

THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

advances

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Native oysters have been returned to River Conwy with the aim of bringing them back from the brink of extinction



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Advances Wales showcases the latest news, research and developments in Welsh science, engineering and technology. This edition and past editions can all be viewed online.

Advances Wales highlights groundbreaking innovations in science, engineering and technology across Wales.

This edition of Advances Wales features The Wild Oysters Project, which has recently returned native oysters to Welsh waters and is aiming to save them from the brink of extinction (page 14).

Meanwhile, scientists at Welsh universities are involved in studies exploring whether anxiety disorders could be treated by reactivating bad memories during sleep (page 6), if chronic acne could be addressed with a drug-free method (page 7) and how hemp could form the basis of new animal disease treatments (page 8).

Digital technology highlighted in this edition includes a 'tag and trace' system for recycling bottles and containers (page 11) and software to create more realistic views of 3D spaces (page 20). There are also two innovations in drone technology, with Welsh companies using AI to help drones tackle weeds in agriculture (page 9) and increasing the amount of time that tethered drones can stay in the air (page 18).

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Sophie Davies
Editor

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Cardiff astronomers join space mission

Astronomers from Cardiff University's School of Physics and Astronomy have joined the science team of the Twinkle space mission.



“Twinkle is a fantastic opportunity for exoplanet science. By getting above the Earth's atmosphere, it will be able to make ultra-sensitive measurements and it will lead to a huge leap in our understanding of the nature of planets beyond the solar system.”

Dr Subi Sarkar
Cardiff University

Twinkle is a pioneering space telescope designed to study the atmospheres of exoplanets, which are planets orbiting stars beyond our solar system. The mission will be launched in 2024 and will operate for seven years, making sensitive visible and infrared spectroscopic measurements to detect molecules in the atmospheres of planets as they pass in front of their host stars. These observations will help astronomers

to discover what the planets are made of and how they formed, and to understand how our own solar system fits into the bigger picture of planetary systems in our galaxy. Space missions usually take a decade or more to design and manufacture, due to the requirements of developing new technologies that will survive the violent launch and the harsh environment of space. This mission is taking a new approach,

using only already proven technology, and with an accelerated programme to build the spacecraft.

The Cardiff team has already contributed to the development of Twinkle by providing a sophisticated software simulator of the mission and its capabilities to detect the presence of molecules in exoplanet atmospheres.



www.cardiff.ac.uk

Providing education through VR technology



The University of South Wales (USW) and Immersity are collaborating to develop VR technology for education and training, intended to be available both within the university and commercially.

Cardiff-based Immersity, which creates VR training solutions for a variety of industries, has worked with USW to build immersive learning experiences for students studying forensics, as well as students studying aircraft engineering and maintenance systems.

The university has a crime scene house and aeronautical engineering facilities, which have traditionally been used to teach students specialist skills. However, when Covid-19 hit, it became more challenging to have groups of students in such enclosed spaces.

The emergence of the pandemic increased and accelerated the appetite for immersive training which could be undertaken remotely. To meet this need, Immersity has created a virtual model of the university's crime scene house, giving students the opportunity to receive their training anytime, anywhere. They are also working on VR technology to help students learn how to handle planes coming into both busy airport terminals and military installations.

A cloud-based platform allows users to access the solutions through any type of VR hardware, such as the popular Oculus Quest 2 and the mobile phone cardboard-box viewer, in addition to 2D desktop for those who do not enjoy the full immersive experience. This means that the technology is accessible to people without the need for expensive headsets.



www.southwales.ac.uk

Welsh manufacturer forms international partnership

Bollé Safety, a specialist in the development of PPE eyewear, has announced a partnership with Welsh firm RotoMedical, making them the French company's exclusive UK manufacturer of PPE eyewear for the healthcare industry.

More than three million PPE items are set to be produced per month at RotoMedical's manufacturing base in Port Talbot, following the launch of production at the beginning of June. The partnership will see products distributed across the UK and Ireland, and also exported to healthcare markets globally.

