



#108

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Research *eu*

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Special feature

The farms of the future – it's all about precision

Heaven scent

Baby smell drives women wild – but turns men docile

Driving on sunshine

World first solar car charges on the move

FINAL ISSUE
LOOK INSIDE FOR A
FOUR-PAGE SPECIAL ON
THE HISTORY OF
RESEARCH*EU

Editorial

Solar-powered cars, farming robots, and a fond farewell

Welcome to the last issue of Research*eu magazine

All good things, they say, must come to an end. Unfortunately Research*eu magazine is no exception. For the last 10 years we've brought you the latest in EU-funded science and innovation, covering everything from anti-ageing medicine to zeolite crystals. Now, after 108 issues, it's time to draw things to a close. This feature-packed issue includes an additional four pages looking back at Research*eu's accomplishments over the years.

Those who still want to know what is happening at the forefront of European research, don't fear, CORDIS will continue to bring you the best stories in EU science, in collaboration with the research agencies of the European Commission services and agencies, and those researchers making exciting new discoveries across Europe and beyond. To find out how you can keep track of all our current activities as well as those we have planned for the future, visit the CORDIS website cordis.europa.eu.

That said, we still have one last magazine for you, and it's a good one. My family home in the English countryside sat next to a dairy farm, and occasionally I would be woken in the small hours by the rumble of the milk tanker passing down the narrow lane. The cows grazed in a field next to our garden, and they would sniff curiously at wayward footballs that sometimes flew over the low fence separating us.

The farm is long gone, and the cows have been replaced by a pair of horses, the expensive pets of whoever bought the farmhouse. A similar story is unfolding across much of Europe: farmers face difficult challenges from tough market conditions, a changing environment and labour shortages to the threat of cheap imports.

To survive, farming needs to change. Our Special section examines the practices and technologies being developed under the umbrella of precision farming. Automated management systems, animal and plant-borne sensors, pocket diagnostic devices and farm robots are all helping to bring new efficiencies to Europe's farmers, supporting Europe's transition to a high-value agricultural system.

As always, we also bring you the latest EU-funded research and innovation from a range of sectors including health, society, industry and space. As ever, we catch up with a past project in **Life After**, discovering how **BPR4GDPR** is continuing to help EU businesses keep their clients' data safe. And we turn to **SHAPES** for our **Project of the Month**, in which an Irish start-up is helping to make the entire world accessible to, well, everyone.

With that, it's time for me to go and sharpen my hatchet. As always, if you have any queries, questions or suggestions (but hopefully never a complaint), please feel free to drop us a line at editorial@cordis.europa.eu.

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HEALTH

- 4** Fertility drug shows promise for combating antibiotic resistance
- 6** Molecular evidence on how obesity may alter medication safety
- 7** Unblocking the body's natural defence against cancer



SOCIETY

- 9** Why the smell of babies may increase aggression in women but decrease it in men
- 10** Study of ancient glass provides a window into the past
- 12** Gestational surrogacy: mapping reformist and abolitionist debates in Italy, Mexico and the United States



PROJECT OF THE MONTH

- 14** Making everywhere accessible to everyone



TRANSPORT AND MOBILITY

- 15** World's first long-range solar car charges on the move
- 17** Lighter, greener, safer: The next generation of fuel bladders
- 18** Advanced fuselage shielding could help propfan aircraft take off



CLIMATE CHANGE AND ENVIRONMENT

- 20** Wood forms a central plank in nearly-zero energy buildings
- 21** The world's first biodegradable laundry fragrance microcapsules



SPECIAL FEATURE

- 01** The farms of the future – it's all about precision



RETROSPECTIVE

- 07** Celebrating 10 years of Research*eu



FOOD AND NATURAL RESOURCES

- 23** A is for aphid, B is for beetle: the order pests arrive makes a big difference to crops
- 25** Engineered plants could be green chemical factories of the future
- 26** Towards a blockchain scenario to guarantee virgin olive oil authenticity



INDUSTRIAL TECHNOLOGIES

- 28** Natural floor tiles support a sustainable building sector
- 29** Laser innovation lights up electronic display sector



DIGITAL ECONOMY

- 31** AI factcheckers aid the battle against fake news
- 32** Upgrading Europe's maritime data infrastructure
- 34** Virtual touch and feel: a new frontier of digital reality



LIFE AFTER...

- 36** Catching up with BPR4GDPR: Helping businesses keep citizens' personal data safe



SPACE

- 37** Reducing the risk of collisions in space through better thermosphere modelling
- 38** Novel ways of analysing observations of exoplanet atmospheres



FUNDAMENTAL RESEARCH

- 40** Magnetic polymers set to be a material of the future
- 41** Searching for treasure in the 'dark matter' of microbial genes



AGENDA

- 43** MARCH 2022



Fertility drug shows promise for combating antibiotic resistance

An FDA-approved medication for treating polycystic ovary syndrome has been identified as a potential adjunct for treating Streptococcus pneumoniae infections, a major cause of childhood mortality. The findings could extend the lifetime of existing frontline antibiotics.

Despite strenuous efforts to combat the bacterium *Streptococcus pneumoniae*, the pathogen remains serious threat to human health, particularly among young children. Every year, 14 million under-5s suffer serious illness as a result of infection, and more than 800 000 children are killed. Although *S. pneumoniae* can be treated with penicillin-based drugs like amoxicillin, resistant strains are increasingly common.

The project GetToKnowPneumo (A pooled CRISPRi screen to identify new cell cycle proteins in the opportunistic human pathogen *Streptococcus pneumoniae*) received funding under the Marie Skłodowska-Curie Actions programme to uncover new insights into the cell biology of the bacterium. Fellow Liselot Dewachter at the University of Lausanne in Switzerland outlines the hopes of the project: “As well as gaining cell cycle details, we were hoping that we would be able to translate our results into practical applications that can be used in the clinic.”

WHY SHAPE MATTERS

Knowing that the development of novel antibiotics can take more than a decade, the researchers aimed to identify drugs which could boost the antimicrobial activity of existing antibiotics. Combining two drugs that target the same process can create a synergistic effect, with the combination stronger than the sum of the individual compounds.

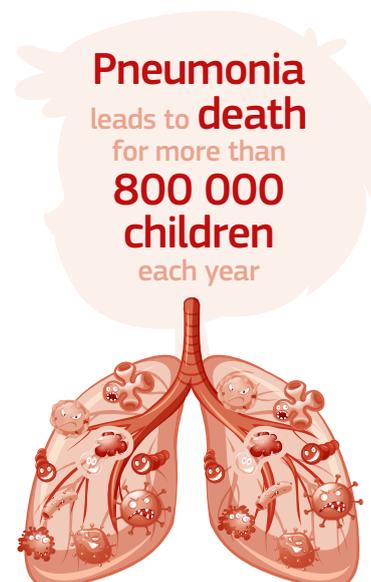
Since amoxicillin works by disrupting the growth and division of bacterial cells, the team used CRISPR interference to identify genes responsible for maintaining proper cell size. “CRISPR interference is a modified version of CRISPR where the DNA is not cut, but the expression of genes that are targeted by the CRISPR interference system is inhibited,” Dewachter explains.

The researchers then used fluorescence-activated cell sorting to screen individual cells for characteristics of interest – in this case, changes to the cell structure. “This bacterium usually has an oval shape that looks like a rugby ball. However, we have found that they can become very long rods when some proteins are depleted,” says Dewachter.

Her team showed that this phenotype was caused by insufficient transport of cell wall precursors across the cell membrane, due to inhibition of undecaprenyl phosphate (Und-P), the lipid carrier responsible for this process.

OLD DRUG, NEW USE

With this information, the team identified the fertility drug clomiphene as a candidate for combination therapy with amoxicillin. The FDA-approved medication is an inhibitor of Und-P synthesis.





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In the lab, a combined treatment made drug-resistant *S. pneumoniae* sensitive again to clinically relevant concentrations of amoxicillin. If these results hold true for human infections, this approach can be used to effectively revert resistance and extend the clinical lifespan of our current antibiotic arsenal.

Currently, a manuscript is in preparation to be finished in the coming months. The project results were presented pre-COVID at the conference ‘Bacterial Morphogenesis, Survival and Virulence: Regulation in 4D’ in 2019 in South Africa.

“Even though the funding of the project has ended, we are still pursuing this research line to completion,” notes Dewachter. Currently, *in vivo* tests are being performed by collaborators to test the clinical potential of this novel treatment strategy. “Additionally, we are looking into the possibility of applying for a patent to hopefully translate them to the clinic.”

“ *Even though the funding of the project has ended, we are still pursuing this research line to completion.* ”

GETTOKNOWPNEUMO

- Coordinated by the University of Lausanne in Switzerland
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/837923

Molecular evidence on how obesity may alter medication safety

Obesity is associated with many comorbidities, including non-alcoholic fatty liver disease. European scientists provided novel insight into how specific drug transporters associate with such chronic liver conditions and may modulate drug distribution, efficacy and safety.



Researchers focused on the organic solute transporter alpha/beta (OST α/β), a heteromeric solute carrier protein that transports bile acids, steroid metabolites and drugs in and out of cells. The hepatic expression of OST α/β is normally low but can increase dramatically in NASH and in conditions with elevated bile acid levels in the liver. Although drugs associated with hepatotoxicity modulate OST α/β activity, the clinical implications for bile acid and drug disposition remain to be elucidated.

Because OST α/β is a bidirectional transporter, both uptake and efflux directions were of interest to OSTtrans scientists. For this reason, they employed a human cell line overexpressing human OST α/β and set up an *in vitro* method that allowed the comparison of both transport directions. This approach provided information not only on the transported substrate levels but also on the chemical composition inside and outside the cells. Moreover, the scientists evaluated the interaction and effect of drugs and endogenous compounds on OST α/β transporter activity.

OSTTRANS PROSPECTS IN DRUG SAFETY

Obesity is reaching epidemic proportions, with nearly 50% of European citizens being obese. “Contrary to drug-metabolising enzymes, little is known about the role of drug and bile acid transporters in metabolic conditions,” says MSCA research fellow Melina Malinen.

The OSTtrans project provided mechanistic knowledge on OST α/β , which is expected to advance research in the field and help develop new chemical entities for chronic metabolic and liver diseases. The research team plans to continue the work on hepatic transporters by further evaluating their expression and function. At the same

Non-alcoholic fatty liver disease (NAFLD) is characterised by fat build-up in the liver and may progress to non-alcoholic steatohepatitis (NASH), liver failure or cancer. Although more than 40% of obese people are likely to develop NAFLD, there are no overall successful therapies to date, and our understanding of the impact of NAFLD on medication efficacy and safety is limited.

INSIGHT INTO THE DRUG AND BILE ACID TRANSPORTER OST α/β

The project OSTtrans (The Role of OST α/β as a Bile Acid and Drug Transporter in Obesity-Associated Chronic Liver Disease, Nonalcoholic Fatty Liver Disease) aimed to investigate the expression and function of drug and bile acid transporters in NAFLD. The research was undertaken with the support of the Marie Skłodowska-Curie Actions (MSCA) programme and involved mass spectrometry-based proteomic analysis of liver tissue from subjects with NAFLD or NASH.

“ Contrary to drug-metabolising enzymes, little is known about the role of drug and bile acid transporters in metabolic conditions. ”

time, the methodologies generated will fuel the discovery of novel drug interactions with hepatic transporters. Inhibition of a hepatic transporter may actually be an alert for drug-induced liver injury (DILI) risk.

On another level, the OSTtrans project addresses a key medical issue. Considering that the liver is the primary site

for the biotransformation of drugs, it is unclear whether obesity or chronic liver disorders affect the efficacy and safety of medications. By advancing knowledge on the transporters abundant in liver diseases, OSTtrans paves the way towards safer and more efficacious drugs.

OSTTRANS

- Coordinated by the University of Eastern Finland in Finland
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/799510

HEALTH

Unblocking the body's natural defence against cancer

An EU-funded project has identified a novel way of helping the body's immune system fight cancer. Currently in clinical trials, the therapy could improve how we treat this disease.

Special immune cells in our body called T-lymphocytes play a critical role in helping us to fight infections. They work by recognising antigens, usually found on the surface of cells infected by viruses and bacteria and alerting our bodies to mount a defence.

“In the early 1990s, it was discovered that these so-called ‘T-cells’ can also recognise antigens on the surface of tumour cells,” says project coordinator of TARG-SUP (Targeting TGF-β activation, likely the core mechanism of immunosuppression by human regulatory T cells) Sophie Lucas from UCLouvain in Belgium. This project was supported by the European Research Council (ERC).

“This means that cancer patients are able to mount immune responses against their own tumour cells.”

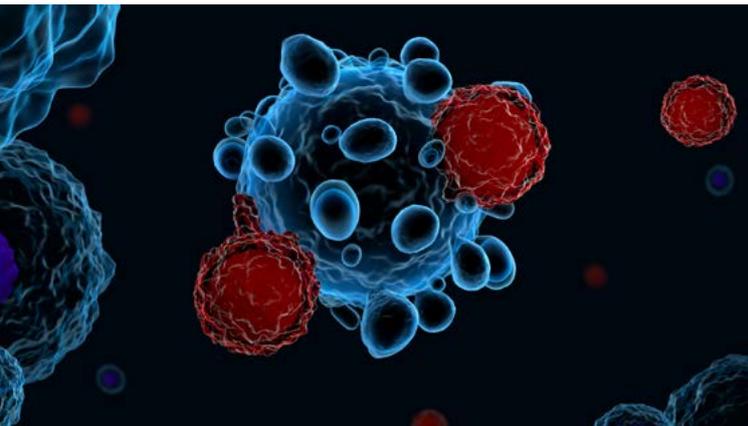
This discovery has opened the door to the development of immunotherapies, which use the body's own immune system to fight cancer. While huge progress has been made in this field, not all patients are receptive to treatments.

“We know that it is not possible to boost antitumour T-cell responses in all patients,” adds Lucas. “One hypothesis is that some specialised T-cells – called regulatory T-cells or ‘Tregs’ – are too potent, and can actually inhibit antitumour activity.”

BLOCKING IMMUNOSUPPRESSIVE ACTIVITY

This was the starting point of the TARG-SUP project. Lucas wanted to know: whether Tregs do indeed inhibit antitumour T-cell responses; how they achieve this; and whether this deleterious activity can somehow be blocked.

The project built on Lucas's previous lab work. A study of human Treg cells kept in culture *in vitro* had enabled her team to identify one possible mechanism whereby Tregs inhibit antitumour T-cell activity. They do this by secreting a specific messenger protein called TGF-beta which performs an immunosuppressive function. And to do that, they need another protein partner – called GARP – on their surface.



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“Our aim in this project was to demonstrate this activity, develop antibodies to block GARP, and see if this diminishes immunosuppression by Tregs,” notes Lucas.

These antibodies were tested as potential therapeutic agents in mice. The project team demonstrated that, combined with other immunotherapy approaches, they could indeed help mice get rid of tumours.

POTENTIAL NEW THERAPIES

These impressive results opened the way for human clinical trials of anti-GARP antibodies beginning in March 2019. The first phase I clinical trial is due for completion around the first quarter of 2022.

“The only thing we will learn from the phase 1 trial is whether this novel therapy is not too toxic for it to proceed to phase 2,” explains Lucas. “Then finally, there will be phase 3 trials.” This is the type of trial that will determine

“*We were able to show in just five years that our hypothesis about GARP was correct.*”

whether the new treatment is at least as efficient as standard therapies.

While it will be years before the new treatment is ready for market, Lucas is proud of the speed with which important discoveries have been made.

“This ERC grant really allowed me to rapidly develop this research,” she adds. “We were able to show in just five years that our hypothesis about GARP was correct, even getting to the point where we have potential therapeutic agents.” Ultimately, Lucas hopes that all this hard work will eventually result in the successful development of an effective immunotherapy. Blocking immunosuppression by Tregs will help cancer patients to fight back against disease and save lives.

“To get to this point within five years is as far as I could possibly have hoped to get,” she says.

TARG-SUP

- Hosted by UCLouvain in Belgium
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/682818
- Project website: deduveinstitute.be/tregs-and-tgfb



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The rise and rise of antimicrobial resistance is putting us at increasing risk of chronic illnesses and deadly infections. Episode 10 of **CORDIScovery** examines how we can best manage our complex relationship with microbes, from pharmaceuticals to farming.

→ bit.ly/CORDIScovery_Episode_10





SOCIETY

Why the smell of babies may increase aggression in women but decrease it in men

Olfactory cues are an overlooked aspect of human social behaviour. EU-funded researchers have been sniffing out new findings in how our health and behaviour are affected by body odours.

All terrestrial mammals use airborne molecules to communicate, through secretions such as body odour. These scents contain meaningful information about behaviour, health, reproduction status, and more. The EU-funded SocioSmell (Social Chemosignaling as a Factor in Human Behavior in both Health and Disease) project sought to examine this phenomenon in humans.

“For various reasons, this behaviour is largely overlooked in humans,” says project coordinator Noam Sobel. “We humans don’t walk up and sniff strangers. That is not part of accepted behaviour.”

