIR

- ★ Coordinated by Pipistrel Aircraft in Slovenia.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/news/rcn/124890>

MODERN STATION DESIGNS FOR PROTECTION AGAINST HARMFUL POLLUTANTS

EU-funded researchers have discovered that the adoption of a specific station design would significantly reduce the exposure of underground metro travellers to harmful air pollutants.

The Seventh Framework Programme-funded HEXACOMM (Human EXposure to Aerosol Contaminants in Modern Microenvironments) project, in collaboration with the European Commission's LIFE programme-funded IMPROVE project, has published the results of a study investigating the air quality in underground metro stations and how station design could limit travellers' exposure to potentially harmful pollutants.

Underground trains are amongst the most widely used public transport systems in the world, and the millions of commuters and tourists who use them daily are at risk of being exposed to pollutants such as 'particulate matter' (PM) which has been linked to health problems including heart and respiratory diseases. Potential sources of these particles in metro systems include the wear of brakes, wheels and rails, as well as outdoor air that enters stations through ventilation systems and entrances.

Experimentation on the Barcelona metro

The two projects identified the concentration, chemical composition and sources of fine particle matter (PM2.5) on the Barcelona metro system. During two seasonal periods (warm — April to July 2013 and cold — October 2013 to March 2014), high volume samplers were placed on the platforms of four stations to collect PM2.5.

Each location chosen represented a specific station design. Three of the chosen locations for the study were older stations, designed with one or two rail tracks, with or without a dividing wall between tracks. The fourth station chosen had a modern design, with safety-conscious sliding doors across the platform edges, separating them from the tunnel. The research team also measured PM2.5 in outdoor air at a suburban Barcelona station for comparative purposes.

An analysis of the results highlighted that concentrations of PM2.5 were variable at the different stations and during the two different seasons. Higher concentrations of PM2.5 were recorded at all stations during the colder season. This is likely due to increased air ventilation during the warmer period that results in an increased dispersion of PM2.5.

Researchers also discovered that concentrations of PM2.5 were lowest at the station with the most modern design, compared to the older stations. They argue that this is likely due to the sliding door, which keeps tunnel air separate from the platform. Better ventilation in the new station, alongside the fact

that the station was visited by fewer trains, also likely contributed to the better air quality.

The two projects also examined the chemical composition of the samples received. The largest component of PM2.5 (28-65% of the total) was haematite, generated mainly by the abrasion of rail tracks, wheels and brake pads. Haematite concentration was 60% lower in the modern station, where the tunnel was separated from the platform. Based on this, the researchers suggest that the haematite found on the metro platforms originate from the tunnel.

It was also found that PM2.5 concentrations were 1.4 to 5.4 times higher in all metro stations compared with outdoor air. Additionally, concentrations of some trace metals, such as barium, copper, manganese and zinc were higher in metro stations than in outdoor air. Between the four test stations, the lowest trace metal concentration was found in the modern station.

Building modern stations for better protection

The research team concluded that to better protect travellers from potentially harmful pollutants, rapid transit planners should take better ventilation into account, as well as overall station design. They particularly emphasise that screen doors installed on platforms reduce exposure to PM2.5, and they also have the additional value of protecting passengers from falling or jumping into the path of oncoming trains.

One of the core research objectives of the HEXACOMM project is to determine the human exposure to particulate matter in modern microenvironments. It is due to finish at the end of 2016 and has received approximately EUR 4 million in EU funding.

The LIFE programme-funded IMPROVE project is specifically focussing on the improvement of metro system indoor air quality.

HEXACOMM

- ★ Coordinated by the Research Committee of the Technical University of Crete.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/news/rcn/124906>
- ★ Project website: <http://hexacomm.nilu.no/>
- ★  <http://bit.ly/1VIB19d>



ENVIRONMENT AND SOCIETY

NEWLY PUBLISHED FINDINGS SHOW SPECIES-DIVERSE FORESTS BRING GREATER ECOLOGICAL BENEFITS

EU-funded researchers have released findings that highlight how forest homogenisation results in lower overall ecosystem performance.

Publishing in the renowned scientific journal 'Proceedings of the National Academy of Sciences', researchers from the FUNDIVEUROPE (Functional Significance of Forest Biodiversity in Europe) project have highlighted how species-rich forests give rise to a higher number and more varied range of services than those with fewer species. Over the course of five years, the project studied 200 forests across six European countries.

The trees that comprise the world's forests provide valuable services on behalf of humankind. They filter dust from the air, turn carbon dioxide into oxygen, protect the ground from erosion, help ensure the supply of drinking water, and provide a ready source of wood for construction and heating. Additionally, forests are also used for sport and recreation.

Benefits of multi-species forests

However, the project found that the majority of European forests merely consist of one or just a small selection of tree species. With this discovery, the

FUNDIVEUROPE researchers tasked themselves with investigating the correlation between local and regional biodiversity, as well as ecosystem services, based on European forests in a range of climatic zones, from Finland to Spain.

Those forests that were more species-rich were found to offer more services to humankind and nature than those with fewer species. The researchers point out that one tree species is indeed able to provide individual services, such as high quality wood, but a species-diverse forest can achieve a plethora of simultaneous services. These can include the provision of bird habitats, an attractive tourist destination and an environment in which to conserve water.

The project also concludes that encouraging further forest diversity should be easy to achieve by supporting natural seed dispersal and varied young growth, as well as physically planting additional species and varying how species are put together in large woodlands. However,

such measures are not often taken in EU Member States.

Organising the project

FUNDIVEUROPE's organisation was based on three scientific platforms. Firstly, the European sites of a global network of tree diversity experiments ('Experimental Platform') were used to establish causal relationships between biodiversity and ecosystem functions. Secondly, the project set up a newly designed network of 209 study plots in existing mature forests ('Exploratory Platform'). The platform covered six focal regions representing important European forest types along the gradient from Boreal to Mediterranean forests. Thirdly, within the 'Inventory Platform', existing information from national forest inventories and other forest monitoring networks had been compiled.

In addition to these three research platforms, FUNDIVEUROPE set up a web-based knowledge transfer platform in order to foster communication, aggregation and synthesis

of individual findings and communication with stakeholders, policymakers and the wider public. The information gained enabled forest owners, forest managers and forest policy makers to adapt policies and management for the sustainable use of forest ecosystems in a changing environment, capitalising on the potential effects of biodiversity for ecosystem functioning.

Possible policy contributions

Now that FUNDIVEUROPE is over, the project team has presented strong

arguments to European policymakers, stressing that efforts should be made to diversify the continent's forests. They argue that the aim of increasing forest species diversity to address the challenges of future forest management must be based on an assessment of the consistency in existing EU and national regulations and policies. They point out that the benefits of increasing species diversity are compatible with the aims of several existing EU policies and strategies, such as its biodiversity policy, native species policy and Europe 2020 strategy.

The project results and the data collected could also contribute to possible future EU actions on addressing climate issues in the wake of the COP21 climate conference in Paris in December 2015.

FUNDIVEUROPE

- ★ Coordinated by Albert Ludwigs University of Freiburg in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/news/rcn/124903>
- ★ Project website: <http://www.fundiveurope.eu>

ELECTRICAL TREATMENT CAN CLEAN CONTAMINATED ENVIRONMENTS

Scientists across Europe are harnessing the power of electrokinetic transport to remove contaminating chemicals from the environment.

‘Electrokinetic’ (EK) transport processes are a new technology that uses low direct current to clean soils and waste. The technique removes certain elements from the environment and has applications such as soil remediation, waste treatment and nutrient recovery.

The EU-funded ELECTROACROSS (Electrokinetics across disciplines and continents: An integrated approach to finding new strategies to sustainable development) initiative supported electrokinetics research across Europe. The project investigated using EK for nutrient recovery, remediation of organic and inorganic pollutants, and the restoration of salt-damaged buildings.

Researchers developed a new method for removing valuable waste phosphorus from wastewater by coupling EK with nanofiltration. They also tested whether EK could remove contaminants such as pesticides and heavy metals from soil and sewage sludge. In general, a combination of

EK and electrodialysis treatment successfully decontaminated the samples.