Rototherm Group, a company dating back to the 1880s, specialises in the production of industrial measuring instruments. During the pandemic, the firm pivoted to also produce medical masks and protective face shields for health and care workers under the brand RotoMedical. Since the pandemic's arrival in the UK, the Port Talbot manufacturer



has increased its production capacity of plastic face visors from 1,000 per day to 250,000 per week. This rapid success catalysed further expansion into the life sciences sector, as they progressed to produce BSI certified Type IIR face masks, which are surgical grade and designed for use by healthcare professionals. Following the supply contract with Bollé, the Welsh

company has added safety goggles to its remit and created a dedicated automated production line. The Bollé face shields will be manufactured using locally sourced raw materials.

 www.rotomedical.com

IN BRIEF

Air quality monitoring with digital tech

Neath Port Talbot Council is undertaking a pioneering air quality monitoring project, aimed at providing accurate, real-time measurement of pollution so that solutions for greener, healthier communities can be found. Working with local company Vortex IoT, the council's project will see 70 digital sensors being attached to lampposts in certain residential areas of Port Talbot. The area will act as a test bed for the technology and will provide instant data on how air quality varies between different neighbourhoods. Air quality is not the same everywhere and pollution can build up in isolated pockets, with local sources such as industry or a busy road affecting air quality. The aim of this pilot study is to achieve a better understanding of air quality on a local level. This would allow the council to more effectively target interventions, and to identify any pollution hotspots and pollution sources that were previously hidden.

Awards recognition for medtech firm

Creo Medical (who featured in Advances Issue 87) has been named as one of three finalists shortlisted for a prestigious UK engineering award. The Chepstow-based company designs and manufactures advanced, miniaturised surgical tools that integrate radio frequency and high frequency microwave energy for highly targeted, minimally invasive endoscopic surgery. The aim is to improve patient outcomes for cancer care, while providing earlier treatment, minimising the need for traditional surgical interventions and moving treatment out of the operating room. In 2020, the company successfully CE marked five new medical devices. The MacRobert Award is the UK's longest running engineering prize, recognising engineering achievements that demonstrate outstanding innovation, tangible societal benefit and proven commercial success. Creo Medical has been selected as a finalist for the award alongside DnaNudge and PragmatlC Semiconductor.

Dementia scanner roll-out for earlier diagnoses

A scanner used to identify some of the earliest and most difficult to diagnose forms of dementia is being rolled out across Wales. It comes after a successful pilot between Cardiff University's Wales Research and Diagnostic PET Imaging Centre at the University Hospital of Wales, Aneurin Bevan University Health Board and the Royal College of Psychiatrists in Wales. PET scans, using a radioactive tracer drug, show how a person's tissues and organs are functioning. In dementia, the scan can reveal the areas of the brain which have reduced function in people who are presumed to have the condition but have few symptoms. The technique allows patients and their families to receive an earlier and more definitive diagnosis, as well as the opportunity for earlier treatment and more appropriate psychological and lifestyle interventions. PET scans for dementia will now be available across Wales, helping to clear some of the backlog of patients who have been waiting for a diagnosis due to the pandemic.

Supercomputer to accelerate AI research

A supercomputer that can perform 15,000 trillion operations per second, making it 15,000 times more powerful than a desktop PC, is to be installed at Swansea University, where it will support AI research in fields from engineering to medicine. The supercomputer will be based at the university's Bay Data Centre but will be available to researchers and companies across Wales. It will become a crucial research tool for teams investigating the potential of AI, with applications such as analysing patient data for early diagnosis and personalised treatment, improving the efficiency of industrial processes such as steel manufacturing, and optimising power grid systems. Dr Cinzia Giannetti from Swansea University's School of Engineering said: "This will enable us to significantly reduce the time it takes to develop new algorithms and predictive models for smart manufacturing applications, facilitating the design, development and validation of novel AI-driven frameworks that will help industry to improve the efficiency and sustainability of their production processes."

New ostomy pouch offers greater independence

Cardiff-based Pelican Healthcare Ltd has launched a new innovative ostomy pouch range, following significant investment. Based on feedback and insight from nurses and ostomates, the ModaVi range has been developed not only to deliver clinical performance, but also with lifestyle in mind. It has key features designed to give ostomates greater independence and more control of their day-to-day lives. This launch has been three years in the making and resulted from significant investment, including £1 million of new machinery at the company's HQ. Stuart Welland, Managing Director, commented: "The ModaVi launch is designed to challenge stigma, make a difference to someone's life, and not allow people to be defined by a stoma. This product provides the support, freedom and quality of life that someone living with a stoma deserves. It's a product designed with lifestyle and choice at its heart."