The goal of the SocioSmell project was to uncover the role sociochemical signalling plays in human behaviour,

health and disease, and to understand the molecules and brain mechanisms involved.

SNIFFING SKYDIVERS

In an early result, Sobel and his team at the Weizmann Institute of Science found that humans surreptitiously sniff their hand after shaking hands with a stranger. “Humans rub their faces, touch their faces all the time. It’s almost impossible to stop doing it,” adds Sobel. “This showed we are constantly exchanging this type of information.”

He hypothesised that sociochemical signalling may be altered in cases where social behaviour is dysfunctional. In a subsequent experiment, typically developed adults



and adults with autism spectrum disorder (ASD) were exposed to 'the smell of fear', in this case body odour collected from skydivers.

"The typical reaction is an increase in autonomic arousal – fear is contagious," explains Sobel. "But we saw a profoundly different physiological and psychological response in adults with ASD." The research suggests that some of the social dysfunction experienced by adults with ASD may be caused by changes in how sociochemical signals are received or processed in the brain.

CHEMICAL MESSENGER

Sobel and his team were able to isolate one of the molecules central to sociochemical signalling, hexadecanal, from more than 5 000 volatiles found on the skin. Young babies produce significant amounts of hexadecanal in their scalp. The group was able to show that exposure to this chemical reduces aggression in men, but increases it in women.

The difference was highly conserved between the sexes – Sobel and his colleagues could differentiate female fMRI brain scans from male ones with 80% certainty simply by the pattern of activity elicited by the molecule. But why should such a difference exist?

"Maternal aggression increases the life expectancy of offspring, as maternal aggression is typically protective," notes Sobel. "In contrast, paternal aggression reduces the life expectancy of offspring, as it is often directed at the infants themselves." The Weizmann Institute of Science has applied for a patent on the molecule.

“If humans can have a normal sense of smell with no olfactory bulb, it's a particular challenge to our understanding of how odour is encoded in the brain.”

MISSING BULBS

The project also uncovered a group of women who lack olfactory bulbs, yet retain a normal sense of smell. The discovery was made serendipitously during a routine brain scan of a woman involved in one of Sobel's experiments. A search through the Human Brain Connectome Project database revealed several more women with an identical condition. Curiously, all these women are left-handed.

"It made absolutely no sense. Three per cent of left-handed women have perfect olfactory ability without olfactory bulbs," says Sobel. "If humans can have a normal sense of smell with no olfactory bulb, it's a particular challenge to our understanding of how odour is encoded in the brain."

The work was supported by the European Research Council. "Without this funding we would be lost," remarks Sobel. "It gave us the opportunity to think freely and test freely." Sobel says he and his team will continue to publish from the collected data for several years.

SOCIOSMELL

- Hosted by the Weizmann Institute of Science in Israel
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/670798

SOCIETY

Study of ancient glass provides a window into the past

A groundbreaking study into how the production, trade and consumption of glass developed along cultural and political lines has helped to shed new light on the cultural identities of medieval societies.

Glassmaking dates back thousands of years. It has been used for both functional and artistic purposes and has been employed by numerous civilisations. This

means that distribution patterns of glass can be used as a kind of barometer of long-distance exchange and technological sophistication.

“The development of regional glassmaking centres in the western Mediterranean was intimately linked to the processes of Islamisation.”



© GlasRoutes-Schibille

“The period between the 7th and 12th centuries was pivotal in the history of glassmaking,” explains GlassRoutes (Mapping the First Millennium Glass Economy) project coordinator Nadine Schibille, researcher at the National Centre for Scientific Research (CNRS) in France. “During this time, autonomous regional glass industries emerged in both the Islamic world as well as western Europe.”

These new autonomous systems replaced the centralised production model established during the Roman Empire. Studying their emergence could help to reveal some of the mechanisms and motivations that drove technological innovation and transfer, as well as cultural and economic exchange in the medieval Mediterranean.

SIGNIFICANCE OF GLASS

This was the objective of the GlassRoutes project, supported by the European Research Council. Schibille’s starting point was the Arab conquest of the Middle East, northern Africa and the Iberian Peninsula in the 7th century. Key issues to be addressed included how glass production diversified, as well as better understanding of the aesthetic significance of glass.

“In simple terms, why were mosaic decorations that could be considered a quintessentially Byzantine art adopted in the early Umayyad caliphate for the embellishment of some of the most important monumental mosques such as the Great Umayyad Mosques in Damascus and Cordoba?” she asks.

The project encompassed extensive compositional analyses of glass collections. Examples were sourced from well-dated archaeological contexts across different geographical regions.

These enabled Schibille and her team to build a large database of reliable chemical data, from which distribution patterns of specific glass production groups could be gleaned.

REGIONAL CENTRES OF INDUSTRY

From this painstaking work, impressive results were obtained. Schibille was able to trace the establishment of primary glass production in the Iberian Peninsula to an early Islamic glass assemblage in a suburb of Cordoba,

in the late 8th or early 9th century CE. An autonomous Iberian glass industry subsequently developed.

“Similarly, we identified a likely Sicilian primary production as early as the 10th century CE,” she says. “This indicates that the development of regional glassmaking centres in the western Mediterranean was intimately linked to the processes of Islamisation.”

A study of the mosaic decoration of the Great Umayyad Mosque in Cordoba furthermore confirmed cross-cultural exchange with the Byzantine Empire in the 10th century.

The project findings have helped to confirm that geopolitical dynamics influenced the adoption of new glassmaking recipes, either directly through immediate contact (in Mesopotamia), or indirectly through geographical and political isolation and resulting shortages (in the Iberian Peninsula).

They also show how market forces influenced the flow of resources and the transformation of regional glass industries. When commercial activities were concentrated in Damascus in the late 7th and early 8th century for example, large amounts of Egyptian glass were imported for the first time to this region. Similarly, the foundation of caliphal residences in Greater Syria and Mesopotamia led to the intensification of local industrial activities.

“What my project has really shown is the extent to which the medieval Islamic Mediterranean was a globalised system of economic and cultural exchange,” adds Schibille. “My next step will be to focus on regions such as the Maghreb, which have so far been overlooked.”

GLASSROUTES

- Hosted by the National Centre for Scientific Research in France
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/647315

Gestational surrogacy: mapping reformist and abolitionist debates in Italy, Mexico and the United States

Surrogacy is a highly divisive topic – WoMoGeS provides insights into the competing social discourses to define the problems and solutions of gestational surrogacy in three countries.

Gestational surrogacy (GS) involves women hosting embryos made from egg and sperm taken from the intended parents or from donors. GS is an attractive option for heterosexual couples, where the woman medically cannot carry out a pregnancy, and homosexual couples. It is estimated that 20 000 such babies are born annually.

Feminist interest in GS has been growing as it poses challenging questions such as: does it help or hinder women's emancipation? "Within women's reproductive politics, surrogacy ignites the most debate and divisions," says Daniela Bandelli, fellow of the Marie Skłodowska-Curie Actions supported project WoMoGeS (Women's movements and gestational surrogacy: engaging, debating and policy making), conducted at LUMSA university in Rome, in partnership with the University of Texas at Austin.

Taking three country-based case studies, Bandelli identified key conceptual frames within prevailing feminist discourses. She found that for abolitionists they were 'reproductive exploitation' and the 'commodification of women and children', while for reformists principally 'reproductive rights', 'women's autonomy' and 'protection of women and children'.

"The key finding was the different prevalence of the abolitionist or reformist approach within national women's movements and their organisation around the issue," explains Bandelli.

CROSS-COUNTRY COMPARISONS

WoMoGeS's three case studies were based in countries – Italy, Mexico and the United States – with differences in women's social conditions, social inequality, surrogacy legislation and social acceptance of surrogacy.

It is estimated that worldwide, **20 000 babies** are born through gestational surrogacy annually



For each case study, Bandelli investigated prominent media, analysing 92 newspaper articles: 44 from the Texan-American press, 28 from Mexico and 20 from Italy. Bandelli also conducted 50 in-depth interviews with feminists, activists, scholars and journalists, amongst others.

Bandelli found that in the United States the dominant regulatory approach among feminists seeks to improve GS ethics and safety with discourse focusing on contracts, women's health and medical procedures. "Despite being home to the 'Stop Surrogacy Now' campaign, surrogacy remains marginal in the feminist US public debate," according to Bandelli.

For Mexican feminists, GS is an emerging concern with some advocating regulation and others a ban in order to avoid the exploitation of poverty. However, demands for abolition are contested by a lack of confidence in its

“Feminist arguments against surrogacy pivot around the principle of *mater semper certa* – meaning that the mother of the child is conclusively established, from the moment of birth, by the mother’s role in the birth.”



enforceability by the state. “While those for regulation have more influence on policymakers, the abolitionists are gaining ground,” notes Bandelli.

In Italy, Bandelli found that while feminist opposition to GS is visible and organised, with events and coalitions, there is no established advocacy for surrogacy legalisation within the women’s movement.

“Regulatory demand comes especially from same-sex parents and civil rights organisations with the debate focusing on birth registration and parental rights over babies born abroad,” says Bandelli. “Feminist arguments

against surrogacy pivot around the principle of *mater semper certa* – meaning that the mother of the child is conclusively established, from the moment of birth, by the mother’s role in the birth – along with motherhood as a marker of feminine identity.”

Bandelli also found that while abolitionists had two main international initiatives (the Stop Surrogacy Now campaign and the International Coalition for the Abolition of Surrogate Motherhood), reformists had nothing comparable.

TOWARDS A MORE CHILD-CENTRED APPROACH

Bandelli did find consensus on the need for more scientific research, quantitative data on surrogacy births, as well as follow-up studies on the well-being of women after surrogacy and of children born this way.

“In policymaking the child’s rights are subordinated to the freedom of the adult to self-determine. I suggest a shift to a more child-centric discourse,” adds Bandelli.

Bandelli’s recent book queries current feminist responses, such as their appropriateness in various future scenarios which could see the availability of viable artificial wombs, and questions stances that suggest women involved in surrogacy are complicit in patriarchal violence against women.

WOMOGES

- Coordinated by LUMSA in Italy
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/792464
- Project website: womoges.wordpress.com



What can cloth, glass and stone tell us about the societies that created, traded and appreciated them? Episode 9 of **CORDIScovery** reveals the innovation and cultural connections forged by these valued commodities during the Middle Ages.

→ bit.ly/CORDIScovery_Episode_9





Making everywhere accessible to everyone

A quarter of Europeans experience some form of long-standing limitation to their physical activity. Yet information about a building's accessibility is often missing, out-of-date, or simply incorrect. Irish start-up Access Earth is hoping to change that by offering better information to both citizens and local authorities.



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For those with mobility issues, climbing a flight of stairs is only part of the challenge – you also need to know when to expect them. “I use a walking frame to get around, and growing up, there was a lack of information about what places were accessible,” explains Matt McCann, CEO of Access Earth.

Six years ago, he and Dónal McClean, co-founder and COA of the company, launched Access Earth, a free app which has collected up-to-date, crowdsourced accessibility information on over 110,000 shops, cafes and public buildings. As well as those with disabilities, the information can help parents with prams, and older people who use mobility aids. “We are building the world’s largest database of accessibility information,” says McClean. “We want to allow everyone to find accessibility information as easily as opening hours.”

Access Earth was approached by the National University of Ireland Maynooth to join the EU-funded SHAPES (Smart and Healthy Ageing through People Engaging in Supportive Systems) consortium, a 4-year project that launched in November 2019. Thirty-six participants are working together to support the deployment of a broad range of digital solutions for independent living.

By collecting and analysing individuals’ health, environmental and lifestyle information, SHAPES aims to build an interoperable

“We are building the world’s largest database of accessibility information.”

platform to identify their needs and provide personalised solutions while maintaining individuals’ data protection.

“One of the main goals of the SHAPES project is promoting healthy ageing throughout Europe,” says McCann. “We are using our app to demonstrate how the built environment at the moment can be bad for disabled users. People with accessibility issues are the largest minority user group, and we can help businesses access them, and their wallets,” he adds.

As well as crowdsourcing information, Access Earth also draws from other sources: the firm recently worked with the European Space Agency to identify the locations of accessible parking spots from satellite images and aerial photos. These were then mapped into a single database for the first time.

Access Earth aims to license the data it has gathered to help local authorities and venue providers identify accessibility issues in their area, and learn how they can better serve visitors. The company hopes to launch a paid accreditation service next year that will highlight those venues which provide truly accessible spaces.

In this way, the app can be kept free – and accessible – to all users.

SHAPES

- Coordinated by the National University of Ireland Maynooth
- Funded under Horizon 2020-LEIT-ICT and Horizon 2020-HEALTH
- cordis.europa.eu/project/id/857159
- Project website: shapes2020.eu



TRANSPORT AND MOBILITY

World's first long-range solar car charges on the move

A dedicated team of engineers has developed a hyper-efficient solar electric sedan car providing an unprecedented driving range of 725 km.

Imagine a car that charges itself with sunlight – no visits to the petrol station required, and you can drive for weeks or months without worrying about needing to charge. Meet the Lightyear One, a sleek 5-seater electric sedan charged by solar panels with extremely low energy consumption.

The EU-funded LIGHTYEAR (Developing the electric car that charges itself: Lightyear One) project brings to the world the first commercially available electric solar car that charges itself.

DRIVING CLEAN MOBILITY

Engineers at the Dutch high-tech company, Lightyear, wanted to build a car that was incredibly efficient with its own energy source. To achieve this, the team had to minimise the car's energy consumption and maximise its energy input.

The benefit would be reduced reliance on charging grids, some of which are coal-powered plants that have a heavy carbon footprint. This would overcome some major

barriers to market uptake on a global scale – range, high costs and heavy reliance on charging infrastructure.

Founded in 2016 by world champion solar car racers from the Eindhoven University of Technology, further growth was facilitated by industry experts (Hans Heijmans, former Volvo and Royal DSM executive, Laurens Weers and Feike Sijbesma, honorary chairman of Royal DSM) who have extensive experience in fast-growing high-tech and automotive companies. With over 150 employees aboard, Lightyear is close to bringing the first long-range solar car to the market.

"Lightyear's mission is to provide clean mobility for everyone, everywhere. Its product strategy is to deliver an ultra-efficient, long-range solar electric vehicle (EV) with convenient user experience while keeping the production complexity low," says Qurein Biewenga, LIGHTYEAR project fellow. By leapfrogging the EV charging infrastructure, Lightyear can serve any consumers worldwide who want to start driving electric.

© Lightyear



“Lightyear’s mission is to provide clean mobility for everyone, everywhere. Its product strategy is to deliver an ultra-efficient, long-range solar electric vehicle (EV) with convenient user experience while keeping the production complexity low.”

PARTNERING FOR PRODUCTION

Rens Melsen, Investor Relations at Lightyear, explains: “In the past few months, we have managed to establish several partnerships that will guarantee delivery of the first set of Lightyear One cars in the summer of 2022.” The company has recently selected Valmet Automotive – based in Finland – as production partner so they can ramp up production in 2022 and start delivering the Lightyear One cars.

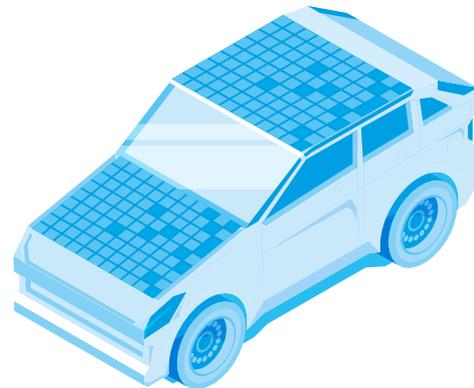
The launch of Lightyear’s first car resulted in many positive reactions. Horizon 2020 was a valuable instrument as it helped the team get to required technology readiness levels.

HATS OFF TO THE LIGHTYEAR TEAM

“Delivering and unveiling our first prototype on 25 June 2019 was one of our most significant achievements. On that day we were able to showcase our work to the world,” continues Melsen. Of course, there are various other notable achievements, such as being listed in TIME’s Best Inventions of 2019 and setting the record for the most aerodynamic production car.

The solar car can compete on cost because it uses a relatively small battery, which significantly decreases

Lightyear One – An unprecedented driving range of 725 km



the material costs of the car. It requires 80-90% less energy from the grid and is therefore very affordable to drive. “Our mission is to bring clean mobility to everyone, everywhere. We are currently developing a second model that will have a target purchase price far below EUR 50 000,” concludes Melsen. So future models will be available to a wider population.

LIGHTYEAR

- Coordinated by Atlas Technologies in the Netherlands
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/848620
- Project website: lightyear.one
- ▶ bit.ly/LIGHTYEAR-video

AI AND INDUSTRY: ADVANCED INNOVATION FOR EUROPEAN MANUFACTURING

As economies aim for sustained post-COVID recoveries, industry needs to innovate in a way that is in line with the priorities of the European Commission. Industry 5.0 provides a coherent vision for such a future industry, focused on human centricity, sustainability and resilience. It emphasises integrating social and environmental priorities into technological innovation, and shifting the focus from shareholder value to stakeholder value.