The team showed that this process could be used to restore and desalinate tiles and other building materials to extend their lifespan. Lastly, EK works well to decontaminate plastic and phenol waste in combination with nanotechnological cleaning agents.

Soil remediation and the recovery of various contaminants from wastes is an increasingly important part of sustainable development. ELECTROACROSS has harnessed an exciting new technology to achieve this goal.

ELECTROACROSS

- ★ Coordinated by FCT in Portugal.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/92013>
- ★ Project website: <http://sites.fct.unl.pt/electroacross>



NEW POLICY RECOMMENDATIONS TO FACILITATE EU ACTION AGAINST ENVIRONMENTAL CRIME

The EU-funded EFFACE project has delivered a series of comprehensive recommendations on how the EU can better detect incidents of environmental crime and suitably punish those responsible.

Although there are differing opinions on the exact definition of environmental crime, the project, which hosted its final conference in Brussels from 17 to 18 February 2016, worked on the basis that environmental crime effectively damages the environment and often also has a negative impact on people living in the affected areas. Environmental crime can also be linked to organised crime or corruption, and, as such, incidents can take on many forms.

The EFFACE (European Union Action to Fight Environmental Crime) researchers undertook 12 detailed case studies that focused on various sectors affected by environmental crime, both within the EU and in third countries. These included a focus on mining, fisheries, wildlife conservation, waste, pollution and the illegal cultivation of narcotics.

Through the case studies, the project provided detailed recommendations on how the EU can better identify, prosecute and punish individuals or organisations that commit acts of environmental crime.

The importance of reliable data

One of the key conclusions that was repeatedly emphasised throughout the conference was the need to improve data gathering and analysis methods.

The project looked at the issue of data from a variety of angles, including within EU Member States, at EU level, internationally and through the scope of different types of crime. The overall picture was of a fragmented data landscape, where some EU Member States may possess good data on environmental crime, but such data is not compared, collated or shared with other Member States or at EU level.

EFFACE has recommended that there should be an obligation imposed on EU Member States to provide relevant data on the precise number of violations, prosecutions and imposed sanctions for breaches of European environmental law.

This would not only help Member States adequately target real violations, but also guide action and channel support from the EU level to where it is most needed. 'Smart environmental crime



enforcement relies on data to direct resources to where they are most needed: what, where and when to make inspections,' commented Andrew Farmer from the Institute for European Environmental Policy (IEEP), who presented the project's findings.

The project also recommended more technological innovations to improve data collection, such as using satellites to track incidents of illegal fishing and fossil fuel-related pollution, or the use of DNA tagging to combat poaching and wildlife destruction.

A stronger legal and administrative framework

EFFACE also provided detailed recommendations on how the EU can reinforce its legal and regulatory frameworks to be more effective in tackling environmental crime.

First amongst its core proposals regarding the EU, the project argues that rules on the confiscation and forfeiture of the proceeds of environmental crime should be adopted at EU level — in essence, those who commit environmental crime should not be allowed to profit from it. Finally, there should be minimum criteria in the EU for inspections and monitoring that all Member States should follow.

At Member State level, there should be effective sanctions, including civil and administrative sanctions that also include fines. When relevant, perpetrators of environmental crime should also be made to repair the damage they've caused.

The need for a wider and more comprehensive toolbox for combating environmental crime, through administrative, civil and — when necessary — criminal means, was succinctly summarised by Michael Faure, Chair of the Flemish High Enforcement Council for the Environment: 'Enforcement policy should be just like a good Belgian café — there should be many different penalties on draught to choose from.'

Next steps

Although the EFFACE project will be ending shortly, its project team has highlighted a number of topics that are suitable for further research and consideration.

This includes whether or not harmonised sanctions against perpetrators of environmental crime should be adopted into EU law and further research on how effective these are likely to be.

Finally, the external dimension of the EU's efforts against environmental crime should also be studied in more detail. EFFACE argues that the EU should take incidents of environmental crime beyond its borders seriously, but acknowledged that there is still a serious debate to have on how far the EU should go in this regard, and what this would mean in practice with regards to its external policy priorities.

EFFACE

- ★ Coordinated by the Ecologic Institute in Germany.
- ★ Funded under FP7-SSH.
- ★ <http://cordis.europa.eu/news/rcn/124860>
- ★ Project website: <http://efface.eu>

THE EVOLUTION OF KILLER WHALE DIALECTS

A new study has revealed that killer whale dialects evolve in much the same way as human language, and as such represent a form of animal culture.

Killer whales have vocal dialects — a unique repertoire of clicks, whistles and calls shared by each pod — similar to bird song or human language. Since dialects are passed from mother to offspring through social learning and copying, scientists believe they may change gradually with time by random copying errors.

The EU-funded DIALECT EVOLUTION (Principles of dialect evolution in killer whales) project used both evolutionary biology and human linguistics computational tools to confirm how killer whale dialects evolve.

Researchers first created models of the different ways that calls can change when passed on from one generation to the next. These ranged from random call mistakes accumulating over time, to major innovations representing

evolutionary ‘leaps’ between generations. They showed that differences in calls between different whale pods in nature can only be explained by a combination of random errors and innovations.

To confirm this model, researchers analysed group call repertoires of two distinct North Pacific killer whale populations containing different group sizes and social stabilities. They also compared Icelandic and Norwegian populations to the North Pacific groups.

Overall, the finding that innovations play an important role in dialect evolution agreed with their model. In this case, dialects split over time into distinct groupings, rather than one call type gradually evolving into another.

Interestingly, call similarities did not always correlate with genetic relatedness, suggesting major differences between cultural and biological evolution. While biological evolution occurs almost entirely through random genetic errors and natural selection, cultural evolution occurs more quickly via innovation, and includes non-genetic influences.

Besides uncovering a universal mechanism of cultural evolution shared by social groups, including humans, this study provides a way to acoustically identify killer whale populations. Monitoring different populations is important for conserving and managing this threatened species.



DIALECT EVOLUTION

- ★ Coordinated by the University Court of the University of St Andrews in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180894>

OFFSHORE PLATFORMS FOR SUSTAINABLE DEVELOPMENT OF OCEAN RESOURCES

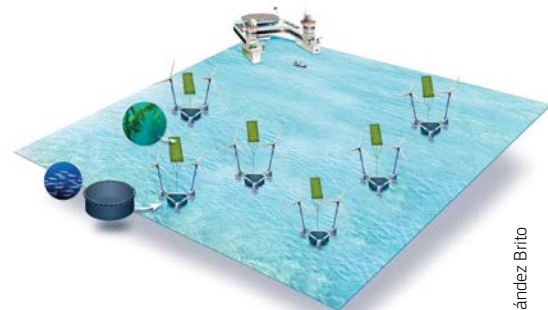
Europe’s coastal areas are becoming more crowded and space for developing marine renewable energy and other environment-friendly technologies is limited. Floating offshore platforms capable of supporting a range of sustainable, eco-friendly activities could be the answer we are all looking for.

The aim of the EU-backed TROPOS (Modular multi-use deep water offshore platform harnessing and servicing Mediterranean, subtropical and tropical marine and maritime resources) project was to develop a floating ‘Multi-use platform’ (MUP) capable of operating in deep water where fixed structures are not feasible.

The platform comprises a central unit with different modules for aquaculture, maritime transport, renewable energy and leisure. These modules will allow access to the ocean’s resources and ensure they are used in a sustainable way.

TROPOS and its sister projects H2OCEAN and MERMAID were part of the ‘Ocean of tomorrow’ cross-thematic initiative whose objective was to develop new ideas for sustainable development of the marine environment. TROPOS developed MUPs capable of sharing sites, infrastructures and reduced costs while minimising negative environmental impacts.

Project partners identified MUP locations that had marine renewable energy sources and were suitable for aquaculture, leisure and maritime transport support services. The consortium also developed



innovative designs for platforms that enable them to be spaced close together.

Appropriate locations were identified for the different concepts with the help of a specifically designed support tool. A Green & Blue scenario was

located north of Crete, integrating wind energy exploitation and fish and algae aquaculture.