Investment for meter reading technology

Port Talbot-based Deer Technology has secured investment of £1.32 million and announced a £2.5 million contract win with Wave, a leading retailer in the non-household water market.

The company's founders created the LimpetReader to take accurate, real-time meter readings. The technology is designed to provide a new standard in remote, non-invasive recording of meter readings for water, electricity, gas and other metered consumption.

It can be retrofitted to any traditional analogue meter and uses micro-cameras in sealed housings to capture time-stamped images of the meter display, before sending them via secure data connection to an online portal. This removes the need for costly and unreliable manual reads.

The new investment will be used to fund rapid commercial growth and to install 8,500 readers over the next two years for national water retailer, Wave. The company will continue to enhance its core technology and products, and a next generation slimline LimpetReader is due to launch in late 2021.



"Utility businesses are facing increased pressure to provide accurate meter readings and improve their environmental credentials. We've spent the time developing and patenting our innovative technology that now provides real-time, accurate meter readings, meeting regulatory requirements remotely and at half the cost."

Craig Mellor
Chief Executive, Deer Technology

 www.deertechnology.com

Software to improve knee osteoarthritis surgery

High Tibial Osteotomy (HTO) is an effective treatment for younger knee osteoarthritis patients, but patient outcomes are still dependent on the accuracy of the procedure, and current solutions are a one-size-fits-all approach. A collaborative project between TOKA, Cardiff and Vale University Health Board and Cardiff University is working to address this problem by introducing a bespoke surgical planning tool. The aim is that surgeons will be able to precisely achieve the planned correction using a combination of intuitive 3D planning and custom-made, minimally invasive devices. This could lead to a significant improvement in clinical treatment options, allowing for a more personalised surgical approach and ultimately enhancing the patient experience. Patients scheduled for HTO surgery at Cardiff and Vale Orthopaedic Centre will be recruited as volunteers to take part in a study to collect biomechanical and knee joint imaging data pre- and post-surgery. This data will be used to inform changes to the planning software.

Investment boosts sustainability at Folly Farm

Folly Farm has upgraded its popular outdoor go karts to sustainable, electric models, making it the first family attraction in Wales to introduce all-electric go karts. The Pembrokeshire zoo invested £160,000 in 18 electric-powered karts designed and built by Rhyl-based business, Formula K. Royston Badham, Operations Manager at Folly Farms, explained: "The cars run on batteries which are charged using solar power. Solar panels on our fairground roofs already power many of the attractions on site as part of our ongoing commitment to sustainability. The new greener go karts will reduce our carbon emissions as we are no longer using petrol, and what's more, they're much quieter than the old models which is an added bonus. We were pleased to work with another Welsh business, Formula K, who have made the upgrade a smooth and easy process for us, delivering our order during challenging times."

Aberystwyth leads greenhouse gas removal research

Scientists at Aberystwyth University will play a leading role in a major drive to remove greenhouse gases from the atmosphere. As part of a £30 million investment over four-and-a-half years, researchers at the university's Institute for Biological, Environmental and Rural Sciences (IBERS) will lead a consortium of partners to develop biomass crops and will also collaborate on the restoration of peat soil. Alongside project partners, they will be demonstrating the latest technologies for planting willow and Miscanthus, the two perennial biomass crops that are best suited to UK conditions. Both crops grow well on land that is less suited to food production, and can be harvested every one-to-three years. Since they remove carbon dioxide from the atmosphere as they grow, they are regarded as a renewable and low carbon source of electricity. The team will also undertake detailed measurements of carbon flows in order to more accurately account for this carbon.

Funding raised for crypto startup

Coincover, a Cardiff-based platform providing protection and guarantees for cryptocurrency investors, has raised \$9.2 million in Series A funding. The platform is designed to ensure that users and businesses never lose access to cryptocurrency funds due to user error, or business infrastructure failure. By combining advanced technology and insurance-backed guarantees, it provides disaster recovery and business continuity options for cryptocurrency businesses and enables consumers to enter the market safely. As interest in cryptocurrency grows, so does the scale of potential problems. For example, it is estimated that around 20 per cent of bitcoin are lost or stranded in wallets that can't be accessed, and just like regular bank accounts, crypto wallets can be hacked. Coincover was built to prevent and protect against these issues, allowing people to invest in cryptocurrency with greater security and reassurance that they will not lose their investments if they lose a password or private key.