This CORDIS Results Pack showcases 14 trailblazing projects that are shaping the future with advanced AI technologies designed to support and boost industry and manufacturing across a range of objectives.

To find out more, browse, download or order a physical copy of the Results Pack here:

cordis.europa.eu/article/id/435233



Lighter, greener, safer: The next generation of fuel bladders

An EU-funded project has developed new flexible, woven fuel tanks for helicopters that reduce lifetime emissions and offer greater resilience in the event of crashes.

The European aviation industry accounts for 3% of global CO₂ emissions – a figure that is expected to rise in the future. With the aim of improving the environmental performance of aircraft, the Clean Sky programme put into place ambitious targets to develop breakthrough technologies that will significantly reduce aircraft emissions and noise levels while strengthening European aero-industry collaboration, leadership and competitiveness. As part of the second phase of this programme, a tilt rotor and a compound rotorcraft are planned.

Supporting the rotorcraft of the future, the EU-funded ACTIonRCraft (Anti-Crash lightweight fuel bladder Tank Integrated on a new RotorCraft) project set out to design, develop and manufacture anti-crash lightweight fuel bladder tanks with a low environmental footprint. “These tanks will integrate Safran Aerosystems’ robust, light and eco-friendly novel technologies that include a functionalised liner, lighter fabric and solvents and will be tested, verified and validated for the high-speed compound helicopter,” says Valérie Briand, project coordinator.

THE MAKING OF THE INNOVATIVE FUEL BLADDER TANKS

Anti-crash resistant fabrics are usually made of polyamide. “In ACTIonRCraft, a new fibre type has been identified and used. The weaving of the fabric has also been optimised,” Briand notes. The new fabric type and coating optimisation reduced the weight of the tank wall by 25% and 10% in fuel tanks, which comprises metallic interfaces and other rubber parts.

Moreover, the design of the tank wall takes into account the deformation and energy absorption of a helicopter structure when it crashes. “Both the simulation of a real crash and cube crash test conducted in the project demonstrated that the cube, comprising a fuel tank with the new tank wall in a compound rotorcraft structure, passed the crash test,” adds Briand.



The project also carried out a study into the replacement of methyl ethyl ketone solvent, usually used in the making of fuel tanks. As a result of the project’s work, a new solvent has been identified and qualified up to TRL 6. “This new solvent has been used to make the seven fuel tanks of the RACER. It also led to a 40% reduction in emissions during the manufacturing of the fuel tanks. This includes the process of coating materials,” says Briand.

MOVING FORWARD WITH IMPACTFUL RESULTS

“We have developed seven fuel tanks with a new lightweight tank wall. The tank wall is made of a functionalised liner and a textile fabric that are bonded together with a rubber coating,” explains Briand. The tanks are in line with CS-29 certification and mechanical properties. Additionally, the manufacturing of these tanks, compared to the production of others, results in a significant reduction in volatile organic compound (VOC) emissions. They are also lighter, contributing to the goals of the emerging rotorcraft, such as the RACER.

“ This new solvent led to a 40% reduction in emissions during the manufacturing of the fuel tanks. ”

Looking towards the future, ACTIonRCraft plans to implement the new solvent in the serial production of the fuel tanks. “This will lead to a real improvement regarding the environmental impact of VOC emissions in production and for the health of operators,” remarks Briand. Regarding the next generation of the functionalised liner, the project

plans to continue to develop it. “ACTIonRCraft will also continue its work in the EU-funded STRONGRCRAFT project whereby the complete fuel system will be implemented in the RACER demonstrator,” concludes Briand.

ACTIONRCRAFT

- Coordinated by Zodiac Aerosafety Systems in France
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/714249

TRANSPORT AND MOBILITY

Advanced fuselage shielding could help propfan aircraft take off

Uncontained engine failures, where debris can erupt from the aircraft engine in any direction, are violent but mercifully very rare. An EU-funded project produced innovative shielding structures, test methodologies and simulations to assess how high-energy debris affects the aircraft fuselage.

Aircraft are expected to undergo substantial technological changes over the next decades. Stringent fuel economy and CO₂ emission standards are driving forces accelerating advanced engine and material designs. Counter-rotating open rotor (CROR) architectures, also known as propfans, are a promising path being explored to power next-generation commercial jets, as they could improve fuel consumption by 20-30%.

To achieve safe integration, the aircraft structure should tolerate certain failures from open-rotor engines. Against this backdrop, the EU-funded ELEMENT (CROR Engine debris Middle level Impact and Mechanical test) project focused on practical solutions and modelling activities to mitigate the risks of uncontained engine failures. “High-energy debris could impact the fuselage, causing large structural damage that could compromise aircraft and passengers’ safety,” notes project coordinator Jorge López-Puente.

VIRTUAL MODELS REPLICATING REAL TEST CONDITIONS

Researchers validated the maturity level of different shielding configurations that help minimise the penalty

weight and protect aircraft from different engine failures. Both physical and virtual impact tests of debris exiting the engine case at high speeds were performed on simple panels and full-scale representative aircraft structures.

“Virtual tests could decrease the number and cost of experimental tests and ideally limit them to the exact number needed for aircraft certification. Computer simulations are currently widely used in static but not in dynamic conditions,” explains López-Puente. Virtual tests are key to more flexible product designs and could speed up the certification process of structures, while simultaneously meeting safety standards.

“ Studies that involve impacted structures representative of real-scale aircraft are either confidential or non-existent. ”



Researchers put a great deal of effort into preparing the experimental set-up for coupon-level testing. A carbon fibre-reinforced polymer was used to produce the prism fragment representing the blades, whereas a steel sphere represented the metallic fragments. Different rig set-ups and materials were developed and tested to integrate the rigid and flexible shielding structures.

In total, the team conducted more than 300 test coupons using a pneumatic launcher. High-speed cameras recorded the absorbed energies and the debris' residual velocities in the shielding structures.

PHYSICAL TEST IMPACT ANALYSIS ON AIRCRAFT STRUCTURES

A first, researchers carried out physical experimental tests truly representative of the virtual models to assess the impact of uncontained engine debris. Importantly, these tests did not require engine destruction. "Large specimens representative of real aircraft structures allow significant reduction in experimental costs and increase the repeatability of our testing procedures which is necessary for validating integrated solutions. Ultimately, these developments could help establish standards for more affordable certification test campaigns," he notes.

"Experimental tests are usually performed on coupons of reduced dimensions to save costs. Studies that involve impacted structures representative of real-scale aircraft are either confidential or non-existent," adds López-Puente. What's more, current studies typically focus on metallic fragments that do not appreciably deform once they strike the aircraft or soft bodies such as birds that completely fracture once they collide with the fuselage. Studies involving fragments or fuselage sections made of carbon fibre-reinforced polymers are scarce. Their mechanical behaviour could deviate from those reported in the literature for other materials.

Project experimental and theoretical results could greatly facilitate CROR engine integration into future aircraft. Potential benefits are not limited to the realm of aircraft but could also extend to other fields such as high-speed rail, focusing on how track ballasts affect the train structure.

ELEMENT

- Coordinated by the University Carlos III of Madrid in Spain
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/715873
- Project website: bit.ly/Element-CROR



Wood forms a central plank in nearly-zero energy buildings

Replacing non-renewable materials like concrete with timber can help shrink the construction industry's carbon footprint and reduce lifelong carbon emissions of building stock.

Efforts to tackle climate change must occur on all fronts. The construction industry is responsible for around 8% of the world's CO₂ emissions. Can a change in building materials help reduce its impact?

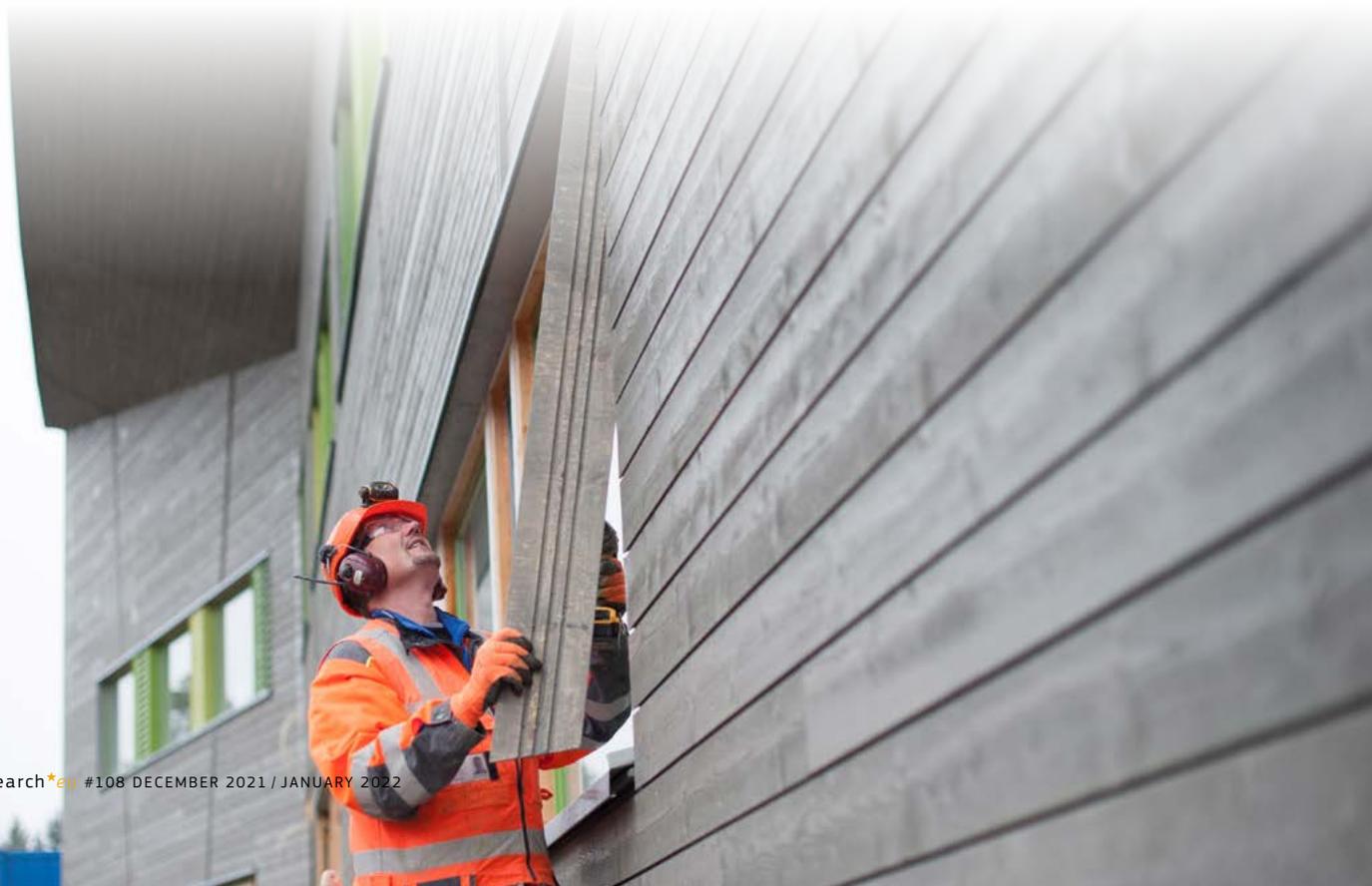
The EU and EU national policies have stepped up efforts to combat climate change by boosting wood construction. Wooden buildings can result in 50% reduced greenhouse gas (GHG) emissions compared to conventional buildings with steel and concrete structures. One way to achieve this is with wooden nearly zero-energy buildings (NZEBS).

The EU-funded NERO (Cost reduction of new Nearly Zero-Energy Wooden buildings in the Northern Climatic Conditions) project collected and identified best practices and technical solutions that significantly reduce the costs of wooden NZEBs in four different seasons. "The growing use of wooden products in buildings gives us a material that is light, durable, and more local. Unlike concrete, wood offers

a circular material that can be taken from old homes and reused in new ones, and acts as a long-term carbon sink," explains project coordinator Tero Hasu.

The project team collected construction costs, implementation and operational energy data examples of carbon emissions from 17 demonstration buildings, 11 of which were already completed, with six demos being planned and mainly completed during the project.

Life cycle assessments (LCAs) of the case and demonstration NZEBs were conducted to analyse the environmental impact of representative NZEBs in partner countries. Such information was used to compare technical solutions (e.g. structures and envelope systems) among the buildings to identify the areas of potential abatement of embodied emissions and energy.



“ Unlike concrete, wood offers a circular material that can be taken from old homes and reused in new ones. ”

A LOOK AT TWO OF THE CASE STUDIES

In one case study in Växjö, Sweden, where wooden public buildings have been a top priority, NERO developed multifamily buildings one step further. Project findings showed that the national NZEBs could offer 30-40% lower delivered operational energy use than stipulated by the existing national building code. The LCAs showed that wood-based buildings offer a significantly lower production stage primary energy use and lower carbon footprint than non-wood alternatives.

Cost-optimal analysis showed thicknesses of insulation to achieve the NZEB energy level are considerably higher than required to meet the minimum energy requirement by the code. Implementation of the NZEB solutions results in economic benefits, but not as much as the implementation of cost-optimal solutions.

In another case study in Trondheim, Norway, an analysis of the case and demonstration NERO buildings showed that replacing concrete with wide use of cross-laminated timber

for structural elements was deemed important, with at least a 30% reduction in GHGs. It is expected that a large uptake of such a construction technology in the Nordic market will reduce these costs.

“The trend for the near future is clear. At least here in the north, an increasing number of main structures for new buildings will be made of wood,” concludes Hasu. In the long run, prefabrication and industrialisation of production coupled with a lean process at factories and existing supply-demand balance on the market through a wider market uptake will bring the biggest emissions reductions. Also, near-future recommendations, guidance and legislation for emissions allowed in construction will yield the same results.

The benefit from reducing the amount of concrete was evident in the NERO project where LCA was defined. Today, however, having only a carrot without a stick, the benefits are difficult to quantify in terms of societal cost savings.

NERO

- Coordinated by Kouvola Innovation in Finland
- Funded under Horizon 2020-ENERGY
- cordis.europa.eu/project/id/754177
- Project website: neroproject.net

CLIMATE CHANGE AND ENVIRONMENT

The world's first biodegradable laundry fragrance microcapsules

While we all want our clothes to retain long-lasting freshness, today's typical solutions are plastic beads which damage the environment. EnviroCaps offers a game-changing green solution.

Fragrance microcapsules are an essential ingredient in laundry care products. They selectively apply the fragrance to fabrics during a wash cycle and then slowly release that fragrance during wear, for long-lasting freshness.

The current state of the art is melamine formaldehyde microcapsules. These microcapsules fall under the definition of intentionally added microplastics – plastic pieces less than 5 mm in diameter that are added to products to enhance performance.

As part of the EU's plastics strategy, the European Chemicals Agency (ECHA) has proposed new regulations to ban intentionally added microplastics starting from 2022.

However, today, there is no microcapsule technology on the market that combines biodegradability with fragrance performance and stability in a laundry care product.

According to Jamie Walters, co-founder and CEO of Calyxia, project host of the EU-funded EnviroCaps

“ We are proud to be contributing to the EU’s efforts against microplastics. ”

(Enabling a future of safer laundry products and cleaner oceans) project, “the key challenge is to eliminate melamine formaldehyde capsules, while still retaining and even enhancing the fragrance effects of laundry care products.”

Calyxia’s EnviroCaps solution is a world first, offering a new formaldehyde-free, readily biodegradable microcapsule technology, with both high fragrance performance and high formulation stability. The resulting portfolio of environmentally friendly microcapsules with varying fragrances was designed and optimised for cost and performance.

GREEN MICROENCAPSULATION

After over 25 years of fundamental research at Harvard University and ESPCI Paris – PSL, Calyxia has developed a fully tested reliable green manufacturing process that creates microcapsule products from thousands of different shell materials. This enabled Calyxia to rapidly screen a massive library of these shell materials, to design microcapsules that combine unprecedented performance and biodegradability. The result was EnviroCaps.

“Our approach offers a paradigm shift in the performance and sustainability of everyday products, essential to our quality of life,” explains Walters.



The biodegradability of the EnviroCaps shell materials was independently validated by a world-leading analytical testing laboratory (as meeting the OECD 301B standard), as was their performance by manufacturers.

PIVOTAL TECHNOLOGY TO BATTLE MICROPLASTIC POLLUTION

Microplastics remain and accumulate in our oceans for hundreds, possibly thousands of years. Without remediation action, they could destroy aquatic ecosystems and biodiversity, and introduce catastrophically high quantities of toxic elements into the food chain.

“We are proud to be contributing to the EU’s efforts against microplastics. As new regulations to eliminate intentionally added microplastics are implemented, so manufacturers and consumers will need greener solutions such as ours,” says Walters.

Calyxia has already signed commercial agreements with global laundry product manufacturers. The first industrial unit for EnviroCaps production has now been designed, engineered, assembled and implemented, ready for widespread production in Europe. Expansion is planned for the American and Asian markets in the coming years.