The Leisure Island scenario was sited off the coast of Gran Canaria and combines leisure facilities with the use of solar energy. The Sustainable Service Hub was located on the Dogger Bank in the North Sea and focuses on transport and energy-related needs.

In addition, two future scenarios were also developed. The first was a Green & Blue scenario in Taiwan, which integrates

aquaculture ocean thermal energy conversion for energy supply. The second was the Offshore Container Terminal in Panama, which is intended to serve as a central energy and transport hub.

The design of the three official scenarios was specified in great detail. All scenarios were assessed by considering their particular logistic requirements, economic viability, and environmental and socioeconomic impacts, and refined according to the results wherever necessary and feasible.

MUPs developed by the TROPOS consortium promise an exciting, innovative and environment-friendly solution for harnessing solar and offshore renewable energy and other resources from the marine environment.

TROPOS

- ★ Coordinated by PLOCAN in Spain.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/result/rcn/92768>
- ★ Project website: <http://www.troposplatform.eu/>

MAMMAL'S RESPONSE TO ENVIRONMENTAL CHANGES

A 22-year-long study showing how an Alpine mammal responded to changing environmental conditions may help scientists predict the impacts of future climate change.

Today's rate of biodiversity loss is one thousand times higher than historical rates of extinction. As a major driver of this catastrophic loss, climate change represents a significant environmental challenge worldwide.

To better understand the consequences of climate change for biodiversity, the EU-funded ARC (Adaptive responses to climate change) initiative studied an Alpine mammal's response to environmental change.

The hibernating Alpine marmot (*Marmota marmota*) is part of the highly vulnerable ecosystem of the Alps, and, as such, represents an ideal model species. Researchers used data from 1 329 marmots captured over 22 years (1991-2013) to evaluate marmot populations' vulnerability or resilience to current climate change.

During the study, spring ambient temperatures increased, summer drought became more frequent and winters became harsher. In response to these environmental changes, a decrease in litter size was detected, and preliminary analyses showed subsequent changes in population dynamics. Investigating the dynamics of size, mass and body temperature — three physical characteristics strongly related to reproduction and survival — can provide mechanistic insight into the relationship between environmental variables and population dynamics.

Over the 22 years of study, Alpine marmots' size decreased while mass stayed constant. Moreover, while size responded only to inter-annual variations in spring conditions, mass was further influenced by summer and winter conditions. However, both traits' dynamics did not involve any genetic response to selection.

By recording body temperatures of 40 marmots over two years, researchers discovered that marmots were able to adjust their body temperatures according to environmental conditions; during both hibernation and active periods. During the hibernation period, they adjusted their body temperature to the burrow-specific ambient temperature, which can be buffered by the social environment. Outside the hibernation period, marmot body temperature and activity was also highly flexible. In summer, patterns of



body temperature reflected temporal variation in air temperature, rainfall and wind speed.

In particular, researchers observed low body temperatures (below 32°C) and low activity during cold and rainy days during the active season. Marmots may therefore respond to challenging environmental conditions by going into daily torpor (i.e. a type of brief hibernation state) until conditions improve.

If marmots can adapt to environmental disturbances by adjusting their size, mass and body temperature accordingly, the most flexible individuals should produce the most offspring and survive better. Thus, the evaluation of the complex dynamics between traits and their plasticity to environmental change will enhance researchers' ability to assess whether or not the observed plasticity could be an adaptive response to environmental change. This would also shed light on whether marmot populations may be resilient enough to cope with future climate change.

Understanding how climate change affects the viability of a vulnerable mammal population, following the mechanistic approach demonstrated in this research, will help policymakers to forecast population changes and develop conservation strategies.

ARC

- ★ Coordinated by the University of Zurich in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180893>

HERE COMES THE RAIN AGAIN — IMPROVED STATISTICAL MODELS OF FLOODS

A new approach by EU-funded researchers, based on sophisticated statistical analysis of flood events, emphasises the importance of the role of different atmospheric and hydrological processes in multivariate flood frequency estimation.

When water resource managers conduct flood frequency analysis, one of the greatest challenges they face is modelling two or more dependent variables. The project IMPALA (Improved multivariate frequency analysis of flood extremes by copulas in a non-stationary environment) offered a multidisciplinary solution to this problem.

“A novel methodology was developed to identify storm events with convective character on the basis of high-resolution climatological data and lightning activity.”

The answer comprises copula-based multivariate frequency modelling of flood extremes, which includes information on historical and regional ungauged extremes. Copulas are statistical tools used to describe the dependence between two random variables and are suitable for modelling the frequency of multivariate flood extremes. The IMPALA initiative set out to improve the multivariate frequency modelling of flood variates by increasing the number of observations at the extremes of the marginal distribution of flood data.

Extraordinary flood data was included in a univariate flood frequency analysis through Bayesian Markov chain Monte Carlo techniques. The project made use of

existing Europe-wide databases of streamflow records and catchment descriptors as well as data from the relevant Austrian and Slovakian authorities.

Generally, studies dealing with fitting univariate or multivariate frequency models to observed data do not go beyond the statistics; the hydrological and/or meteorological drivers of flood processes are usually not explored. Therefore, the IMPALA project was mostly governed by the philosophy that it is inevitable to differentiate between flood driving mechanisms.

Within the IMPALA project, a novel methodology was developed to identify storm events with convective character on the basis of high-resolution climatological data and lightning activity. The methodology proved to be useful in the typology of flood processes, since convective storms are precursors of flash floods.

In a related study, the variability in the Clausius-Clapeyron rates of increase in precipitation intensity with air temperature was examined. The outcomes have serious implications on hydrological risk: as a consequence of the climate change, the mean air temperature is expected to rise, which implies higher Clausius-Clapeyron scaling rates, and this might be manifested in more severe rainstorms and, consequently, flash floods.

Researchers further examined whether floods have changed in the past and explored the processes in the

atmosphere, the catchments and the river systems in Europe that drive such changes. Moreover, methods were reviewed for assessing whether floods may increase in the future and suggestions were made for integrated food management to deal with the risk of future flooding.

The dependence between flood peaks and flood volumes in Austria was analysed for different flood processes (synoptic, flash and snowmelt floods). It was found that uncertainty in statistical models can be reduced through deeper hydrological analysis of the factors influencing flood peaks and volumes. The reliability of the frequency estimation can also be enhanced by taking into consideration the model's suitability and the flood generation mechanisms in the target region.

IMPALA outcomes will help to answer many theoretical and practical questions regarding flood risk and the hydrological cycle. They therefore support the work of the scientific community and will benefit professional end users, flood mitigation policymakers, non-governmental organisations, and national, regional and local authorities.

IMPALA

- ★ Coordinated by Vienna University of Technology in Austria.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180895>



IT AND TELECOMMUNICATIONS

NOVEL PROTOCOLS AND ALGORITHMS TO OPTIMISE WIRELESS NETWORKS

With the exploding popularity of all things wireless, the ‘radio frequency’ (RF) spectrum has become a scarce commodity. In response, an EU initiative has provided solutions to boost the performance and efficiency of wireless networks.

Without enough RF, the frequencies and airwaves that wireless signals get transmitted over, mobile providers are not able to offer the most optimal and cost-effective services to consumers.

To address this issue, the EU-funded WINIE (Wireless networks with interference exploitation) project set out to develop algorithms and protocols to enhance the capacity of wireless networks. The focus was on examining the

“The focus was on examining the potential of physical-layer network coding to considerably improve the capacity of distributed and dynamic wireless networks with multiple communicating stations.”

potential of physical-layer network coding to considerably improve the capacity of distributed and dynamic wireless networks with multiple communicating stations.

The WINIE team designed, applied and validated vari-

ous protocols and signal processing algorithms for wireless networks. The complete set of developed protocols and algorithms enable several wireless network users to transmit simultaneously over the same RF spectrum.

To achieve such network efficiency as network users continuously grow, two novel approaches were carried out. First, project partners introduced a protocol that selects which two users should transmit simultaneously. This consistently performs better than contemporary multi-source or standard cooperative protocols. Second, they proposed ‘Distributed space-time codes’ (DSTCs) to address the simultaneous transmission of multiple users and the signals that interfere with the relays. The DSTCs were found to significantly boost the RF spectrum efficiency of wireless communication.