Scaffolding firm secures windfarm deals

North Wales firm BGB Scaffolding has opened new headquarters and continues to expand after securing international deals during the Covid-19 pandemic. The company has been awarded access work in Taiwan on the Greater Changhua 1 and 2a Offshore Wind Farms, and for the world's largest offshore windfarm, Hornsea 2, off the Yorkshire coast. To meet demand in the Asia-Pacific region, they have also launched BGB APAC (Asia-Pacific). Ben Badham, Managing Director of BGB Scaffolding, said: "We are excited to be playing a major role in helping to construct offshore windfarms, especially in light of plans by so many countries to increase and speed up the development of offshore wind energy by 2030. Taiwan is our first port of call, where we are looking to build new relationships and support their green energy development by finally meeting face-to-face with the suppliers we've been in contact with over the past year."

Sleep study tackles negative memories

Results from a sleep study, involving scientists from Cardiff University, could hold the key to treating PTSD and other anxiety disorders.

Sleep plays a crucial role in the consolidation of memories, and there is growing evidence that sleep can help to ‘decouple’ emotions from difficult experiences. A new study, carried out by psychologists from Cardiff University with experts from the University of Manchester, has found that triggering bad memories to reactivate during a light stage of sleep reduces the emotion associated with these memories when awake.

The research suggests that targeted memory reactivation (TMR) could have potential use as a tool for treating anxiety disorders, including PTSD. The TMR technique involves pairing sounds with learned material during the daytime, then re-presenting the sounds at night to trigger the memory. The ‘sleep to forget, sleep to remember’ hypothesis suggests that TMR during a light stage of sleep can lessen negative emotions linked to bad memories.

In the study, participants were divided into two groups to evaluate the technique in two different stages of sleep – REM and SWS. Rapid-eye movement (REM) is a light stage of sleep in which people dream the most vividly, while slow-wave sleep (SWS) is often referred to as deep sleep. The participants rated image-sound pairs in terms of how upsetting they were before and after sleep. In each group, half of the negative and half of the neutral image-sound pairs were reactivated in sleep via TMR.

Results showed that reactivation in REM, but not SWS, led to a significant reduction in how upsetting participants found the pictures the next day. This was true for both negative and neutral pairs, but the effect was driven by the negative ones.