ENVIROCAPS

- Coordinated by Calyxia in France
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/849456
- Project website: calyxia.com/blog/calyxia-microcapsules



SPECIAL FEATURE

THE FARMS OF THE FUTURE – IT'S ALL ABOUT PRECISION

Editorial

“When tillage begins, other arts follow. The farmers, therefore, are the founders of human civilization.” –

Daniel Webster, American lawyer and statesman

For the better part of a century, Europe's farming system has been geared toward providing a reliable supply of affordable food. Yet success in this area has come at a significant environmental cost, and there is a growing recognition that trying to compete with cheaper imports will only encourage a race to the bottom. How we grow food in Europe will change, and must change to ensure a sustainable future.

It is no surprise then that one of the cornerstones of the EU Green Deal and its Farm to Fork Strategy is a focus on developing Europe's agriculture industry toward a high-value food system. The EU aims to offer its citizens – and export markets – the best agricultural system in terms of the quality of goods on offer, the welfare of livestock and those working in food production, and the highest environmental and sustainability standards possible. It's for this reason that it aims for 25% of cultivated land to be under organic production by 2030.

Achieving this goal requires developing new practices and technologies, new breeds of livestock more closely adapted to their local environment, better disease prevention to reduce losses, crop diversification strategies, enhanced soil and water management, and support for farmers to share knowledge and engage with market opportunities.

Precision farming offers many of these. It is a management practice that offers dramatic efficiency increases to agriculture

through the use of a data-rich approach. This includes real-time monitoring of animals, crops and geophysical factors, recognising and responding to variability within these.

It also supports the greater use of AI to help decision-making by farmers, and deploys automated systems that can carry out operations with greater accuracy, cutting labour costs and making more efficient use of pesticides and fertilisers.

The seven projects presented in this Special Feature showcase the practical research that is helping farmers achieve greater profits, reduced waste and more sustainable practices. They include a SCADA-style management system for safeguarding hazelnut orchards, AI-powered cablebot and rover pairs that work together to manage microfarms, a knowledge-sharing hub in Serbia, rapid disease detection in pigs, and sensor-equipped cows for healthier herds.

The research and innovation supported by EU funding is opening up new opportunities in farming systems, allowing us to support our agricultural industry and food systems, and compete in a global marketplace, without jeopardising the health and welfare of our farmers, their livestock, or the environment.

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

Contents



SPECIAL FEATURE

THE FARMS OF THE FUTURE – IT'S ALL ABOUT PRECISION

02

A tough nut to crack? Personalised care for individual trees

03

Connected cows for better meat and dairy products

05

Genomic management for better cattle resilience and efficiency

11

Robots lend a helping hand to European microfarms

12

Software tracks playful pigs to boost animal welfare

14

Lighting a beacon for precision farming knowledge in Serbia

15

Mobile diagnostics to curb the loss of pigs to disease

A tough nut to crack? Personalised care for individual trees

Orchards need to be constantly monitored to prevent pests and disease spreading among the trees. The EU-funded PANTHEON project hopes to make this easier with robots, remote sensors and a supervisory control and data acquisition system for trees.

While squirrels are often credited as hazelnuts' number one fans, we humans aren't shy of filling our cheeks. We consumed 424,000 tonnes of hazelnuts in 2018 alone. Consumers' appetite for hazelnuts has forced producers to constantly re-evaluate their best practices in order to increase productivity, product quality and environmental sustainability.

Nobody on the market escapes these concerns, not even big players. "In 2017, we met one of Ferrero's senior agronomists," says Andrea Gasparri, associate professor at Roma Tre University. "He told us about how orchards were managed and how difficult it was to monitor individual plants. All decisions were made by assessing the status of a few plants and extending treatments to the entire section, which was sometimes unnecessary or even counterproductive."

That's when Gasparri and his team thought about building a set of terrestrial and aerial robots specifically for hazelnut farming operations, funded through the Horizon 2020 PANTHEON (Precision Farming of Hazelnut Orchards) project. Together, they would collect data and perform the likes of pruning, sucker detection and removal, irrigation, pest and disease detection, and yield estimation.



© Rodica Vasiliev, Shutterstock

“Sucker control and plant monitoring are two of the most time- and resource-demanding operations in today’s orchard management.”

Meanwhile, a network of internet of things (IoT) devices would collect environmental and meteorological measurements and send them to a central operative unit. Farmers could use the data to support their decisions and plan robotic actions accordingly.

“It’s the equivalent of an industrial supervisory control and data acquisition (SCADA) system, but made specifically for hazelnut crops,” Gasparri explains. “Farmers can interact with the software interface, get an overview of the orchard health status and access details on each single plant. They have a dashboard with various widgets that they can simply access from a browser or directly in the field from a smartphone or tablet.”

For example, one widget PANTHEON developed relates to pruning, and helps farmers manage interventions. They can access 3D interactive views of a tree, select specific branches to be cut and get information on the wood biomass that will be removed. Historical data can even be used to predict required operations or consolidate those from past seasons.

EN ROUTE TO COMMERCIAL APPLICATIONS

Whilst this technology won’t be available tomorrow, the PANTHEON project has successfully proven both the feasibility of single plant level monitoring and the viability

of autonomous robotic operations in orchards. As Gasparri remarks, “the idea of understanding and adapting to the needs of each single plant is not new but PANTHEON is the first project to develop a SCADA architecture for that purpose.”

Amongst the project’s most important achievements are the development of an automated sucker management system, which calibrates the amount of herbicide to be sprayed based on individual plant needs, and advanced pruning protocols that suggest cuts according to the chosen plant training system.

The project team successfully validated their findings in the commercial hazelnut orchards of the Azienda Agricola Vignola– a specialised hazelnut farm located in Nepi, Italy. “As far as commercialisation plans are concerned, we believe that PANTHEON represents a milestone in hazelnut precision farming,” says Gasparri.

“The midterm objective will now be to turn some of their solutions into scalable and commercial products. Sucker control and plant monitoring are two of the most time- and resource-demanding operations in today’s orchard management, so they could very well lead to market-ready, standalone products in the coming years,” Gasparri concludes.

PANTHEON

- Coordinated by Roma Tre University in Italy
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/774571
- Project website: pantheon.inf.uniroma3.it

Connected cows for better meat and dairy products

The CATTLECHAIN 4.0 project has devised new solutions for farmers to cope better with large numbers of animals while assuring full transparency of the supply chain. The new products could be rolled out as soon as next year.

A new generation of farmers can easily feel as though they’re stuck between the devil and the deep blue sea. Remaining profitable means a push toward ever larger farms, and spending dearly on precision farming equipment to closely monitor meat and dairy product quality. This is enough pressure to discourage many wannabe farmers, but it’s also a must for those taking the leap. Only then can they quench governments’ and

consumers’ thirst for transparency and traceability in the supply chain.

With CATTLECHAIN 4.0 (Enhancing farm productivity and guaranteeing CATTLE traceability and welfare with blockCHAIN), Carlos Callejero and his team bet on new internet of things (IoT) devices and algorithms to provide a reliable and cost-effective solution capable of

continuously monitoring single animals. Their technology, which has been validated in scenarios involving up to 5000 cows, completely changes the way livestock is managed.

Can you tell us more about the IoT devices and algorithms you developed? What's their purpose and what makes them particularly innovative?

Carlos Callejero: We combined IoT devices – collars and ear tags – and external sensors that weighed the animals and measured the amount of water they ingested. Our algorithms check the following animal welfare parameters: access to food, access to water and activity level (i.e. stress) of the animal.

Eventually, some of the developed algorithms will work from the devices themselves (so-called edge computing) and therefore provide processed information that's as close to the source as it gets. All in all, we can expect a future with smarter IoT devices that will capture more valuable information.

In what situations do these algorithms and devices come in particularly handy?

We have been working on three tools, each with its own purpose: a tool to monitor the amount of time an animal has been outside grazing, a tool to alert farms when the animal drinks less water than it should or has been gaining less weight than expected, and a tool to monitor stress levels and trigger notifications when they become abnormal.

What are the project's main achievements so far?

Our new collars and ear tags are ready. They communicate with each other and have been proved to minimise the overall cost of herd monitoring. We have also successfully developed a new generation of algorithms using artificial intelligence to obtain more information on the state of the animal, as I already mentioned. This is all expected to increase the profitability of large herds.

At the blockchain level, we came up with a tool that provides consumers with exhaustive information on the traceability of meat products. This tool has been validated with different farms selling their products directly to consumers. As you buy your meat, you get valuable information such as the place of origin, animal welfare certificates, etc.

What's left to be done?

We have yet to launch our upgraded collar and ear tag with the edge computing capabilities I mentioned. With this new generation of devices, we hope to change the common perception among our customers that technology can only help with localisation.



We are also working to improve the detection rates of reproductive events, as well as the grazing hour count algorithm. We want the latter to take into account variations induced by meteorological conditions. An algorithm to monitor nutritional activity during grazing will also be introduced.

The last months of the project will be dedicated to the integration of blockchain technology within FIWARE – a community and framework of open source platform components that aims to accelerate the development of smart solutions – and including it in a pan-European decentralised network such as Alastria.

How can this technology help a younger generation of farmers thrive?

The European Green Deal will transform the EU into a modern, resource-efficient, and competitive economy. This is a challenge for the younger generations of livestock farmers. It calls for the development of management techniques and technologies that improve the efficiency and profitability of farms, all this respecting animal welfare and minimising the environmental impact associated with livestock activities. CATTLECHAIN

anticipates these challenges with solutions helping young farmers face them and guaranteeing the longevity of their activity.

You're working on an animal welfare seal as well. How do your tools provide a guarantee for this welfare?

IDELE (the French livestock Institute) are partners in this project. They provide expertise in animal behaviour and welfare. The Spanish institute IRTA is also subcontracted to set the thresholds beyond which incidents related to animal welfare have to be reported. Our objective is not to define those standards, it is rather to provide a technology that guarantees their application.

Can you tell us more about your commercialisation plans?

We're planning for three distinct phases. First, we'll focus on marketing efforts in Spain. The solution will be integrated into our distribution channels (web, commercial agents and distributors). Moreover, a promotional campaign will be carried out both digitally (social networks, website) and through our partners amongst livestock associations and cooperatives. Contacts with these associations and public administrations will also be intensified.

The second phase will consist of consolidation in Spain and commercialisation in France, Portugal and the United



Carlos Callejero
CATTLECHAIN 4.0 project
coordinator
© Carlos Callejero

“ Our algorithms check the following animal welfare parameters: access to food, access to water and activity level of the animal. ”

Kingdom. Our marketing strategy will be replicated in the other two European markets where we are already present.

Phase three is that of international marketing. We'll be looking for a distributor in the main targeted markets, creating a network of resellers to better reach livestock farmers. We have already carried out this plan with other products in collaboration with telecommunications and technology providers.

CATTLECHAIN 4.0

- Coordinated by Management, Construction and Trade, Innovative Solutions International in Spain
- Funded under Horizon 2020-LEIT, Horizon 2020-Societal Challenges and Horizon 2020-Framework Programme
- cordis.europa.eu/project/id/853864
- Project website: cattlechain.eu
- ▶ bit.ly/CATTLECHAIN4

Genomic management for better cattle resilience and efficiency

Not all cows are made equal. By analysing each cow's genome and phenotype, the GenTORE project promises to increase the economic, environmental and social sustainability of European cattle production systems.

Animal husbandry – including sorting breeding stock from those destined for the slaughterhouse – relies on a fair amount of intuition and guesswork. But what if farmers could have their decisions informed by precise genetic and non-genetic information? In this new reality, the value of individual animals and their suitability for breeding would be determined using dedicated management tools. This is precisely what the EU-funded GenTORE (Genomic management Tools to Optimise Resilience and Efficiency) project has set out to achieve.

“Farmers often have many questions about their animals, and the answers depend mostly on their innate capacities – their genotype – and their current state or phenotype,” explains Nicolas Friggens, a researcher at INRAE and coordinator of the GenTORE project.

Until recently, both could only be approximated. But the advent of genomics and automated on-farm monitoring technologies has the potential to completely change this.

“Thanks to GenTORE, farmers can rank their cows according to their dairy worth.”

“It could provide highly accurate information to guide farmers’ most crucial decisions,” says Friggens.

Directly building on these advances, GenTORE provides a set of tools that improve cattle management every step of the way. These tools enable multi-breed selection for better cattle resilience and efficiency (R&E), characterisation of diverse farm environments, large-scale phenotyping of R&E using on-farm technology, and on-farm management of breeding and culling decisions. Farmers can even use GenTORE to predict the consequences of changing breeding and management on overall farm resilience.

CATTLE MANAGEMENT UNDER THE MICROSCOPE

Thanks to GenTORE, farmers can rank their cows according to their dairy worth. Using this information, they can then decide which of their cows should be bred using dairy semen, and which ones should be bred using beef breeds that will increase calf value for meat production.

Yet the range of possibilities is wider: “With this genomic information on their cows, farmers will be able to select the bulls that give the most favourable combination of genes. GenTORE has already developed such tools and they are being deployed by breeding companies and farmers,” Friggens notes.

To get to this level of precision, the GenTORE consortium had to compile a unique database of over 1 million genotypes and combine genotypes with R&E phenotypes.

This was perhaps the most difficult part of the project. “In some situations, typically extensive beef production systems, there was very limited data available. We had to carry out dedicated trials within GenTORE,” says Friggens.

He adds: “We also wanted to see if remote monitoring of animals was feasible. As there was no information available, we carried out our own studies using drone technology. These show that such technology has potential but is not yet ready for deployment.”

Many other tools are. Besides the ranking tool, the GenTORE team have successfully developed a Europe-wide cartography combining geophysical, weather and

farm type information that provides key information on the local production context.

They have also devised improved methods for phenotyping R&E using on-farm technologies that measure both animal performance (milk production, bodyweight, etc.) and other facets such as activity and temperature. Finally, they created new methods to improve the genomic evaluation of cross-bred animals.

“We hope our work will enable new generations of cows that are better adapted to their local production environments. Better adapted animals means improved welfare, improved longevity, and sustainable efficiency for cattle production systems.”

The on-farm management tools will also allow farmers to tailor their breeding strategies to produce the right numbers of animals for their needs. This means fewer replacement animals, which is good news for the environmental footprint of cattle production.

“Finally, the longer-term prediction models developed in GenTORE will allow farm advisors and farmers to better anticipate, and adapt to, the impacts of climate change on their regions,” Friggens concludes.

GENTORE

- Coordinated by INRAE in France
- Funded under Horizon 2020-FOOD
- cordis.europa.eu/project/id/727213
- Project website: gentore.eu
- ▶ bit.ly/GenTORE



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Research*eu in numbers

For the last decade, the Research*eu magazine has brought you the most exciting, innovative and important EU-funded research taking place across Europe and beyond. Here, we take a look at the milestones achieved by the magazine.



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In total we published **108 issues** of Research*eu, featuring **5 988** remarkable EU-funded **projects** from across **9 key domains, including:**



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1 224 articles



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1 094 articles



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1 016 articles



Since October 2018, **32** particularly impressive projects that caught our eye have been awarded **Project of the Month** status.

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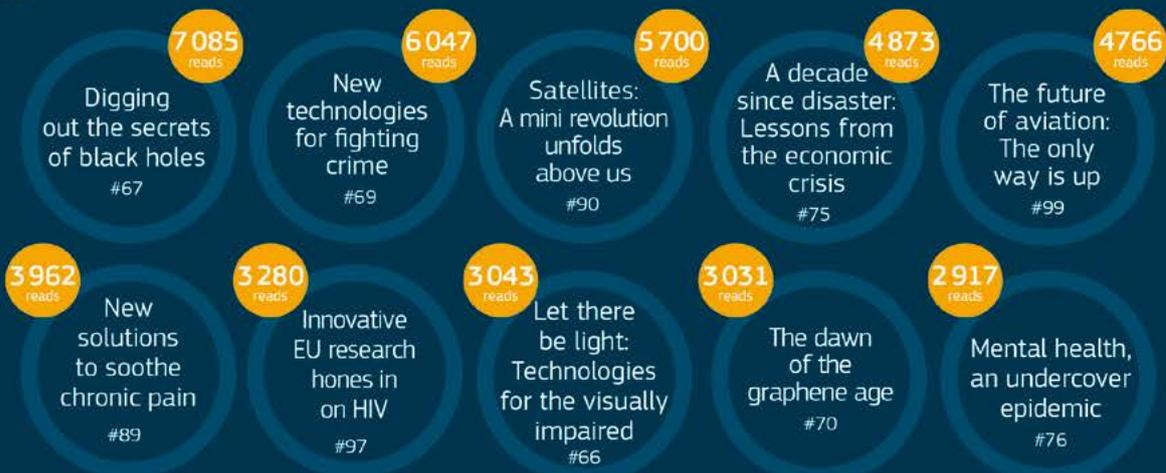
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We're never happier than when our stories of the latest EU-funded research results resonate with our audience. Over the past 10 years we've received innumerable messages from readers, some of which are reprinted below. Thank you for your support!