WINIE delivered efficient algorithms and protocols to tackle several issues, from RF spectrum scarcity and its physical constraints to wireless network interference. The wireless sector that develops and standardises communications protocols stands to benefit from these innovations, and ultimately so will the users of these networked systems.

WINIE

- ★ Coordinated by the University of Thessaly in Greece.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180896>

ENHANCED CRYPTOGRAPHY MEANS MORE SECURE DATA

Hackers often break into smart cards and other secure technologies, undermining current cryptographic technology. One enterprising EU-funded project is helping to overcome this challenge.



Cryptography, which involves techniques for secure communication without the intrusion of third parties, is pivotal for protecting all kinds of data. From ensuring the confidentiality and integrity of online payments to validating electronic passports, the technology relies on security proofs for developing algorithms that minimise attacks or hacks from external parties.

Although the black-box computation reasoning behind cryptography is considered foolproof, in practice the interaction of outside parties (known as adversaries) with a cryptographically secure device can be compromised. Using side-channel attacks, hackers can measure the running time, power consumption or other external parameters of a device to help break into an encrypted system based on the black-box model.

With this in mind, the project GAPS (Guiding physical security by proofs) is developing a better theory for physical security based on the proof-driven design approach. It is working to prevent side-channel attacks on the black-box model to extend the proof-driven security analysis in cryptographic implementations.

In more technical terms, the project's three-pronged approach involves developing better masking schemes, enhanced designs for leakage-resilient symmetric cryptography, and new computer-aided physical security analysis. In this respect, the project team is investigating the so-called masking countermeasure widely used on smart cards to protect against power analysis attacks. It is developing new security models and proof techniques for the masking countermeasure.

From this perspective, GAPS successfully demonstrated the relationship between the two key cryptographic black-box security models, namely the probing model and the noisy leakage model. Although it is easier to develop and automate security proofs in the probing model, the project is focusing on proofs for the noisy leakage model, which is closer to practical applications and has the potential to enhance security significantly.

Project results could have a major impact on countering attacks against smart cards. These are widely used not only for payment transactions but also for a variety of activities and applications from medical insurance to mobility and access. The project's results so far have led to seven publications that will help stakeholders strengthen cryptography and improve confidentiality in unprecedented ways.

“GAPS successfully demonstrated the relationship between the two key cryptographic black-box security models, namely the probing model and the noisy leakage model.”

GAPS

- ★ Coordinated by the EPFL in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180871>

NEW ON-CHIP LIGHT SOURCES FOR SILICON PHOTONICS

Silicon photonics is an ideal platform for building intelligent transceivers for high-speed fibre optic links. However, the lack of suitable light sources close to the chip is the main bottleneck holding back the technology from truly transforming the landscape of telecommunications networks.

The demand for high data rates and more compact and lower-cost optical devices has been the main driving force behind integrating photonics on silicon chips. Until now, many efficient optical devices such as filters, modulators, multiplexers and detectors have been developed and take advantage of state-of-the-art silicon technology.

By developing new light sources, which are the other main transceiver elements, and properly integrating them on silicon chips, the EU-backed HYSSOP (Hybrid III-V/silicon laser for the future generation of photonic integrated circuits) project sought to overcome the main obstacle hindering widespread use of silicon photonics. The focus was on semiconductor lasers fabricated from both silicon and group III-V semiconductor materials. Silicon waveguides were first fabricated on a silicon-on-insulator wafer that was then fused to a III-V epitaxial semiconductor wafer.

The project team successfully demonstrated the potential of different hybrid silicon lasers for applications ranging from short-reach optical interconnect to long-distance optical transmission.

'Distributed feedback' (DFB) lasers integrated with high-speed modulators are an emerging application of 100 Gb Ethernet. Scientists unveiled a standard-compliant transceiver module using a 25 mW hybrid silicon DFB laser operating at 1550 nm integrated with a modulator. The output power exceeded the 10 mW threshold set for this standard.

Another major achievement was the development of tunable hybrid silicon lasers that can be used at both the transmitter and the receiver side in long-haul optics. Scientists carried out extensive work to demonstrate lasers with wide tunability and high output power. To reach the required power value for long-distance communications, the team coupled a low-noise

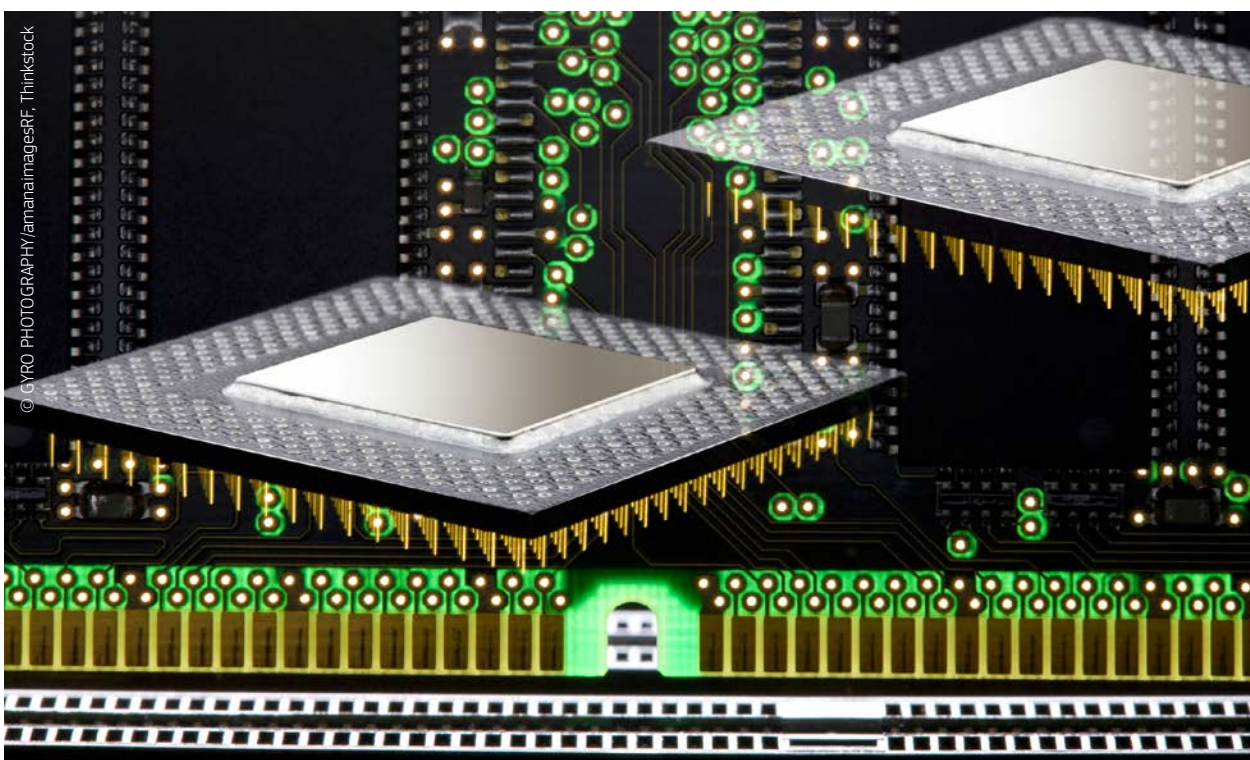
hybrid semiconductor optical amplifier to the laser, thereby significantly increasing the power.

Due to their low cost, directly modulated tunable lasers are highly attractive for use in access networks. The team successfully developed such lasers for 10 Gb/s single-mode fibres up to 25 km.

Silicon photonics is set to revolutionise telecommunications and data communications over the next 10 years. HYSSOP significantly contributed to this. By using quantum dots or dashes instead of quantum wells as the active material of hybrid lasers, one could get higher-power and lower-noise devices.

HYSSOP

- ★ Coordinated by III V Lab in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/180870>





INDUSTRIAL TECHNOLOGIES

NOVEL PACKAGING PRODUCTS FOR A CIRCULAR ECONOMY

The EU-funded DIBBIOPACK project has developed a series of multifunctional packaging products that are bio-based, compostable and biodegradable, and will contribute to the growth of a truly circular economy.