On #76 'Mental health: an undercover epidemic' – October 2018

Many thanks for your 'Special Feature' in your edition of Research*eu #76 (...)

My wife and I are respectively suffering from anorexia nervosa and posttraumatic stress disorder, and found your reports highly interesting and encouraging.

A scientist based in Germany

“

On #106 'Innovative EU research targets breast cancer' – October 2021

I've been subscribing to CORDIS for 4 years. It's exciting to see all these European research projects showcased! I was particularly interested in the last edition on breast cancer. Thanks for these 4 years of discoveries!

Léa Briet, Junior Medical Advisor
Immuno/Oncology, Grenoble
(France)

“

On #95 'Speaking in tongues: Celebrating linguistic diversity' – August/September 2020

The subject of issue #95 is a real treat. Really enjoyed reading and acquired a wealth of knowledge.

Thank you.

M Z M Nazim, Colombo (Sri Lanka)

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”

“

I think the format is great and the articles the right length, as they give you a good overview of the research.

Geneviève Bender (Luxembourg)

”

“

For a long time, I have looked forward to receiving Research*eu in my post. Always an interesting read. This is just one of many, many reasons I voted for the UK to remain in the EU. In the sad event of the UK departing from the EU, will I still be able to receive this publication? I dearly hope so. In any event, thank you for continually providing a wonderful publication that has always added to my love and knowledge of science.

Mike White, Walsall (United Kingdom)

”

“

On #92 'Biodiversity: A new deal for nature' – May 2020

Please give my congratulations to the team (...) for their biodiversity feature which is a pleasure to read! There will be good use of these articles even beyond the Research*eu communication.

Marco Fritz, Team leader 'Biodiversity and nature-based solutions'
Directorate-General for Research and Innovation,
European Commission

”

“

On #100 'The new synergies of shopping: E-commerce or 'bricks and mortar?' – March 2021

From the first day that I subscribed to your magazine, I must confess that I was truly surprised and satisfied with the quality of your work. From that day until now I have to thank you for your hard work, well executed and professional, characteristics that can be noticed even in the small details. It is jobs like these that increase my determination to continue studying and always seek to know a little more and beyond. The postcard you sent in this magazine is very inspiring. Its beautiful words will stay a long time on my study table. Good luck for what you will continue to do. I'll be waiting for the results of your good work. Thank you.

Elisabete Silva Cardoso Oliveira, Nurse, Santa Maria da Feira (Portugal)

”

Robots lend a helping hand to European microfarms

While smaller farms can be more flexible, they lack the same resources as larger enterprises. ROMI's affordable robotic system cuts labour costs and carbon emissions, and reduces dependence on fertilisers and herbicides.

Microfarms can be highly productive, cultivating diverse offers to local markets with 'just-in-time' distribution, a feat that is more difficult for larger conventional farms. They appeal to entrepreneurial farmers, and attract consumers with high-value organic and specialist produce. Some can grow 100 different crops in under 5 hectares.

Yet, these small farmers still face challenges with a lack of resources, and labour-intensive crops that often result in physical ailments such as back problems.

The ROMI (RObotics for Microfarms) project brought together a consortium which aims to deploy affordable autonomous tools capable of tailored and precise tasks. Their developments include a customisable platform for controlling smart farm management tools, a ground rover and cablebot, and a phenotyping scanner for accurate plant modelling.

FIELD TESTING

Based on a battery-powered platform designed Sony CSL, the rover is lightweight but robust enough to mechanically work the soil with a rotary tool, and is controlled by open-source code developed by the project.

This is complemented by a cablebot – a robotic camera that moves along a horizontal cable suspended above the ground – for when drones are problematic, such as near airports.

"It was clear that farmers needed something besides another drone. Our cablebot can run continuously, powered by a recharging station, recording plant growth as well as

alerting farmers when they need to intervene," explains project coordinator Jonathan Minchin, a researcher at project host IAAC in Barcelona, Spain. Software developed by the project analyses the cablebot's images, creating maps to orient the rover when weeding or identifying plants.

The heart of the system is a software dashboard that allows farmers to control the rover and cablebot, as well as receive reports and visualise incoming data, on their preferred devices. "Farmers can adapt our open-source system to their farm and markets, while remaining the custodians of their own data, without relying on expensive third parties," says Minchin.

ATTRACTING NEW FARMERS

ROMI's AI-powered phenotyping scanner can create accurate plant models, follow their growth trajectory, and identify individual plant organs such as fruits, leaves and stems. This last ability is a crucial step towards automatic harvesting as well as disease detection. Humboldt University in Germany, a project partner, has provided additional adaptive learning algorithms to optimise movement of the scanner's camera.

Some microfarms can grow
100 different crops
in under **5 hectares**



“Farmers can adapt our open-source system to their farm and markets, while remaining the custodians of their own data.”



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The rover and cablebot were developed in collaboration with farmers at Chatelain Maraîchage organic farm in France and at Valldaura Labs in Barcelona, Spain. The phenotyping scanner was tested on real and virtual plants by developmental plant biologists at CNRS and INRIA.

“We demonstrated in the field that the rover could effectively weed lettuce crops in a number of layouts. The scanner successfully automated the time-consuming

process of taking measurements from plants, useful in both the lab and field,” notes Minchin.

By helping microfarmers cost-effectively better manage crops, ROMI supports their growth and sustainability. “We want to make agriculture more attractive to young people,” adds Minchin. “Farming practices can be highly traditional and slow to change, but we’ve seen a real willingness to embrace robotics on microfarms.”

The ROMI consortium is now seeking funding to further advance the robotic tools and platforms.

ROMI

- Coordinated by the Institute of Advanced Architecture of Catalonia in Spain
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/773875
- Project website: romi-project.eu
- ▶ bit.ly/ROMI_Rover

Software tracks playful pigs to boost animal welfare

Responding to calls for higher welfare in livestock farming, AutoPlayPig harnesses the emerging field of computational ethology to monitor play behaviour in pigs as an indicator of their well-being.

Animal scientists, industry practitioners and animal rights bodies all agree that farm animal welfare needs improvement. In response, food producers are increasingly turning to precision farming technologies, as sensors, cameras and microphones – coupled with data processing algorithms – can monitor not only productivity but animal welfare as well.

The AutoPlayPig (Automatic detection of play behaviour in young pigs as a measure of positive affective states) project, supported by the Marie Skłodowska-Curie Actions (MSCA) programme, has been exploring these technologies for the pig production industry.

“A comprehensive picture of animal well-being should capture different indicators of health and welfare. We

explored play behaviour as an indicator of positive welfare,” explains Tomas Norton, coordinator of the AutoPlayPig project.

After using human observation to establish baseline data, the team have started developing an algorithm that can automatically identify play behaviour.

“We think AutoPlayPig is the first project of its kind, so we are really breaking new ground in an emerging field,” adds Mona Larsen, the MSCA fellow.

COMPUTATIONAL ETHOLOGY

It is often easier to track the physical health of animals than to track an abstract concept like ‘wellness’. Indicators,

“ *A comprehensive picture of animal well-being should capture different indicators of health and welfare. We explored play behaviour as an indicator of positive welfare.* ”

such as fitness levels or the presence of infection, are easier to monitor and measure. The so-called affective states – emotions, moods and feelings – cannot be measured directly, so are usually inferred through indirect means.

Play behaviour is a good well-being indicator in young pigs, as it seems self-rewarding and usually takes place in the absence of threats, such as illness. Furthermore, it can be measured non-invasively, unlike other health indicators, such as body temperature, which require sensors attached to the animal.

Yet, the sporadic, spontaneous and short-lived nature of play in pigs, makes it difficult for researchers to observe directly.

“Long-term animal observation can be subjective, inconsistent between observers, and limited by human senses, so our team are developing tools for computational ethology,” adds Norton.

Computational ethology combines computer science with the study of animal behaviour, enabling automated, continuous and consistent monitoring.

“Play behaviours are often immature versions of adulthood behaviours, meaning they can be confused with other behaviours. This is where computers and algorithms excel: they recognise patterns in the data not noticeable to humans,” says Larsen.

The team first created an ethogram – a codified list of indicators based on observed behaviours. This was then used during algorithm development by matching experimentally induced pig behaviour to the ethogram’s classifications. When cameras record the locomotor play of the pigs, video clips can be analysed by the algorithm to check if the displayed behaviours match those in the data set.

“The algorithm is showing promising results in isolating video frames related to locomotor play, while also separating fast from slow movements,” notes Larsen.



BETTER DECISION SUPPORT TOOLS

European Union efforts to improve farm animal welfare have intensified recently. New animal welfare reference centres, starting with pigs, have been established, and welfare standards are being reconsidered as part of the new Farm to Fork Strategy within the European Green Deal.

The team is now exploring more sophisticated analysis techniques, such as deep learning, to identify play and other social behaviours. This increases adoption by farmers by keeping the computational resources needed to a minimum.

As the algorithm was developed using young pigs housed in pens and immediately after weaning, future algorithms will cater for pigs of different ages and environments.

“These algorithms can be developed into decision support tools to manage animal welfare. However, despite increased interest, we need to collaborate with industry, farmers and consumers to identify business models for these emerging tools,” says Norton.

AUTOPLAYPIG

- Coordinated by KU Leuven in Belgium
- Funded under Horizon 2020-MSCA
- cordis.europa.eu/project/id/842555

Lighting a beacon for precision farming knowledge in Serbia

A lack of information amongst farmers about the return on investment offered by precision agriculture methods impedes their adoption. Engaging with farmers in Serbia while supporting peer-to-peer initiatives enabled DRAGON to spread knowledge beyond research circles.



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Until farmers see compelling business reasons for adopting precision agriculture (PA) technologies, they will likely retain their more traditional practices. While much knowledge does exist about the benefits of PA, it has largely been confined to scientific circles.

The EU-supported DRAGON (Data Driven Precision Agriculture Services and Skill Acquisition) project has developed PA expertise in Serbia, making information about tools and techniques to help increase their yield and profit while reducing risk available to farmers.

DRAGON established a knowledge ecosystem within the BioSense Institute, soon to become a European Centre of Excellence for Sustainable Agriculture and comprising both farmers and researchers, with collaborators from the United Kingdom's Agri-EPI Centre and Wageningen University in the Netherlands.

“Our young researchers became familiar with best practices and precision farming tools, based on big data and data analytics,” says project coordinator Ivana Gadjanski from BioSense, the project host. “Increasing our technical capacity allowed us to position BioSense as a knowledge lighthouse capable of implementing innovations in Serbian agriculture.”

DRAGON's researchers have already published a number of joint papers and collaborated on new projects. They have also developed a massive open online course (MOOC) about big data in agriculture, to be launched on EdX early next year.

A MIX OF TECHNICAL AND SOCIAL OBJECTIVES

Building the right expertise rested on both increased technical understanding of PA amongst researchers, as well as communicating its benefits to farmers.

DRAGON helped double in size BioSense's Center for Information Technologies (CIT) to 28 researchers. The CIT had been set up to apply advanced artificial intelligence (AI) techniques and develop data-driven solutions for agriculture (including soil, crop growth, yields, postharvest, and supply-chain applications) and environmental monitoring (for example pollen or biodiversity), enabling improved decision-making.

Through DRAGON, CIT's researchers benefited from collaboration with experts from partner institutions who introduced them to new tools and techniques.

Case studies presented included an exploration of accelerometer-based sensor systems to monitor cattle behaviour and detect health and welfare issues in large herds. Others explored the use of satellites for identifying crops and detecting irrigation problems.

Various modelling tools were also introduced for assessing the environmental impact of human behaviour, classifying airborne pollen, plant phenotyping, soil properties analysis and weather data processing. Additionally, the researchers became familiar with genomic tools for plant breeding.

“At the start of DRAGON, BioSense was under 3 years old, with enthusiastic but inexperienced young researchers. Today we have a mature research centre developing and implementing advanced solutions,” adds Gadjanski.

One such solution is DRAGON's own suite of data-driven services which includes yield prediction services, satellite crop identification and crop monitoring modules. These may soon be included in BioSense's AgroSense platform, currently used by over 60 000 people in Serbia.

FOR LOCAL OWNERSHIP AND THE NEXT GENERATION

DRAGON also adopted co-creation methods to share knowledge, organising 'infodays' and business-to-business meetings for specific stakeholders (farmers, SMEs and start-ups, governmental agencies). Here DRAGON's researchers gained insights about real-life problems faced by farmers, and the farmers themselves benefited from peer-to-peer knowledge sharing.

"This network had high participation from the Serbian agricultural community, who best understand problems specific to their own land and were interested in solutions developed in Serbian," explains Gadjanski.

Informed by feedback from farmers during DRAGON, BioSense has now set up Cropt, a spin-off company

“ Today we have a mature research centre developing and implementing advanced solutions. ”

for commercialisation of AI-assisted agricultural decision-making.

"DRAGON's overview of data-driven research and innovation, leading to multiscale and multisource interventions, provides a good baseline for new projects," concludes Gadjanski. "We are currently pursuing satellite-based monitoring of regional agricultural production, phenotyping to monitor crop development and metagenomics for microbiome analysis of soil health."

DRAGON

- Coordinated by the BioSense Institute in Serbia
- Funded under Horizon 2020-Spreading excellence; widening participation
- cordis.europa.eu/project/id/810775
- Project website: datadragon.eu

Mobile diagnostics to curb the loss of pigs to disease

Intensive meat production leaves animals increasingly vulnerable to infection, and inefficient means of controlling this are risking both animal and human health. The SWINOSTICS device offers a precise, mobile tool to quickly detect viruses in pigs.

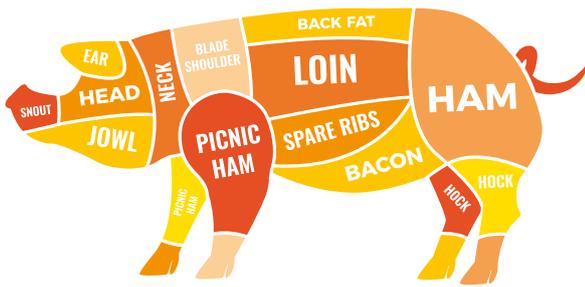
In modern meat production, animals are often housed in crowded pens, making them vulnerable to the spread of infectious diseases. This makes early detection and vaccination crucial to limiting the damaging economic and animal welfare consequences.

Outbreaks of disease will contribute to an expected 10% drop in worldwide pork production from 2018 to 2021, from 113 to 101.5 million tonnes. In response, the EU-supported SWINOSTICS (Swine diseases field diagnostics toolbox) project has developed a fast, precise, on-the-spot, mobile swine diagnostic tool.

Currently, disease monitoring involves laboratory tests of random population samples. The SWINOSTICS mobile device can simultaneously analyse four samples to detect six of the most important swine viruses: African



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Worldwide pork production is expected to fall by 11.5 million tonnes from 2018-2021, a 10% reduction

Swine Fever virus, Porcine Reproductive and Respiratory Syndrome virus, CSF virus, PCV2, PPV and Swine Influenza virus. The sensors can be reused up to 10 times, with results available after just 45 minutes.

“Our device can revolutionise the way swine industry controls are done as it can screen populations more often and is ideal for import/export border controls,” says Alessandro Giusti, R&D director at project host CyRIC, the project host.

VIRAL APP

At the heart of the device is a photonic integrated circuit (PIC) biosensor. PICs are usually silicon-based circuits, similar to those in electronic devices such as cell phones, but instead of transmitting electricity in the SWINOSTICS device they manipulate light particles (photons).

The surface of the PIC contains antibodies against the viruses of interest. When samples are passed over the PIC biosensors, any virus present binds to the antibodies. The device then measures the resulting shift in the refractive index of the light coming out of the PIC. These measurements indicate the presence, or not, of the targeted virus. The device’s communication module then alerts the user about the result.

“As the system reports viral levels, it can be used to indicate the probability of animals developing illness or in danger of infecting others,” explains Giusti.

Users connect to the diagnostics device through a Bluetooth connection using the SWINOSTICS app. Additionally, a more advanced cloud-based interface and

“ Our device can revolutionise the way swine industry controls are done as it can screen populations more often and is ideal for import/export border controls. ”

platform is available for detailed data analysis, aimed at researchers, standardisation bodies and public authorities.

After initial testing in CyRIC’s lab, four versions of the device, alongside over 100 sensors, were shared with the four pilot locations in Greece, Hungary, Italy and Poland for full validation. This stage is still ongoing. “The results so far have been highly promising, with both sensitivity and specificity over 70%,” adds Giusti.

TOWARDS AUTONOMOUS DIAGNOSTICS

Increased prevalence of disease among farm animals threatens the availability of high-quality meat, reducing profits for European farmers while pushing up food prices for consumers. Crucially, it also results in more intensive antimicrobial use, affecting not only animals but, through the food chain, human health.

“Guided by the One-Health agenda, our device’s ability to maintain the health of pigs can help solve these challenges,” says Giusti. “Longer term we see our mobile device as a stepping stone to fully automated animal health diagnostics for a range of farm animals.”