The project has created its innovative packaging from polymers with three sectors in mind — pharmaceuticals, cosmetics and the food industry. These polymers are labelled as ‘smart’ due to the bioplastic materials presenting new characteristics that make them real leaders in product preservation. They do this by increasing product durability, maintaining quality and reporting to the consumer on content preservation conditions.

Solutions for a circular economy

The materials used to create the packaging products are environment-friendly and produced from renewable sources. They are sustainable and contribute to the creation of a circular economy, which is currently a major European goal, following an ambitious package put forward by the European Commission in December 2015.

Currently, an average of 200 plastic bags per person per year are used in Europe. The majority of these bags fall under the category of lighter plastic, thus being the least reused and the most difficult to recycle. The same can be said of thousands of bottles and packaging units, of all types, made from petroleum products. Half of these will be dumped and will take centuries to degrade.

To address the need to reduce Europe’s usage of these environment-damaging products, the DIBBIOPACK

(Development of injection and blow extrusion molded biodegradable and multifunctional packages by nanotechnology: improvement of structural and barrier properties, smart features and sustainability) project has aimed to help companies and consumers in the transition to a more efficient economy by providing solutions for a reduction in petroleum-based packaging. In the longer term, sectors other than the three specifically focused on in the project — such as waste packing and disposal — may also benefit from the project’s novel packaging applications.

Eco-design innovations

When designing its products, the project has specifically employed nanofibers as these provide the packaging with durability and mechanical properties similar to those found in conventional plastics. These nanofibers do not come into direct contact with the product being packaged.

To keep the content apart, biodegradable labels are used. Additionally, these labels incorporate antimicrobial agents that are released in the event of humidity, thus checking bacteria emergence.

The packaging designs also incorporate sensors that change their colour according to the amount of oxygen present within the packaging. This is to provide more information about the products and the processes of the packaging

value chain that increase the safety and quality of the products throughout the supply chain. As a result, this improves the shelf-life of the packaged products.

With the incorporation of these sensors, any valuable information on content condition is readily available without the need for any actual content contact due to the use of an RFID antenna integrated in a mobile phone or tablet. This leads to more convenience for traceability and access to information records.

Finally, the packaging also uses biodegradable films with enhanced barrier properties, due to a three-coating solution that combines biodegradable organic-coating materials with other plasma-applied inorganic ones.

Next steps

The DIBBIOPACK consortium is now in the process of defining not only the rules necessary to exploit its results on a

commercial scale, but also the required intellectual property protection for the processes involved.

The project partners believe that some of their products have reached a stage of development that would allow industries to introduce them onto the market. Others will require further research and development following the project's official end in February 2016.

DIBBIOPACK

- ★ Coordinated by the Aitiip Technology Centre in Spain.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/news/rcn/124864>
- ★ Project website: <http://www.dibbiopack.eu/>
- ★  <http://bit.ly/1STTpF1>

NEW NANOTECH FIBRE TECHNIQUE TO LIGHT UP EUROPEAN INDUSTRY

A new, cost-effective method of fabricating high-quality light-emitting fibres could benefit sectors ranging from sensors to wearable smart devices.



EU-funded researchers have developed a new method for manufacturing fibres made from nanostructured organic materials. The breakthrough could lead to the cost-effective fabrication of light-emitting fibres at the nanoscale that can be used in sensors and bio-sensors, for energy harvesting (i.e. solar panels) and even in 'smart' clothing that can react to the environment.

Other potential applications include smart wearable devices, point-of-care diagnostics for medical professionals and home automation applications for lighting and sound systems.

Structures at the nanoscale are usually between 1 and 100 nanometres — a nanometre is a billionth of a metre — and can possess properties that offer manufacturers amazing strength, flexibility and/or electrical conductivity. However, while significant advances in nanotechnology have been achieved in recent years, the nanofabrication of light-emitting fibres has proved difficult to optimise.

One reason for this is that there are so many variables in the manufacturing process that must be controlled, which pushes

up costs and reduces production efficiencies. For example, the presence of oxygen and moisture in the processing environment can severely affect the optical properties of certain compounds, and thus impact the efficacy of the nanostructures built from them.

New manufacturing technique

In order to address this, the five-year NANO-JETS (Next-generation polymer nanofibers: from electrified jets to hybrid optoelectronics) project, which began in 2013, has pioneered a new manufacturing technique called electrostatic spinning, or 'electrospinning'. In this technique, electrified fields are applied to produce polymer filaments, which can then be embedded in various device platforms.

The first step of the process involves placing a polymer solution into a syringe, which is then pushed to the tip of a metallic needle by external pumping. Pumping is usually applied by mechanical pistons, which generates a flow of the solution in the syringe. A high concentration of polymer solvent is needed in order to achieve a sufficient amount of entanglements between macromolecules in the solution.

An electric volt is then applied between the tip and a collector placed in front of it. The voltage applied is gradually increased, elongating the droplet to form an apex and finally a jet. The velocity of the jet can reach values of a few metres per second. The solvent quickly evaporates from the

"A key advantage for end users is the fact that these collected fibres are generally flexible and can conform to surfaces of all shapes."

jet, and solid nanofibers are finally deposited on the collector. A key advantage for end users is the fact that these collected fibres are generally flexible and can conform to surfaces of all shapes.

In their initial tests, the project team used a controlled nitrogen atmosphere with oxygen content below two parts per million. This enhanced the optical properties of the fibres collected. Other discoveries included the fact that low levels of ambient humidity lead to reduced surface

roughness of individual light-emitting fibres. All this will contribute towards the development of more efficient manufacturing practices.

Next steps

The NANO-JETS project is due for final completion in February 2018. The team will now investigate ways of extending the variety of processed materials in order to achieve new classes of light-emitting fibres, and investigate the

light-transport properties of samples made of multiple filaments.

NANO-JETS

- ★ Coordinated by the University of Salento in Italy.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/news/rcn/124824>
- ★ Project website: <http://www.nanojets.eu/>

LIGHTWEIGHT MATERIALS PROVIDE OPPORTUNITIES FOR THE NEXT GENERATION OF RAILWAY VEHICLES

Researchers have put forward technical recommendations for adopting lightweight composite materials in the construction of rail car bodies.

The transportation industry has for a long time been engaged in the application of new lightweight materials for primary structural design. In aeronautics, where the weight of an aircraft is a crucial factor for fuel consumption, composite materials are now replacing metallic materials in both structural and non-structural parts.

The railway industry could also benefit from the use of new structural materials. If a train's car body is made of composite materials, the train's weight would be reduced by 20 to 30%. These weight savings would result in lower energy consumption and a reduction of at least 5% in CO₂ emissions.

Regulatory limitations

Current European legislation does not allow train manufacturers to use composite materials when constructing train car bodies. The railway sector currently only uses composites for non-bearing structural components, with steel being most commonly used to construct a train's car body.

One of the key obstacles to overcome has been the lack of suitable certification procedures addressing the specific operational

“Composite materials behave differently from materials such as steel or aluminium, being more brittle and orthotropic, raising the question of the strength of a body-shell structure built from composite materials when a collision occurs.”

requirements of a railway vehicle. The EU-funded REFRESO (Towards a REgulatory FRamework for the use of Structural new materials in railway passenger and freight CarbOdyshells) project was set up to provide solutions to this and other obstacles, and pave the way for the adoption of new pro-

Benchmarking materials

cedures that will allow for using composite materials in rail car manufacturing. REFRESO has benchmarked the most promising new materials being used both inside and outside the transport sector and which could be integrated into railway rolling stock.

cedures that will allow for using composite materials in rail car manufacturing.



After an analysis of certification processes and standards applicable to rail vehicle car bodies, the project found that the current European railway certification process gives opportunities for innovative solutions. However, the set of technical standards needed to prove compliance for composite car bodies is not yet in place and therefore has to be developed further.

Following a gap analysis, REFRESO concluded that even if some standards need adaptation for composite material behaviour, most can be applied to a composite car body shell without jeopardising safety.

Structural considerations

When studying the practical structural requirements for the adoption of composite materials, the project focused on subjects such as strength, crash and fire resistance, noise and vibration, electromagnetic compatibility and maintainability.

The project studied the crashworthiness of composite materials in detail, due to strict safety requirements. Composite materials behave differently from materials such as steel or aluminium, being more brittle and orthotropic, raising the question of the strength of a body-shell structure built from composite materials when a collision occurs.

Reference crash simulations were carried out on current metallic designs to observe their behaviour and confirm current safety behaviour. Composite materials were integrated into a cabin structure shell, with initial results showing some cracking. However, the project saw that by reinforcing the composite structure or extending the surrounding metallic interfaces, it is possible to pass the collision scenario test.

The project also concluded that maintenance processes would have to be modified if composite materials were introduced. Not only would maintenance buildings have to be equipped to service them, but railway technicians would have to be trained to be able to work with composites.

Next steps

Currently, the prices of composites are higher than those of steel constructions, but this is expected to change, as the automotive industry has been increasingly using them. The production of raw materials for composites is also increasing, which will probably lower their price further.

Although the REFRESKO project officially ended in February 2016, the project partners aim to utilise its results to work with regulators to update certification procedures, allowing the rail industry to take advantage of these promising lightweight materials.

REFRESKO

- ★ Coordinated by UNIFE in Belgium.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/news/rcn/124886>
- ★ Project website: <http://www.refresco-project.eu/>

FIRE-RESISTANT COMPOSITE MATERIALS

Although the benefits of using lightweight polymer composites are well known, their wider adoption has been hindered by uncertainty over their performance when subjected to extreme heat. Recently, EU-funded scientists have developed new materials that are either fire-resistant or provide protection with a minimum weight penalty.

Composite materials, consisting of reinforced carbon or glass fibres in an organic resin matrix, are an established technology for producing lightweight structures in aerospace and other transport sectors. However, they can decompose and collapse in a fire, releasing smoke and toxic chemicals as well as heat.

The EU-funded project FIRE-RESIST (Developing novel fire-resistant high performance composites) was initiated to develop solutions for enhancing their fire performance. The project consortium of 18 partners brought together experiences and requirements from the aerospace, railway and maritime industries.

Project work entailed fundamental research to better understand the performance of composite materials under high-temperature conditions. In total, six new polymer composites were optimised, including a furan resin combined with cork

agglomeration. This material fulfilled fire resistance requirements for wall, ceiling and floor coverings.

Besides fire-resistant polymer resins, investigations into new formulations of composite materials focused on multi-layer metallic laminates and co-mingling technology. Co-mingling involves the formation of fibre reinforcement mats from a mixture of glass and polymeric fibres. The mat is then placed in a mould where pressure and heat are applied.

The most promising new materials were used in case study components, designed and prototyped for railway, aerospace and maritime applications. The components were subjected to fire tests, and the performance of the FIRE-RESIST materials was validated. The behaviour of structural elements in a fire was analysed with respect to heat transfer and deflection as well as heat load-bearing capacity.

In addition, project researchers developed a dedicated framework for numerical simulations of polymer composite materials and thermomechanical analysis. Numerical simulations combined computational fluid dynamics modelling of fire, flames and thermal radiation with finite element analysis of structural responses.

By working towards improving the fire resistance of composite materials without compromising their structural performance, FIRE-RESIST has made a valuable contribution to greater passenger safety. The new technology is also expected to lower fuel consumption and carbon dioxide emissions while enhancing the European industry's competitiveness.

FIRE-RESIST

- ★ Coordinated by the University of Newcastle upon Tyne in the United Kingdom.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/result/rcn/90930>
- ★ Project website: <http://www.fire-resist.eu/>



“The most promising new materials were used in case study components, designed and prototyped for railway, aerospace and maritime applications.”

FOOD AND AGRICULTURE

GENETIC MARKERS SIGNAL INCREASED CROP PRODUCTIVITY POTENTIAL

An EU-funded project has developed new molecular markers that will enable wheat breeders to precisely select the most productive genetic stocks.

The new markers, delivered through the ADAPTAWHEAT (Genetics and physiology of wheat development to flowering: tools to breed for improved adaptation and yield potential) project, were developed after four years of research into the genes that control flowering time in wheat. This work enabled the project team to identify certain key traits that can help breeders increase wheat productivity.

The project has also provided breeders with other new skills and knowledge to select certain physiological traits, along with new data sets that can predict the likely success and potential limitations of certain approaches. Three SMEs involved in the project will now exploit the tools developed in order to deliver the project outcomes anticipated.

Wheat is a crucially important foodstuff. In 2013, world wheat production amounted to 713 million tons, making it the third most-produced cereal after maize and rice. Globally, wheat is the leading source of vegetable protein in human food, having higher protein content than other major cereals, and is currently second to rice as the main human food crop in terms of total production tonnage.

The results of this project will therefore open up new market opportunities for wheat breeders and potentially increase income for farmers through achieving cost efficiencies. They will also contribute to addressing some pressing concerns facing the global food supply chain.

For example, the global population is expected to grow by over a third, or by 2.3 billion people, between 2009 and 2050. According to the UN Food and Agricultural Organisation (FAO), this means that feeding a world population of 9.1 billion people in 2050 would require raising overall food production by some 70% between now and 2050. Furthermore, demand for cereals, for both food and animal feed uses, is projected to reach some 3 billion tonnes by 2050, up from today's nearly 2.1 billion tonnes.

In this context, achieving production efficiencies in farming — especially cereals farming — has become a priority for both the agricultural sector and policy makers.

The ADAPTAWHEAT project will help breeders, farmers and decision makers to identify opportunities to improve crop sustainability and efficiency, and thus help to guarantee global food security.

Another pressing concern is climate change. As arable land becomes less productive in certain parts of the world — most notably in developing countries — crop yields will be reduced, which could lead to global wheat shortages in the future if no action is taken.

The ADAPTAWHEAT project began by screening the genes that control flowering in over 1 000 different wheat lines and collecting information on the physical characteristics of each line. New laboratory methods were then developed to track the expression of key genes over the flowering period, to identify promising characteristics.

The ADAPTAWHEAT project has also sought to uncover exactly how certain genes are influenced by environmental conditions. To accomplish this, various wheat lines were planted in locations within and near Europe, to show how genetic flowering time variation can be exploited to mitigate the effects of climate change.

The ADAPTAWHEAT project, which received some EUR 3 million in EU funding, was officially completed at the end of December 2015.

ADAPTAWHEAT

- ★ Coordinated by the John Innes Centre in the United Kingdom.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/news/rcn/124823>
- ★ Project website: <https://www.jic.ac.uk/adaptawheat/>

INNOVATIVE AND ECO-EFFICIENT CAPSULES TO REVOLUTIONISE PEST CONTROL IN POTATO CROPS

The EU-funded INBIOSOIL project has developed a new, eco-friendly method to control wireworm in potatoes that can be used in conventional and organic systems.

The new method of pest control specifically uses special capsules called ATRACAP. They contain a strain of an entomopathogenic fungus that attacks specific pest insects and can reduce chemical pesticide use on European farms.

The company BIOCARE, in Lower Saxony, Germany, has just established production of these capsules. In 2016, an area of about 300 hectares will be covered. 'We are overwhelmed by inquiries from farmers willing to use the product on their fields, therefore the upscaling of production will continue,' Prof. Dr Stefan Vidal, INBIOSOIL (Innovative biological products for soil pest control) Project Coordinator, said. 'We expect ATRACAP to become a standard control strategy for both organic and conventional farmers,' he added.

Targeting wireworms

The capsules aim to control wireworms — currently regarded as the most pressing problem in potato production in both conventional and organic systems. 'They contain compounds which are non-synthetic products and therefore their use is possible in both organic and conventional cropping systems. The Attract & Kill strategy, based on these capsules, will substitute the use of synthetic chemical insecticides,' Vidal explained.

The launch of these capsules is even timelier since, from this year onwards, virtually no specific synthetic compounds targeting wireworms are available. The compound used in conventional fields in the past was Fipronil, known commercially as Goldor® Bait, a product produced by BASF.