The device and sensors are now undergoing larger validation studies, alongside further improvements to ensure increased accuracy and compatibility with industry standards before being commercialised.

SWINOSTICS

- Coordinated by CyRIC in Cyprus
- Funded under Horizon 2020-FOOD
- cordis.europa.eu/project/id/771649
- Project website: swinostics.eu



A is for aphid, B is for beetle: the order pests arrive makes a big difference to crops

How plants defend against one insect herbivore can influence their resistance to the next. The MULTIATTACK project examined how plants plan for the future, which holds important clues for better pest control and plant breeding.

Every year, around 2.5% of Europe's crops are lost to insects such as aphids, beetle larvae and caterpillars. This figure is expected to grow as a result of climate change, at a time when farmers are under increasing pressure to phase out pesticides for environmental and ecological reasons.

Breeding plants with better resistance to pest species could make an important contribution to the EU's environmental and food security goals. The MULTIATTACK (Plant adaptations to unpredictable attack by dynamic insect communities) project, which was supported by the European Research Council, investigated how plants organise their defences against multiple insect herbivores.



“We worked with the hypothesis that plants adapt to common orders of arrival of herbivores in the field,” explains project coordinator Erik Poelman. “If you as a plant respond to the first herbivore attacker, how will that affect your resistance against the second, third, fourth attacker?”

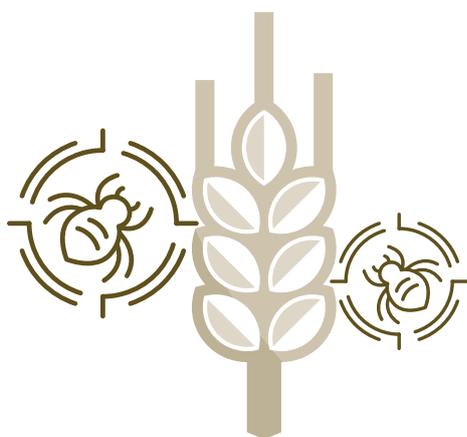
CHEMICAL WEAPONS

The life cycle of different insect species dictates when they might arrive to feed on a plant during the growing season. The presence of some insects on a plant can also influence the arrival of others, which may sense opportunity, or wish to avoid competition.

When a plant is attacked by an insect herbivore, it can respond in a number of ways. By recognising the type of damage a herbivore does, or the compounds in its saliva, a plant can tailor resistance to that specific type of attacker.

This can include enhancing secondary chemistry that makes it taste unappealing or attracts predators that will attack the pest, or growing more defensive hairs or thicker leaf cuticles. These cost the plant valuable resources, but a well-chosen defence against one species may protect against the next.

To understand more about this strategy, Poelman and his team at Wageningen University exposed Brassica plants such as mustard and cabbage to different sequences of insect pest species in a greenhouse setting, measuring how well the plants resisted different combinations of attack.



Every year, around **2.5%** of Europe's crops are lost to insect pests such as aphids, beetle larvae and caterpillars

“*We think plants are good risk managers, strategic game players, similar to Tetris players.*”

A second series of experiments carried out in the field monitored the arrival of different insect herbivores each week, and how this shaped the insect community.

The team found that plants adapted best to the most common sequences of herbivore arrivals. The most recent herbivore strongly determines how well a plant can launch resistance against the current attacker.

“Plants anticipate what’s going to happen in the future,” says Poelman. “We think plants are good risk managers, strategic game players, similar to Tetris players. They can adjust their strategy to the current problem by including what may happen in the future.”

NEW BREEDS

Poelman says future research will examine whether related plant species anticipate similar sequences of herbivores, and if those that evolved under more unpredictable orders of arrival have more plasticity in their defence.

The findings suggest that by exposing plants to one insect herbivore, farmers may be able to induce resistance to more damaging ones in the future. “This message is a little scary to the farmer, to say it’s good to allow some level of herbivory,” notes Poelman. “It’s counter-intuitive.”

“We will have to start to think about breeding cultivars capable of dealing with multiple herbivores,” he adds. “Currently in breeding these are approached as independent problems, and we have shown they are dependent problems.”

MULTIATTACK

- Hosted by Wageningen University in the Netherlands
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/677139
- Project website: erikpoelman.com/site

Engineered plants could be green chemical factories of the future

Synthetically engineered plants can be made to be more resilient, and even produce green chemicals and biopharmaceuticals. This could help agriculture to feed a growing population and tackle the challenges of climate change.

Synthetic biology aims to modify existing organisms by designing biological systems based on IT and engineering. One key approach is to design and then introduce synthetic genomes into cells. Genomes provide an organism with all its genetic information.

“Plants are particularly attractive targets of synthetic biology,” explains GENEVO SYN (Reshuffling genes and genomes: from experimental evolution to synthetic biology in plants) project coordinator Ralph Bock, director at the Max Planck Institute of Molecular Plant Physiology in Germany.

“First, their genomes can be manipulated relatively easily. Second, plants can tolerate even large changes to their genomes. Third, and most importantly, all life on our planet depends on plants. They produce the oxygen we breathe and the food we eat.”

“In view of the growing world population and the challenges that come with climate change, agricultural productivity must double by 2050,” notes Bock. “New renewable sources of chemicals and fuels must be found.

We urgently need new technologies, and here synthetic biology can play an important role.”

APPLYING GENOMIC ENGINEERING

The GENEVO SYN project, supported by the European Research Council, is built on Bock’s groundbreaking work in developing tools to engineer the genomes of two cell organelles – structures that perform specific functions in cells – called chloroplasts and mitochondria. The genomes of these two organelles are much smaller than the genome in the nucleus of the plant cell.

“This makes chloroplasts and mitochondria particularly amenable to large-scale genome engineering with high precision,” explains Bock. “This allows us to apply synthetic biology approaches that are currently not feasible in the nuclear genome.”

The project had a number of aims. First, Bock wanted to engineer a new metabolic pathway in the chloroplast, to allow for the synthesis of an antimalarial drug called artemisinin. Second, he wanted to develop methods to make the mitochondrial genome more accessible to genetic manipulations.

“Finally, we wanted to build on our discovery that entire genomes can be transferred between plant species by grafting,” says Bock. “Our idea was to exploit this process to generate new synthetic plant species.”

PLANTS AS FACTORIES

The project, completed in March 2021, successfully introduced the artemisinin pathway into chloroplasts. Bock and his team were able to show that this much-needed drug, which has the potential to save thousands of lives, can be produced to high levels in tobacco leaves. “The strategies and tools we developed in this project are



now ready to be applied to other metabolic pathways," adds Bock.

The team also made some progress with mitochondrial genome engineering. "There are still a number of technical obstacles that need to be overcome before we can put additional genes into the mitochondrial genome," says Bock.

Finally, the project succeeded in generating several synthetic species, and the team is currently analysing their genetics, physiology and metabolism.

"We found that grafting can promote the transfer of genetic material between different species," remarks Bock. "This provides plant breeders with a new method for producing new crop species with novel properties."

Overall, the GENEVOSYN project has underlined the potential of synthetic biology in strengthening food security, and in the use of plants as factories for the

“ This provides plant breeders with a new method for producing new crop species with novel properties. ”

efficient synthesis of green chemicals, biopharmaceuticals and other useful compounds.

Bock believes this is only the beginning. "Future challenges that can be addressed through synthetic biology include, for example, the improvement of photosynthesis, and the engineering of plants that can use the nitrogen in the air as fertiliser," he concludes.

GENEVOSYN

- Hosted by the Max Planck Institute of Molecular Plant Physiology in Germany
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/669982

FOOD AND NATURAL RESOURCES

Towards a blockchain scenario to guarantee virgin olive oil authenticity

Virgin olive oils are known for their excellent nutrition and health properties, but not all are created equal. OLEUM has renewed and revised analytical procedures and tools to determine their quality and authenticity before they end up on our shelves.

Europe is the world's largest producer of olive oil. Yet, a combination of growing competitiveness, alongside differing levels of regulation and knowledge, is increasing fraud, as indicated by a 2019 European Commission report.

To strengthen official controls and increase consumer confidence, the EU-supported OLEUM (Advanced solutions for assuring the overall authenticity and quality of olive oil) project has revised and renewed procedures to better guarantee the quality and authenticity of olive oils. The project identified markers for soft deodorisation, a technology used to remove or reduce sensory defects. The project developed testing for illegal blends with other vegetable oils and produced sensory reference materials

to support panel tests. They also developed methods to control product freshness and predict shelf life.

Additionally, OLEUM developed an open-source, collaborative platform called OLEUM Databank to host reference and calibration material, alongside a downloadable library of analytical methods. It also established the OLEUM Network, a global community of stakeholders, to share knowledge and results.

"OLEUM's methods should be adopted internationally to harmonise trade standards. Combining information about quality and authenticity with certified production volumes and their geolocation could form a blockchain to counter



“Combining information about quality and authenticity with certified production volumes and their geolocation could form a blockchain to counter fraud.”

OLEUM also developed methods for assessing olive oil freshness, including software to predict ‘best before dates’ based on analytical parameters of acidity, peroxide value and hydrophilic phenol amounts. This also takes into account light levels in storage conditions, which was validated in a real-time shelf life experiment.

OLEUM Databank, hosting searchable, real-time experiments, results data sets and documentation, is open for public registration, but may be restricted in the future to national official control bodies.

“In conjunction with our OLEUM Network, this tool enables more effective collaboration and harmonisation at a global level,” says Gallina Toschi.

RESPONSIBLE CONSUMPTION AND PRODUCTION

To increase consumer awareness and confidence, OLEUM ran public activities at events such as European Researchers’ Night and even in cooking schools, using materials such as multilingual infographics, videos and games.

Two OLEUM outputs have already been adopted by the market: stock solutions to analyse volatile compounds and two sensory reference materials. The latter were produced with volatile compounds which emulate the olfactory notes of rancid and winey-vinegary aromas in virgin olive oils.

“The main target markets are quality control labs. No similar product exists in the market and this approach could be extended to other food products,” observes Gallina Toschi.

OLEUM

- Coordinated by the University of Bologna in Italy
- Funded under Horizon 2020-FOOD
- cordis.europa.eu/project/id/635690
- Project website: oleumproject.eu
- ▶ bit.ly/OLEUM_video

fraud,” explains project coordinator Tullia Gallina Toschi from the University of Bologna, the project host.

TOOLS FOR DETECTION AND PREVENTION

The project’s initial research underlined the problem of the illegal mixing of extra virgin olive oils with soft deodorised oils, especially remolido or lampante oils, alongside the fraudulent modification of their natural colour and aroma. Faked declarations of origin were also identified as a problem.

To establish the quality of virgin olive oil, and detect fraudulent mixtures, OLEUM developed tools to analyse volatiles along with sensory reference materials to support panel testing.

Two methods for detecting fatty acid ethyl esters – the only officially recognised marker for fraudulent soft deodorisation – were developed. Both are faster than pre-existing options. One, using a high-performance liquid chromatography preparative step, was validated in-house, while the other, using solid-phase extraction, underwent a successful peer study, with results soon to be published.

To strengthen product labelling, especially related to health claims for ‘olive oil polyphenols’, an ultra-high-performance liquid chromatography protocol was developed to enable evaluation before and after hydrolysis, offering a more accurate picture.



INDUSTRIAL TECHNOLOGIES

Natural floor tiles support a sustainable building sector

One Italian design company is using a natural, mushroom-based material to create an eco-friendly alternative to plastic-based floor tiles.

Housing and buildings have a huge environmental footprint. Together, they account for more than 40% of the EU's total energy consumption, 36% of all greenhouse gas emissions, half of all extracted materials, and a third of all water consumption. As if this wasn't enough, the average EU citizen generates over 160 tonnes of construction waste over their lifetime.

If the EU is to meet its Green Deal climate objectives of reducing net greenhouse gas emissions by at least 55% by 2030 and becoming climate-neutral by 2050, it must achieve a more sustainable building and housing sector.

For one Italian design company, this starts with the floors.

To help support a sustainable building sector, Mogu has developed an innovative technology for producing naturally grown flooring materials. "Our company focuses on creating sustainable, natural solutions that protect the environment and enhance the living space," says Stefano Babbini, Mogu CEO. "Our new natural floor tiles exemplify this vision."

Thanks to the support of EU funding for the MOGU floor (Natural-Grown Flooring for Circular Buildings) project, the company's bio-based flooring solutions are now market-ready.

FROM MYCELIUM TO TILE

MOGU floors begin their life as mycelium, the vegetative stage of mushrooms. "The EU funding helped us identify new methods for growing these amazing organisms and for converting them into practical, plastic-free building materials," explains Babbini.

The production process starts with the company growing carefully selected mycelium strains using substrates composed of agro-industrial residues. Next, the mycelium materials are collected and dried. "Not only does this process use very little energy or other resources, it results in a product that is completely stable, safe, durable and biodegradable," adds Babbini.



“For the first time ever, we can take by-products and convert them into high-performance, attractive flooring solutions.”

To create the floor tiles, the company uses the mycelium as a composite core and coats it with a proprietary formula comprised of 80 % resins. “For the first time ever, we can take by-products and convert them into high-performance, attractive flooring solutions,” notes Babbini. “In doing so, we are supporting a circular economy and laying the foundation for an environmentally and economically sustainable flooring sector.”

Mogu’s sustainable tiles are available in a variety of colours and shapes and can be fully customised on a customer’s request. The tiles, which were listed on the ADI Design Index 2020, have been shortlisted for the prestigious ADI Compasso d’Oro Award.

THE ROAD TO SUSTAINABILITY IS A LONG ONE

As with any new manufacturing process, getting from mycelium to flooring was no easy task. According to Babbini, one key challenge was finding industrial plants and subcontractors with the ability to produce the product.

“This is essentially a clean-sheet design, meaning a ready-made manufacturing process didn’t exist,” he says. “To ensure we could produce our product at scale, we had to constantly rework and adapt our formula to match the capabilities of the available industrial plants.”



Buildings in the EU account for more than **40 %** of total energy consumption and **36 %** of all greenhouse gas emissions

Despite these challenges, the company succeeded. “We’ve proved that it is possible to make alternative and sustainable products without sacrificing quality or performance,” concludes Babbini.

But the road to sustainability is a long one, and Mogu is just getting started. The company is currently enhancing its flooring product by increasing its bio content and fine-tuning the industrial process. It is also expanding its market reach by exhibiting at such global events as Expo Dubai, Fuori Salone, DDW and Floriade, amongst others.

MOGU FLOOR

- Coordinated by Mogu in Italy
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/823392
- Project website: mogu.bio/flooring

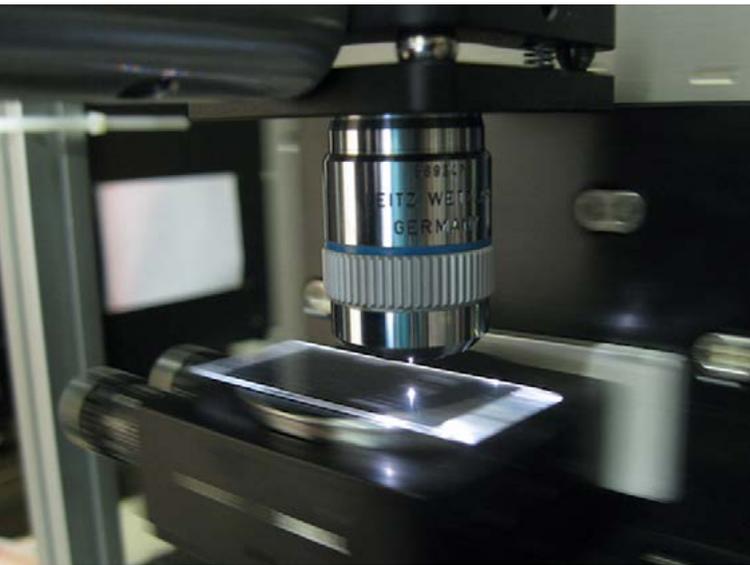
INDUSTRIAL TECHNOLOGIES

Laser innovation lights up electronic display sector

Advances in cutting-edge laser micromachining could lead to the production of more efficient electronic displays, and create new possibilities for 3D vision concepts and even augmented reality technology.

Femtosecond lasers emit extremely short pulses, in the order of a millionth of a billionth of a second. One of their most important applications is in micromachining, the fabrication of structures on the micrometre scale.

“The extremely short duration of the pulse, together with the corresponding high peak intensity, allows for the clean and precise modification of materials,” explains DISPLAYGHT (DISPLAY backliGHT illumination by



© DISPLAYGHT_CNR-IFM

femtosecond laser micromachining) project coordinator Roberto Osellame from the National Research Council (CNR) in Italy.

Another interesting factor is their capability to modify – in 3D – transparent materials such as glass or crystal. Femtosecond lasers can be used in this instance to write photonic circuits, i.e. micrometric channels where light remains confined and routed inside the glass. These circuits can be used in liquid crystal displays (LCDs) found in TV screens and other electronic displays.

This of course is far from straightforward. “One has to consider that a typical display might have millions of pixels, where light needs to be distributed as evenly as possible,” says Osellame. “This represents a great challenge. Complex photonic circuits need to be written with exquisite control.”