However, the European Commission introduced a moratorium on products suspected of playing a role in the bee disease Colony Collapse Disorder. Whilst national registration agencies say that emergency case approval of this product would be possible, BASF has not applied for it.

Economic costs of wireworm infiltration and meeting EU environmental standards

Conventional potato farmers are currently experiencing economic problems due to the poor quality of potatoes that have been damaged by wireworms. Meanwhile, organic farmers are also suffering severe income losses due to the same pest. 'Although reliable data calculating the economic impact of wireworms on crop yields is not available, farmer organisations in different European countries are willing to adopt this new pest control strategy simply because it works,' Vidal outlined.

Moreover, the cost per hectare of ATRACAP capsules is comparable to the cost of Goldor® Bait, so even conventional farmers are content to apply it on their fields, Vidal emphasised.

The killing agent contained in the capsules is an isolate of an entomopathogenic fungus, occurring naturally in arable soils worldwide. Given the 100% biological background of this

strategy, EU environmental protection goals are met. Moreover, the spores of the fungus are applied to the soil, restricting their unintended passive dispersal. This limits interactions with above-ground organisms such as honey bees. Furthermore, earthworms are not attracted to the capsules.

Next steps for the project

According to Vidal, the INBIOSOIL project ran even more smoothly than originally expected. However, the project's idea in the beginning was to additionally target other soil-dwelling pests such as 'Western corn rootworm' (WCR) larvae using the same Attract & Kill approach.

'Laboratory and field experimental data did not provide sufficient control results, thus we are currently modifying the composition of the capsules to better control other pest species. Another pest, cabbage maggots (*Delia radicum*), is a new target for the ATRACAP capsules,' Vidal said.

In the future, the basic technology developed by INBIOSOIL will be used to develop more environment-friendly pest control products. 'Several proposals have been submitted to collect funding for these innovative developments,' Vidal concluded.

INBIOSOIL

- ★ Coordinated by the University of Göttingen in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/news/rcn/124828>
- ★ Project website: <http://inbiosoil.uni-goettingen.de>



EXTENSIVE EXPLORATION OF PERSONALISED NUTRITION AS A WAY TO BETTER HEALTH

Nutrigenomics examines the relationship between food and gene expression. The ability to plan diet recommendations based on an individual's genetic profile is an exciting concept recently explored by an EU initiative.

In an effort to improve public health across the population, the EU-funded FOOD4ME (Personalised nutrition: An integrated analysis of opportunities and challenges) project investigated personalised nutrition as a means for improving health.

FOOD4ME extended state-of-the-art research into personalised nutrition tying in business, science and technology, as well as consumer perspectives. It explored the opportunities and challenges in relation to establishing strong business models for delivering personalised nutrition at all stages.

Project partners assessed the prospects and challenges for future personalised nutrition business models together with a broad range of stakeholders, including the food industry, media, health insurers, patient groups, retailers, regulatory authorities, medical professionals and scientists. They developed novel scientific tools that use dietary, genetic and phenotypic data for tailored nutrition recommendations.

The FOOD4ME team validated the impact of different levels of nutrition advice on consumers using the outcomes from a study carried out in seven EU Member States. The study compared the effects of different levels of personalised nutrition on health-related outcomes. It contains data on over 1 600 individuals.

Researchers analysed consumer attitudes and beliefs concerning all aspects of personalised nutrition, and studied the related ethical and legal issues. In addition, best practice guidelines were delivered for communicating to consumers about tailored dietary advice.

All research conducted, key project results and a future vision for personalised nutrition were included in a White Paper presented at the final project conference.

FOOD4ME provided an in-depth analysis of the opportunities and challenges in the area of personalised nutrition. Relevant stakeholders are now better able to determine in what



way dietary advice in combination with genetic profiles can benefit consumers.

FOOD4ME

- ★ Coordinated by University College Dublin in Ireland.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/result/rcn/91757>
- ★ Project website: <http://www.food4me.org>
- ★ <http://bit.ly/1U4Mk3V>

SAFE AND QUALITY FEED FOR EUROPEAN LIVESTOCK

A European consortium has explored several different approaches to ensure that animal feed in Europe is safe and of good quality.

Safe animal feed is essential for the health of animals and the environment, as well as for the safety of foods of animal origin. However, there is a need for improved monitoring and control of animal feed to ensure that it remains healthy and safe.

“QSAFFE developed and implemented cost-effective tests that can detect contaminated animal feed before it is fed to farm animals.”

Ensuring the highest standards for producing and supplying animal feed in Europe is the underlying concept of the QSAFFE (Quality and safety

of feeds and food for Europe) consortium, funded by the EU.

Firstly, QSAFFE developed and implemented cost-effective tests that can detect contaminated animal feed before it is fed to farm animals. This will dramatically reduce health risks and improve both the quality of animal products and the productivity of farms.

Secondly, the project used risk management approaches to limit false claims about imported animal feed.

The project endeavoured to predict emerging risks in the feed supply chain caused by changes in global economics or climate change. Another focus was improving scientists' understanding of how contaminants in feed materials make their way into consumer foodstuffs.

Lastly, QSAFFE developed and delivered training on these new tests for relevant users in industry, government and academia. Ultimately, project outcomes will improve the quality and safety of animal feed entering ports from outside the EU, as well as feed and food produced within European countries.

QSAFFE

- ★ Coordinated by Queen's University Belfast in the United Kingdom.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/result/rcn/91104>
- ★ Project website: <http://www.qsaffe.eu>

PHYSICS AND MATHEMATICS

A QUANTUM LEAP FOR THE NEXT GENERATION OF SUPERCONDUCTORS

EU-funded scientists have shown how superconductors can work at higher temperatures, opening the door to numerous new industrial applications.

Quantum materials — materials designed at the sub-atomic level — can be finely-tuned to achieve extremely useful properties that are often not found in nature. These include superconductivity, the ability to conduct electricity without resistance below a certain temperature.

Q-MAC (Frontiers in Quantum Materials Control), an ambitious six-year project, was only launched in 2013, but has already achieved a number of potentially significant breakthroughs in this field. These findings could significantly advance European understanding of superconductivity and help to pioneer new industrial applications ranging from supercomputers to hover trains.

Superconductors at higher temperatures

For example, the team has shown that shining lasers at superconductors can make them work at higher temperatures. This is significant because superconductors currently only work at very low temperatures, which requires expensive liquid nitrogen or helium.

Superconductors are used in numerous high-tech instruments such as medical scanners, super-fast electronic computer circuits and trains that use superconducting magnets to hover above the tracks, thus eliminating friction. The development of superconductors that

work at higher temperatures — or even at room temperature — could help to cut costs by eliminating the need for cooling and lead to new applications.

Having focused on material made from potassium atoms and carbon atoms arranged in ball-like structures, the Q-MAC project team will now try to find other superconductors that can be coerced to work at even higher temperatures. The researchers are also looking to engineer new meta-materials — materials that are not found in nature — that offer optimised superconductivity.

High-temperature superconductors for practical applications

Another key objective is to ensure the stability of high-temperature superconductors that can be exploited for practical applications. This is not straightforward; high-temperature superconductivity is a delicate property that is difficult to maintain for prolonged periods of time.

The challenge therefore is to prevent heat or other environmental factors from disturbing the system. In order to address this, the project team is currently looking into the possibility of 'sandwiching' the superconducting system between protective layers of specially engineered materials, which would 'screen out' disturbances. Novel experimental techniques, combined

with advanced computer simulations, will be carried out.

The Q-MAC project team has also discovered that extremely short X-ray pulses can be used to achieve vibrations in crystals, and trigger a change in the magnetic properties of an atomically-thin layer that lies on their surface. This anatomically-thin oxide film has properties very different from its bulk form.

This makes complex oxide structures a versatile tool for engineering the properties of materials and devices. Such ultra-fast light control meta-materials could lead to new prospects in magnetic storage technologies.

In addition to the practical side of things, the Q-MAC project is also focusing on developing an accurate theoretical understanding of the behaviour of atoms and electrons in quantum materials. The Q-MAC project is scheduled to run until September 2019.