3D CIRCUIT DESIGN

Osellame met Jonas Zeuner and Chiara Greganti, co-founders of the start-up VitreaLab during a quantum technology research project. As PhD students, the pair noted that current display technologies direct just 5% of generated light power toward the viewer. Their solution was to use photonic circuits to route all light to the right points – the pixels – and thus avoid any waste of power.

“My technology, based on femtosecond laser micromachining, seemed the perfect match,” notes Osellame. “This was the start of the DISPLAYGHT project.”

DISPLAYGHT focused on demonstrating the feasibility of these highly complex circuit structures being fabricated, and this process being automated as much as possible, in order to

“Complex photonic circuits need to be written with exquisite control.”

achieve high throughput. These advances enabled the team to build complex photonic circuits capable of distributing red, green and blue laser light to the pixels in a display.

This light is invisible as long as it stays in the photonic circuit. However, the 3D capability of the technology enables the circuit to be bent at the pixel site, directing the light out in the direction of the viewer.

The project team was able to showcase a 27 000 subpixel prototype in all three colours, helping to address a key concern expressed by investors – how this technology can be scaled up. “These insights also allowed us to significantly increase our patent portfolio, another key element likely to attract investors,” adds Zeuner.

TAPPING INDUSTRY INTEREST

The success of the project, funded by the European Research Council, has resulted in VitreaLab experiencing significant growth. The company now has an independent laboratory dedicated to several target applications, has raised significant amounts of funding, and has established strong links with potential customers.

“There has been a lot of interest from industry,” says Zeuner. “At the outset of the project, the targeted application was the usage of the laser-fabricated glasses as backlights in LCDs. But during the project, a number of other applications were identified. These include 3D displays and augmented reality goggles.”

Prototypes are currently being shipped to potential partners, and their feedback is helping to shape future priorities. Nevertheless, more work is needed before the technology can be commercialised. “In particular, the move towards multibeam laser fabrication, a key step for low-cost manufacturing, will require further development,” notes Osellame.

DISPLAYGHT

- Hosted by the National Research Council in Italy
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/862085



AI factcheckers aid the battle against fake news

Concern has grown in recent years over how 'fake news' is affecting our democratic processes, social cohesion and economic stability. A pioneering EU-funded project has shown how artificial intelligence can help media professionals identify such misinformation.

Launched in January 2018, the EU-funded FANDANGO (FAKE News discovery and propagation from big Data ANalysis and artificial intelligence Operations) project experienced first-hand the proliferation and evolution of media disinformation. The recent American election, the aftermath of the United Kingdom's Brexit referendum and of course the COVID pandemic, have all underlined the challenge that 'fake news' presents to our understanding of complex events.

"Defining media disinformation is in itself incredibly complex," explains FANDANGO project coordinator Francesco Saverio Nucci, application research director at Engineering R&D Labs, Italy. "Even the meaning of the term 'fake news' has changed, as it has been adopted for more political ends."

Another challenge is that one person's interpretation of what constitutes media disinformation is not necessarily the same as someone else's. And if it is difficult for humans to even agree on a baseline for identifying media disinformation, then applying artificial intelligence algorithms to identify 'fake news' is clearly not a straightforward exercise.

TACKLING MEDIA DISINFORMATION

Nonetheless, this was the key aim of the FANDANGO project. "Our goal was to try to test and validate various AI tools that could be used to identify disinformation," adds Nucci. Some of the issues examined included climate change, European policies and immigration.

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First, the project team applied machine learning tools to identify 'fake' images and so-called 'deep fake' videos – videos that have been manipulated. AI and natural language processing were also applied to text, to help identify if something might be suspicious.

"We made a number of findings," says Nucci. "First, we found that it is not possible to eliminate the human in this context. AI can provide support, but a media professional still needs to be at the end of the line. AI is useful but cannot completely solve the problem of fake news."

Secondly, the team found that it is not enough for the software to just tell the journalist that something is suspected to be 'fake'. The journalist wants to know why an image or a text is suspicious.

The project team also applied machine learning tools to better understand how misinformation is spread across networks. Nucci believes that another important element of the project has been the tight collaboration between technology researchers and those from the social sciences.

"I have technical people on my team who are now experts in media literacy," he remarks. "On the other side, we have seen how critical it is that journalists begin to understand how AI can help solve this challenge of disinformation."

DEVELOPING MEDIA LITERACY

From this research, a modular platform has been developed, with machine learning tools including language processing for text and data investigation for sources.

“*We have seen how critical it is that journalists begin to understand how AI can help solve this challenge of disinformation.*”

While the work is still in its early stages, Nucci envisages that this platform can be further developed and eventually marketed to media companies. "In order to improve these tools, we need more data," he adds. "The more data you have, the better the algorithms will work."

The project has also underlined the need to train media professionals in data literacy, and in how to manage data better. Misinterpreting statistics relating to the percentage of COVID patients who have been vaccinated, for example, has helped to fuel vaccine scepticism.

"In addition to improving machine learning, there are a number of research aspects that we will continue to look at," says Nucci. "These include media literacy, and how 'fake news' is propagated in social networks."

FANDANGO

- Coordinated by Engineering R&D Labs in Italy
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/780355
- Project website: fandango-project.eu

DIGITAL ECONOMY

Upgrading Europe's maritime data infrastructure

European waters are constantly monitored for indicators such as temperature, salinity and sea levels, crucial for authorities and a range of industries. SeaDataCloud has helped realise the value of this data by making it readily accessible and ensuring it is well-managed.

Over 1 000 research institutes, governmental organisations and private companies in the countries bordering the European seas collect oceanographic and marine data.

SeaDataNet is an EU-supported initiative which operates a pan-European infrastructure for managing, indexing and making available, marine data sets and products from

“SeaDataCloud incentivises oceanographic data providers to open their data holdings.”

research vessels and other observation facilities. Its core partners are National Oceanographic Data Centres and institutes from 34 states.

The EU-funded SeaDataCloud (Further developing the pan-European infrastructure for marine and ocean data management) project has helped increase access to SeaDataNet's offers by moving its data sets and online tools to a cloud environment, in cooperation with the EUDAT e-infrastructure team.

“SeaDataCloud incentivises oceanographic data providers to open their data holdings. This means more observation data from more sources is available to SeaDataNet's users in a structured way, with standard metadata formats and semantics,” explains project coordinator Michèle Fichaut.

UPGRADING THE COMMON DATA INDEX AND ITS TOOLS AND SERVICES

SeaDataCloud's priority was to upgrade SeaDataNet's Common Data Index (CDI) service, alongside related tools and services. Technical testing of the newly developed components and integrated systems was first performed by the developers. These were followed by two project-training workshops with representatives from over 100 participating data centres.

One of the drivers for the project was to accommodate the rapid increase in SeaDataNet's data. For example, within the CDI's European directories for European marine organisations, the catalogue of marine and oceanographic *in situ* data sets for physics, chemistry, biology, geology and bathymetry increased from 1.87 million to 2.62 million entries in the 4-year period of the project.

Thanks to SeaDataCloud's efforts, the SeaDataNet CDI cloud environment is now operational, hosting all the CDI's public data.

“It is now possible to deliver datasets, combined from multiple data centres, very effectively. The new search interface has been launched using powerful technologies, offering new features and delivering services which follow FAIR principles,” adds Fichaut.

In addition to upgrading the CDI service, SeaDataCloud completed a series of technical developments. These included: updating and expanding the SeaDataNet common vocabularies to increase semantic interoperability; developing and publishing standards for handling high-frequency radar (HFR) and flow cytometer data, and launching a new DOI service to enable scientists to publish their research data as citable resources.

New tools were also developed for the virtual research environment (VRE), notably: BIOQC to process and run quality control on biological data sets; VIZ – a dynamic visualisation service to explore data sets on a map; and WebODV – a suite of online services based on Ocean Data View designed to perform analysis, exploration and visualisation of ocean data interactively.



The VRE is now operational and publicly available to researchers.

SUPPORTING WIDER DATA-LED INITIATIVES

SeaDataNet is used by many initiatives, including the Copernicus Marine Service and EMODnet projects. Indeed, all the data accessible through the EMODnet chemistry and EMODnet bathymetry portals are managed by the SeaDataNet infrastructure.

Additionally, SeaDataNet is used by EU groups working on environmental management of European seas and coastal waters, including for implementation of the Marine Strategy Framework Directive, Water Framework Directive and European Green Deal.

“SeaDataNet’s services and network of data centres play a major role in stimulating open data and reaching out to other possible data providers such as industry and citizens,” says Fichaut.

To ensure continued management of the data infrastructure, SeaDataNet has established a legal entity, SeaDataNet AISBL, which currently has more than 30 members and is expanding.

SEADATACLOUD

- Coordinated by the National Institute for Ocean Science (Ifremer) in France
- Funded under Horizon 2020-INFRA
- cordis.europa.eu/project/id/730960
- Project website: seadatanet.org

DIGITAL ECONOMY

Virtual touch and feel: a new frontier of digital reality

A truly immersive experience requires a virtual universe that we can not only see and hear, but also touch. The H-Reality project is set to revolutionise the way we can interact with our surroundings in the digital world.

Had the COVID-19 pandemic happened a few years from now, we might have felt its impact very differently. While digital technologies have helped us connect and communicate remotely, many have experienced touch deprivation as a result of social distancing.

New research is on its way to fill the ‘touch gap’ in digital technology. A team of researchers is working towards digital realities we can reach out to and interact with. This tangible, or ‘haptic’ virtual experience is the long-term vision behind the EU-funded H-Reality (Mixed Haptic Feedback for Mid-Air Interactions in Virtual and Augmented Realities) project. The aim is to achieve high-fidelity sensations through technology that is easy and comfortable to use, for both interactive augmented reality (AR) and immersive virtual reality (VR) experiences.

“Nowadays, most VR and AR research is focused on improving the realism of what we see to create a photorealistic virtual experience. Nonetheless, there is no true immersion if we are not able to physically touch and interact with the environment surrounding us,” explains Claudio Pacchierotti, researcher at IRISA and the CNRS, one of the project partners. “Research into haptic technologies is paramount in order to achieve true immersive experiences in the future. This also means having access to effective wearable haptic devices.”

A BETTER UNDERSTANDING OF TOUCH

As a first step, the team investigated the mechanics of touch. “The translation of mechanical signals into the perception of touch is still unclear,” Pacchierotti notes.

“*There is no true immersion if we are not able to physically touch and interact.*”

When running a hand along a surface, vibrations travel through the skin and stimulate nerve endings, so-called mechanoreceptors. The nerve endings then convert the vibrations into electrical signals that are transmitted to the brain. The H-Reality team assessed whether vibrotaction – touch perception through vibrations – could depend on mechanical waves propagating in the hand. The team also found a universal law explaining the favourable placement of vibration-sensitive mechanoreceptors in many mammals.

Building on this work, they identified ways of digitally rendering shapes and textures, using non-contact haptics which rely on ultrasound and contact haptics involving wearable vibrotactile devices. They then began combining contact and non-contact haptics into immersive VR application prototypes to demonstrate the potential and capabilities of this technology.

NEW WAYS OF CONNECTING REMOTELY

“We believe that our mixed-haptic interaction paradigm has the potential to revolutionise the way users interact

with data in a wide range of applications,” Pacchierotti highlights. Ultimately, the team hopes to completely transform online interactions. Examples of concrete applications could include operating dangerous machinery from a safe distance, or carrying out surgery remotely.

While H-Reality focuses on basic research, the researchers are already working on the next steps to bring the technology closer to the market. E-TEXTURES, a spin-off project also funded by the EU, will be exploring opportunities in markets spanning from media and entertainment to retail and healthcare.

Pacchierotti believes the project highlights the importance of joining forces and breaking down traditional disciplinary boundaries, bringing together actors and expertise from a number of different fields. “Collaborative science is a gateway to great discovery and innovation,” he says.

H-REALITY

- Coordinated by the University of Birmingham in the United Kingdom
- Funded under Horizon 2020-FET
- cordis.europa.eu/project/id/801413
- Project website: hreality.eu



Catching up with BPR4GDPR: Helping businesses keep citizens' personal data safe

In our December 2020 special feature on cybersecurity, we discussed how a toolkit developed and built by the BPR4GDPR project could help European businesses navigate the complex requirements of new data privacy laws. One year on, the team tell us how the cookies crumble.



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Introduced in 2018, the EU's General Data Protection Regulation offers citizens comprehensive protections for personal data, as well as simplifying the regulatory landscape for businesses. Nonetheless, achieving GDPR compliance remains a challenge, especially for small businesses with limited resources and expertise.

The BPR4GDPR (Business Process Re-engineering and functional toolkit for GDPR compliance) project brought together 11 organisations from across Europe to build tools that could help SMEs meet their data privacy obligations.

The GDPR landscape has continued to evolve over the years, with a greater awareness of the rules among consumers and industry, and an increased level of resources spent on compliance. "Whereas the core of BPR4GDPR solutions has not been altered, some alignment was deemed necessary," says George Lioudakis, BPR4GDPR Policy Framework leader and co-founder of project partner ICT above.

Lioudakis says key issues included the adaptation of the information models to incorporate additional concepts, the

specification of appropriate process models to handle emerging situations, as well as a comprehensive viewpoint on the data subjects' rights. He adds: "Usability aspects have emerged as an important challenge, which was investigated during the project and is currently being further elaborated."

Market solutions

Over the course of the project, which concluded in April 2021, BPR4GDPR trialled three distinct GDPR use cases covering a governmental healthcare setting, a network of car dealerships, and real estate agencies using cloud-based services. "An extensive regulatory analysis showed that BPR4GDPR delivered a tool portfolio that supports compliance with the crucial obligations set forth by the GDPR," notes project coordinator Spiros Alexakis from CAS Software. "Data subjects' rights, security, privacy by design and by default, accountability obligations can all be improved by the use of BPR4GDPR tools."

Commercial tools from CAS Software and ICT above are anticipated to be released before the end of this year. CAS Software results will be released as an additional module of their CRM software SmartWe. The academic findings of the project have already been released as an open-source resource.

Individual assets generated by BPR4GDPR partners are also being combined into commercial 'feature sets'. These include a process model re-engineering framework and authorisation engine for GDPR compliance, a user-centred GDPR compliance toolkit, and analysis tools for detecting risks and vulnerabilities.

"Though all BPR4GDPR assets may be offered as standalone tools, a feature set is a larger, more complete application targeting specific needs of a customer," explains Alexakis. Each feature set is expected to reach market maturity in around 12 months.

Lioudakis credits the Horizon 2020 programme as instrumental to the project's success, noting that EU funding allowed for the establishment of a strong collaboration across the breadth of Europe to tackle the challenges of online privacy and security, to the benefit of all EU citizens.

BPR4GDPR

- Coordinated by CAS Software in Germany
- Funded under Horizon 2020-SECURITY
- cordis.europa.eu/project/id/787149



Spiros Alexakis
BPR4GDPR project coordinator
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"BPR4GDPR delivered a tool portfolio that supports compliance with the crucial obligations set forth by the GDPR."



Reducing the risk of collisions in space through better thermosphere modelling

There's a lot going on in our thermosphere, from solar storms to the launch of an ever-increasing number of satellites. Operators need accurate projections of orbits and of the highly variable air drag if they are to avoid collisions.

Our upper atmosphere, or thermosphere, is very tenuous. Even if mass densities are more than a billion times smaller than at the surface of our planet, predicting drag due to air resistance is particularly important for satellite operators.

In low Earth orbit, air drag is the dominant error source, playing a central role in satellite mission planning, trajectory, and re-entry prediction, and planning evasive manoeuvres to avoid collisions. The International Space Station is manoeuvred about once a year for just that reason.

Sean Bruinsma, based at the Toulouse Space Centre (CNES) in France, is in charge of outreach for the EU-supported SWAMI (Space Weather Atmosphere Model and Indices) project.

He explains: "The main problem today is collision avoidance, and it will be an even greater problem tomorrow as very large constellations of satellites, such as Starlink, are currently being constructed. It's clear that the sheer number of objects in orbit will lead to greater collision risks."

An accurate density model is required along with reliable forecasts of solar and geomagnetic activity to predict collision probabilities.

The only European thermosphere model, Drag Temperature Model (DTM), has a 120 km altitude boundary, which made it necessary to rely on American models for re-entry computations below that altitude.

"Now, through a combination of monthly-mean digital tables of the Unified Model computed by the United Kingdom's Met Office, and an updated DTM, we have an atmosphere model up to about 1 500 km. This model, MOWA Climatological Model (MCM), can be used for satellite operations, including re-entry computations," Bruinsma says.

"The MCM is a significant step forward for Europe's independence in space operations although the COVID-19 crisis has meant we are not as accurate in the re-entry zone as we had intended."

“It’s clear that the sheer number of objects in orbit will lead to greater collision risks.”

CALCULATING THE EFFECT OF SOLAR WIND

The SWAMI project also created the new, geomagnetic index H_{po}, a proxy for the energy contributed to the upper atmosphere by interaction with the solar wind.