Q-MAC

- ★ Coordinated by the Max Planck Society in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/news/rcn/124825>
- ★ Project website: <http://www.q-mac.eu/>

SUPERCONDUCTING AND FERROMAGNETIC INGREDIENTS FOR NANOHYBRIDS

The collective properties of hybrid systems of nanomaterials are very different from those of the individual components. EU-funded scientists have studied how charge transport is modified to foster device development with an eye on quantum computing.



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In many nanostructures, electron transport has been shown to exhibit quantum coherence and obey peculiar laws, very different from those of macroscopic and microscopic systems. These discoveries paved the way to the new field of mesoscopic physics.

Within the EU-backed project LODIHYBRIDS (Correlations and proximity effect in low-dimensional and hybrid structures), scientists explored mesoscopic behaviours in hybrid systems combining materials with antagonistic properties. Among them, superconductor-ferromagnet systems were an interesting example.

Ferromagnetism and superconductivity are considered antagonism phenomena, at least at first glance. While superconductivity tends to align the spins of electrons in Cooper pairs opposite to each other, ferromagnetism favours parallel alignment of magnetic moments and equally oriented spins.

In hybrid nanostructures, where a non-superconducting material is in contact with a superconductor, Cooper pairs and electronic excitations are being exchanged. The LODIHYBRIDS researchers studied the so-called Andreev current induced by ferromagnetic resonance and other effects at the interface.

Next, they focused on the search for Majorana bound states, a hot topic in experimental mesoscopic physics research. The generation, detection and manipulation of Majorana bound states hold the promise of topologically protected quantum computing.

A hybrid system containing topological insulators or nanowires was used to identify characteristics of Majorana bound states with the aim of proposing novel ways to realise them experimentally. The consequences of topological superconductivity associated with Majorana bound states were investigated at Josephson junctions.

LODIHYBRIDS findings are expected to contribute to a better understanding of hybrid systems where close contact between materials with antagonistic properties causes the emergence of unique dynamics. Such effects will have a key role to play in future quantum computers.

LODIHYBRIDS

- ★ Coordinated by Joseph Fourier University in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/92116>

LIGHT PROPAGATION IN A NONLINEAR MEDIUM

EU-funded scientists have looked at and described light scattering in disordered media that is affected by nonlinearity and noise. Such phenomena in photonic crystal structures hold the promise of supporting data transmission in optical fibre communications.

Light propagating in photonic crystals behaves in a way that is analogous to electrons travelling through a semiconductor crystal. In other words, periodic structures can be used to control the flow of light in a way quite similar to electrons in semiconductor electronic devices.

Much of the research in the EU-backed project INDIGO (Interaction of nonlinearity and disorder: Gateways to optics) was directed at exploring these periodicity effects in photonic crystals. The focus was put on a little-studied phenomenon: the thermalisation of coupled light fields in the presence of cross-phase modulation and wave mixing.

In the framework of nonlinear optics, this situation corresponds to the propagation of polarised light in birefringent materials. The INDIGO team used aluminium gallium arsenide as a sample material

with cubic symmetry and fused silica as the corresponding example of an isotropic crystal.

The evolution of the system to the final equilibrium state was shown to pass through an intermediate stage where the energy exchange between waveguides is negligible. However, the distribution of phase differences, intensity and polarisation state of each waveguide is strongly dependent on the material parameters and initial conditions.

The project research was the first attempt to study polarisation effects on thermalisation in discrete optical waveguide systems. The findings are expected to have a significant impact on signal processing with fibre communication systems. They are also quite general and can be applied to other non-linearly coupled systems.



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As a possible continuation of this research, INDIGO scientists are considering a detailed study of the material dependence on final thermal state and a full thermodynamic analysis.

INDIGO

- ★ Coordinated by the Weizmann Institute of Science in Israel.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/175284>

EVENTS

JUNE
01 ▶ 03

Paris, FRANCE

CONFERENCE

SUN PROJECT AT NANOTECH FRANCE 2016

The EU-funded SUN project will be a keynote speaker at the Nanotech France 2016 conference taking place in Paris, France, from 1 to 3 June.

Nanotech France 2016 brings together leading scientists, researchers, engineers, practitioners, technology developers and policy makers in nanotechnology to exchange information on their latest research progress and innovation.

Participants from the top international academic, government and private industry labs of different disciplines are participating in Nanotech France 2016 to identify new technology trends, development tools, product opportunities, R&D collaborations, and commercialisation partners. The SUN project, as SUN (Sustainable Nanotechnologies) project is the first EU-funded project that addresses the entire lifecycle of nanotechnologies to ensure holistic nanosafety evaluation, and incorporates the results into tools and guidelines for sustainable manufacturing, so that they are easily accessible by industries, regulators and other stakeholders.

For further information, please visit:
<http://www.setcor.org/conferences/Nanotech-France-2016>

JUNE
02 ▶ 03

Eindhoven, THE NETHERLANDS

FORUM

ACTPHAST PROJECT ORGANISES EUROPEAN PHOTONICS VENTURE FORUM

The EU-funded ACTPHAST project is organising the second edition of the European Photonic Venture Forum (EPVF) that will be taking place in Eindhoven, the Netherlands, from 2 to 3 June 2016.

The EPVF aims to market the photonics sector to a wider investor community and create channels to finance for high-potential photonics businesses. The Forum will ensure photonics becomes a pillar of local regional development plans, mirroring the European strategy on photonics and driving forward support and funding for the sector. Each year the Forum is held in a different European city.

The ACTPHAST project is a unique 'one-stop-shop' European access centre for photonics innovation solutions and technology support. ACTPHAST will support and accelerate the innovation capacity of European SMEs by providing them with direct access to the expertise and state-of-the-art facilities of Europe's leading photonics research centres, enabling companies to exploit the tremendous commercial potential of applied photonics.

For further information, please visit:
<http://www.hightechcampus.com/calendar/european-photonics-venture-forum-epvf>

JUNE
15

Brussels, BELGIUM

CONFERENCE

FINAL CLYMBOL CONFERENCE

The EU-funded CLYMBOL project will host its final conference in Brussels, Belgium, on 15 June 2016.

Health claims and symbols are messages on food packages intended to aid consumers in identifying foods that are healthier options. The question is, do they work and if so, how? This is what the EU-funded CLYMBOL project has been investigating. It will consequently present its final results during this conference after four years of research.

Delegates will discuss the toolbox developed within the project for European stakeholders, enabling them to monitor the impact of health claims and symbols, through validated methods. They will also take part in a stakeholder workshop to discuss the project findings and their implications for public policy and also for the food industry.

For further information, please visit:
<http://www.clymbol.eu/component/acymailing/archive/view/listid-4-invitation-to-the-final-conference-addressed-by-first-name/mailed-12-final-conference.html>

EVENTS

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JUNE
29

29
June

Brussels



Brussels, BELGIUM

CONFERENCE

FINAL SCOT CONFERENCE

The EU-funded SCOT project will host its final conference in Brussels, Belgium, on 29 June 2016.

On the 29th of June, SCOT will have its closing conference, presenting its Vision together with state-of-the-art CO₂ utilisation in Europe and around the world. This will be followed by presentations of the Strategic European Research and Innovation Agenda and Joint Action Plan and dedicated panel discussions with EU experts renowned for being thought leaders in the CO₂ Utilisation field.

During the morning session, the CO₂ recycling community will gather together key industrial and academic players in order to discuss the SERIA and the next steps necessary for implementing the Joint Action Plan. During the afternoon session, the event will discuss with European and regional policy makers what can be done from a policy perspective to allow the industrial deployment of these technologies.

For further information, please visit:
<http://www.greenwin.be/en/event/consult/96>

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Should your project meet the criteria to be featured in one of the magazine's sections, our editors will contact you to get some background information and conduct an interview. The article will then be planned for release in the next magazine, enabling your project results to reach our large audience of over 20 000 subscribers in science and industry across Europe.

This service is offered to all completed or close-to-completed EU-funded projects. Priority will be given to those projects which have resulted in the development of a new technology with potential for commercialisation over the next few years, or in potentially game-changing research for a specific field of science. If you feel like your project is a match, please feel free to book your space now!



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