The H_{po} employs shorter sampling intervals, 30 and 60 minutes in comparison to the 180 minutes of the previously used index K_p, and can better represent geomagnetic storms. “The higher temporal resolution of H_{po} makes a more accurate modelling of the variability in the thermosphere possible.

“In satellite operations, the orbits of objects have to be predicted for days to several weeks out. This necessitates forecasts of solar activity and geomagnetic activity for the same period,” notes Bruinsma.

To achieve this, the project used machine learning, and applied a special algorithm to optimise accuracy during geomagnetic storms.

TOOLS FOR ANALYSIS

The MCM and DTM models are available on Github and are free for non-commercial use, and under licence otherwise.

These models are the operational tools created by the SWAMI team to be implemented in a user’s own software. Instructions for implementation and benchmarks are given on the SWAMI website and on Github.

SWAMI

- Coordinated by the Elecnor Deimos Group in Spain
- Funded under Horizon 2020-LEIT-SPACE
- cordis.europa.eu/project/id/776287
- Project website: swami-h2020.eu

SPACE

Novel ways of analysing observations of exoplanet atmospheres

After a first phase mainly devoted to the detection of exoplanets, we have entered a second phase: the characterisation of the atmosphere of these alien worlds. But the data captured by increasingly powerful telescopes has proven hard to interpret.

Measuring the spectrum of electromagnetic radiation is known as spectroscopic observation. Being able to interpret the spectrum is important, allowing a wealth of information to be extracted such as the presence and abundance of atoms, molecules, ions, hazes and clouds and the vertical thermal structures.

“Such information is needed to test and improve the chemistry and dynamics incorporated in the atmospheric models applied to alien worlds,” says Pierre-Olivier Lagage, based at the Astrophysics Department of the French Alternative Energies and Atomic Energy Commission (CEA) in Saclay, France.

Lagage is the principal investigator of the EU-supported Exoplanets A (Exoplanet Atmosphere New Emission Transmission Spectra Analysis) project which has increased our knowledge of the atmosphere of exoplanets by analysing archived space data with novel tools.

“The main challenge in spectroscopic observations of the atmosphere of transiting exoplanets is the characterisation and removal of systematic noise which can be orders of magnitude higher than the signal induced by the exoplanet atmosphere,” explains Lagage.

“ We have analysed about 200 spectroscopic observations resulting in a homogeneous and reliable characterisation of 54 exoplanet atmospheres. ”

UNRAVELLING THE SECRETS OF DISTANT PLANETS

One of the project’s researchers, Jeroen Bouwman, based at the Max Planck Institute for Astronomy in Heidelberg, Germany, developed a novel method of systematic noise characterisation and removal.

In Lagage’s words: “In this method, a data-driven model of the temporal behaviour of the systematics for each pixel of the spectrum can be created using reference pixels at different positions in the spectrum. This is dependent on the underlying causes of the systematics being shared across multiple pixels, which has been the case for the Hubble Space Telescope data we have analysed.”

The method has been implemented in the ‘Calibration of trAnsit Spectroscopy using CAusal Data’ code. Bouwman has applied this approach to all the archived Hubble Space Telescope spectroscopic data on exoplanet atmospheres.

“We have analysed about 200 spectroscopic observations resulting in a homogeneous and reliable characterisation of 54 exoplanet atmospheres,” notes Lagage.

Under the leadership of astrophysicist Vincent Minier, based at the CEA, and David Barrado, professor at the Spanish Center for Astrobiology, part of the National Institute of Aerospace Technology, the project’s website has been developed to disseminate the science results and provide educational tools.

WHAT THE DATA CAN TELL US

Modelling such systems will enable the exploration of the entire atmospheric area around planets. It will reveal the chemical processes and atmospheric circulation patterns which have no precedent on Earth, or other planets in the solar system.

To successfully model the atmosphere of an exoplanet it is necessary to have sound knowledge of the host star. To this end, the project has created a coherent and uniform database of the relevant properties of host stars. This is based on data collected from the European Space Agency archives, combined with data from international space missions and ground-based observatories. These exoplanets and host-star catalogues have been accompanied and interpreted by models to assess the importance of star/planet interactions.

So far most of the information on the molecular content of an atmosphere comes from observations with the Hubble Space Telescope, particularly through Wide Field Camera 3. The camera’s wavelength range can probe water vapour which has been detected in several exoplanets’ atmospheres.

“The situation will soon change dramatically once the James Webb Telescope is launched,” Lagage explains. “This will provide a large wavelength coverage (0.4 to 28 microns) allowing for the characterisation of the various molecules expected in the atmosphere of the exoplanets such as water, carbon dioxide and ammonia. It will have a large collecting area of 25 square metres which will permit us to characterise previously inaccessible exoplanets.”

Lagage notes that this newly acquired knowledge will ultimately help our understanding of our own planet.

“The success of the Exoplanets A project has been down to the collaboration of several leading scientists who have, together, made it possible to peer into the composition of these planets’ atmospheres with more certainty,” he says. “Combine this with the launch of the James Webb Telescope and we will have a strong set of tools with which to interpret the exciting new data that’s coming our way.”

EXOPLANETS A

- Coordinated by the French Alternative Energies and Atomic Energy Commission in France
- Funded under Horizon 2020-LEIT-SPACE
- cordis.europa.eu/project/id/776403
- Project websites: explore-exoplanets.eu and exoplanet-atmosphere.eu





FUNDAMENTAL RESEARCH

Magnetic polymers set to be a material of the future

EU-funded researchers have developed smart new composite materials with unusual magneto-mechanical properties. This could lead to exciting new applications in areas such as healthcare and visual displays.

We use magnets almost every day of our lives. They can be found in numerous applications, from fridge door fittings to earphones.

These magnets however tend to be made from hard, inflexible metals that are not easily deformable. “This inflexibility limits their application in certain fields,” explains project coordinator Kostas Danas, a senior research scientist at the French National Centre for Scientific Research (CNRS) and associate professor at École Polytechnique in France.

“Exploratory medical instruments, for example, where magnetic properties could be useful, need to be highly flexible in order to enter and navigate narrow vessels in the body.”

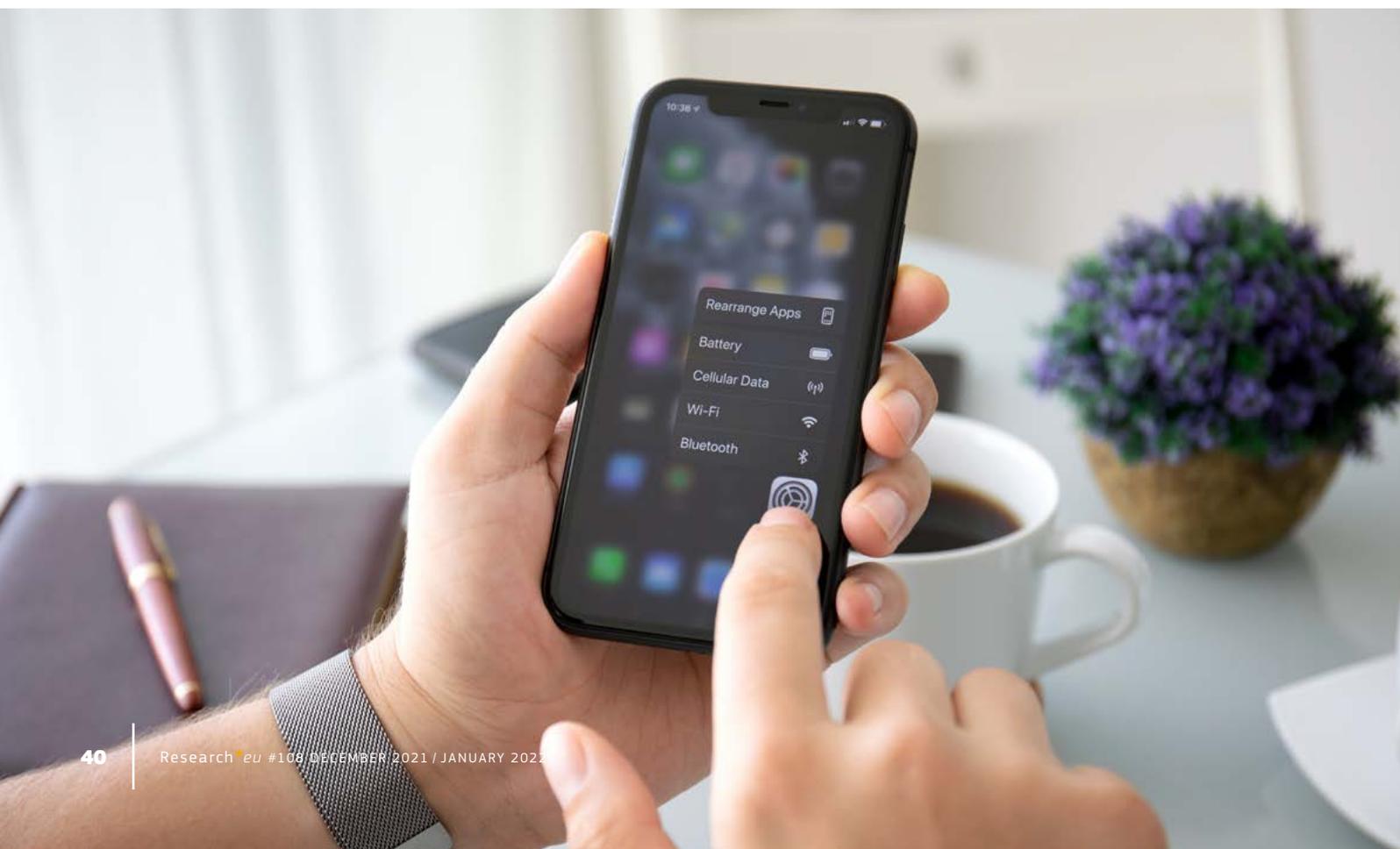
NEW CLASS OF MATERIALS

What if magnetic materials could be made soft and pliable enough to be transformed into complex geometric shapes? This was the objective of the MAGNETO (Active Magnetorheological Elastomers: from Hierarchical Composite Materials to tailored Instabilities) project, funded by the European Research Council (ERC).

To achieve this, magnetic materials were broken down into powder, and then mixed with various polymers. The idea was that finalised soft materials could then be manufactured, but this time with magnetic properties.

The MAGNETO project was able to achieve a breakthrough in part because of timing. The emergence of advanced 3D

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“*Printing 3D magnetoelastic materials is still a challenge, and it can be hard to control the process. This requires more work.*”

printing enabled Danas and his team to attempt much more complex geometric shapes.

These first prototypes have opened the door to a whole range of potential new applications, from diagnostic tools to touchscreen displays.

In this way, MAGNETO has advanced the development of a new class of materials that did not exist in the 1980s. “We are not the first scientists to attempt this,” Danas notes. “Some early research into these materials was carried out in the late 1990s. But because no successful applications were identified, this research ground to a halt.”

RANGE OF APPLICATIONS

The MAGNETO project has changed all this, even though the materials are so new that they are not yet on the market. Further research and development is still needed. Nonetheless, Danas sees huge potential for this technology, especially in the biomedical industry.

“These materials could be used to make biomedical devices such as catheters or drug delivery systems,” he explains. “These are thin and flexible, can enter a vein, and be controlled by an external magnet.”

Another possibility is drug delivery. Small magnetic parcels could deliver drugs to exactly where they are needed, again controlled by an external harmless magnetic field.

Other high-end applications include tactile – or haptic – devices for blind people. A flat screen would pop up at the touch of a finger, perhaps offering the user a specific menu to select from, without the need for visual consultation. Magnetic polymer materials make this possible. “We are currently 3D-printing materials for this application,” adds Danas.

Moving forward, Danas aims to focus on developing ever-more complex geometries, and to improve 3D printing of such materials still further. “Huge developments have been made,” he says. “But we are not quite there yet. Printing 3D magnetoelastic materials is still a challenge, and it can be hard to control the process. This requires more work.”

Nonetheless, the project represents an important milestone in the development of this cutting-edge technology. “The results achieved show the benefit of funding fundamental research,” he says. “This ERC grant enabled us to take a risk, to engage in academic research when we did not know what the deliverable would be.”

MAGNETO

- Hosted by the National Centre for Scientific Research in France
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/636903
- Project website: kostasdanas.com/erc-magneto

FUNDAMENTAL RESEARCH

Searching for treasure in the ‘dark matter’ of microbial genes

Seventy per cent of identified genes have an unknown function. The BHIVE project hoped to find those which can spin straw into gold.

Biomass such as agricultural residue, forestry products and food waste is an important resource in the EU, with an annual supply of nearly 1 billion tonnes expected by 2030. Much of this is used as an energy source – either fermented into fuel or burned directly.

The EU-funded BHIVE (Bio-derived High Value polymers through novel Enzyme function) project sought ways to extract greater value from this feedstock by mapping the ‘dark matter’ of microbial genomes.



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“The goal was to delve deeper into gene sequences with no known function, with particular attention on those likely to transform biomass into sought-after products,” explains project coordinator Emma Master.

The function of the majority of the genes identified so far through genome sequencing remains unknown. “That’s a treasure trove of biocatalysts that can be developed for various industrial sectors,” adds Master.

Her team at Aalto University in Finland studied common sequences found across multiple microbial genomes, hoping to find novel enzymes which can transform lignocellulose, the fibrous material which makes up the bulk of plant dry matter.

VALUE-ADDED PRODUCT

In northern countries such as Finland, biomass takes a long time to grow, and is difficult to process. This makes it compelling to convert biomass into higher-value products. “Many biocatalysts developed for this conversion are focused on deconstruction – turning cellulose into sugars for fermentation to commodity chemicals and fuels,” says Master.

“We were focused on biocatalysts that upgrade, not degrade.” The enzymes would be added to cellulose fibres from pulped trees, for example, to functionalise that material.

To explore the uncharacterised genomic space of plants, Master and her team had to develop new techniques. “In genomics, you get what you screen for. We can only discover things we know how to observe,” she adds. “If you don’t know what the function is, how do you shed light on that?”

Instead, the team started from the types of enzymatic activity they were interested in, and worked backwards to build a screen that would identify catalysts capable of such reactions. To make matters more difficult,

“*We were focused on biocatalysts that upgrade, not degrade.*”

enzyme screens are typically carried out in solution, but lignocellulose is not soluble.

“We had to rethink how to look for that activity, and develop fluorescent labelling and mass spectrometer methods that allowed us to look for changes in these insoluble substrates,” notes Master.

The team examined thousands of genes, and narrowed these down to several hundred which were screened for expression. “We used a guilt by association approach – clues in the genome that helped us home in on sequences likely to be important for lignocellulose functionalisation,” she explains. Ultimately, they characterised close to 100 proteins.

NEW AND IMPROVED

Several of the newly discovered enzymes held particular interest. Among them was an aminating enzyme that can add amine function into polysaccharides. “This is useful for making antimicrobial materials and chelating polymers,” notes Master. “Plants don’t produce polysaccharides with amines in large amounts, but they are useful for textile applications.”

Another enzyme was found to alter the structure of cellulose fibre, changing its porosity and flexibility, useful functions for producing textiles like rayon. “The process to make rayon is not sustainable, and there is a lot of interest in a more sustainable route to the textile, replacing cotton with wood,” remarks Master.

Work on the enzymes is now continuing at Aalto University through a collaboration with researchers in Spain and Sweden and an industry partner. “We couldn’t have done this without the ERC funding,” says Master. “It’s been transformative, and has opened new avenues for us, and for Europe, in biocatalysts and biomaterials engineering.”

BHIVE

- Hosted by Aalto University of Applied Science in Finland
- Funded under Horizon-2020 ERC
- cordis.europa.eu/project/id/648925
- Project website: bit.ly/Protein-technology-research-group



AGENDA

MARCH 2022

STRASBOURG, FRANCE & ONLINE
Second International Virtual
Observatory School
→ bit.ly/EU_ESCAPE

**4
MAR**

**8
MAR**

**INTERNATIONAL
Women's Day**

**INTERNATIONAL
Water Day**

**22
MAR**

**22 → 24
MAR**

PARIS, FRANCE
EuroHPC Summit Week 2022
→ bit.ly/EU_EUROHPC

LISBON, PORTUGAL
InsSciDE Open Conference on
science diplomacy
→ bit.ly/EU_INSSCIDE

**22 → 25
MAR**

**28 → 31
MAR**

GRAN CANARIA, SPAIN
Desalination for the Environment
Conference
→ bit.ly/EU_FORWARD

**26 MAR
→ 1 APR**

TROMSØ, NORWAY
Arctic Science Summit Week 2022

A week-long event bringing together researchers, stakeholders and inhabitants to discuss the regional changes and global impacts of a warming Arctic.

→ assw.info

Whilst at the time of writing all of these events were scheduled to take place, we advise all of our readers to regularly check the status of each event due to the continued uncertainty caused by the ongoing coronavirus pandemic in Europe – events may be cancelled, rescheduled or reformulated (e.g. switched to being a digital event only) at any time.

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