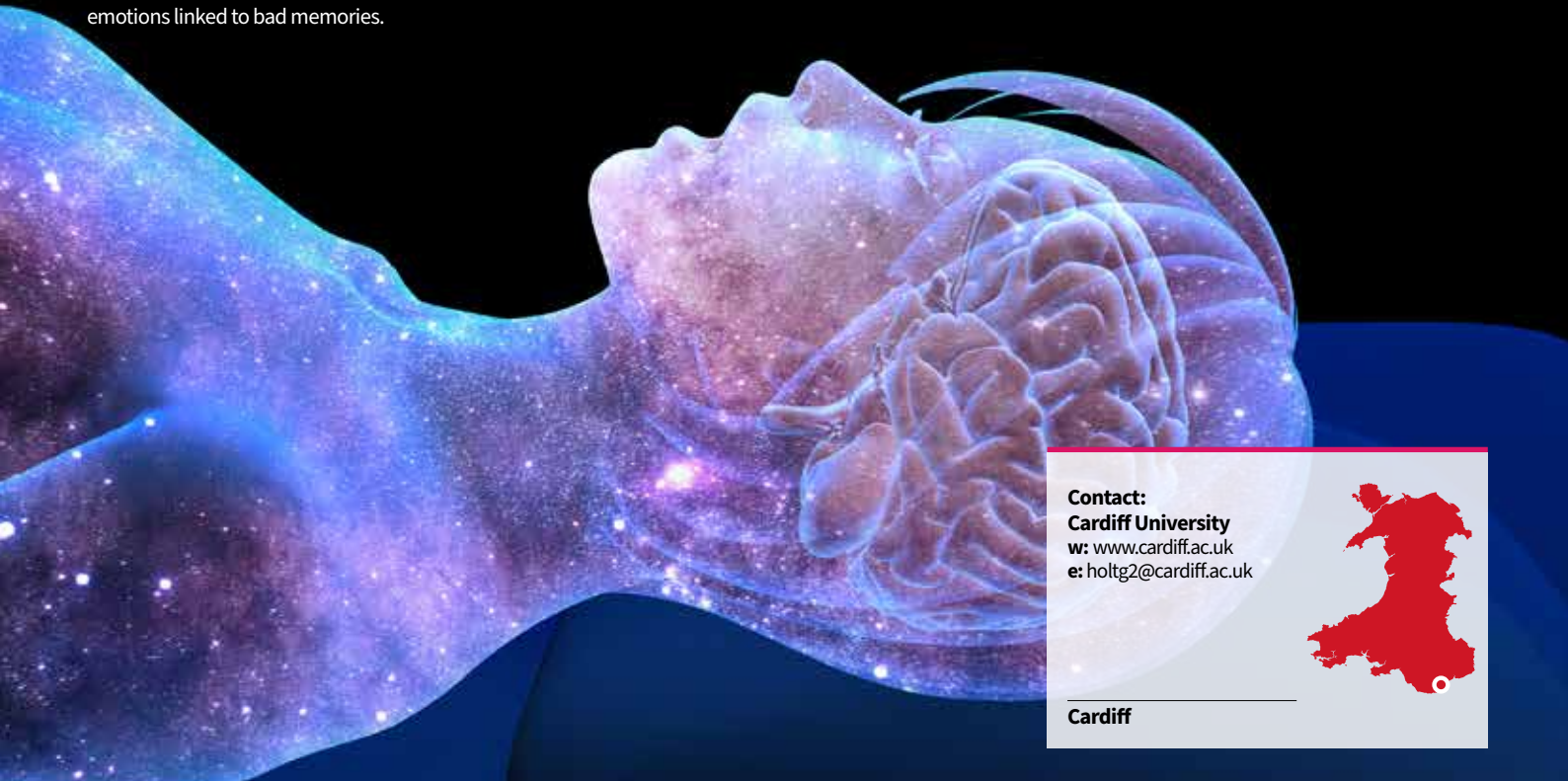
The team intends to look at brain activity associated with this emotional dampening in their next study. They hope to find that this

method of lessening negative emotional reactions also reduces engagement of an area called the amygdala, which is strongly involved in individual emotional responses.



“These results are important because they provide strong support for the idea that triggering emotional memories to reactivate during REM sleep can be used to dampen negative emotions that exist around a bad memory.”

Professor Penny Lewis
Sleep psychologist
Cardiff University Brain Research Imaging Centre (CUBRIC)



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Cardiff

Treating chronic acne with nitrogen plasma technology

A collaborative Welsh project is advancing technology to treat chronic acne conditions.

Energist Medical Group is working with Swansea University Medical School's Healthcare Technology Centre (HTC) and the University of Wales Trinity Saint David's Assistive Technologies Innovation Centre (ATiC) to develop a quick, painless and drug-free treatment option for people living with chronic acne.

Swansea-based Energist Medical Group provides nitrogen plasma technology for the medical aesthetics industry. The company's NeoGen Plasma devices are non-invasive and clinically proven to treat anti-ageing cosmetic and dermatological conditions. These include acne scars, actinic keratosis, facial rhytides, non-facial rhytides, superficial skin lesions, seborrheic keratosis and viral papillomata.

Nitrogen plasma (thermal energy) is created by ionising medical grade nitrogen gas with ultra-high radiofrequency, which is pulsed to the skin's surface. Skin treated with nitrogen plasma forms a natural barrier, resulting in fewer



“Acne is estimated to affect nearly 10 per cent of the population globally and can lead to physiological and psychological complications for those suffering on a severe and prolonged basis. We look forward to collating scientific data that demonstrates nitrogen plasma's anti-acne and drug-penetration enhancement efficacy, underpinning the successful treatment outcomes that a number of users are already having in the field, and paving the way for our next phase in product and clinical development.”

Simon Jones
CEO
Energist

post-treatment complications and reduced recovery time compared to light and laser technologies. Without charring, puncturing or ablating the skin's surface, it penetrates as deep as the dermis, treating the whole skin architecture.

As part of the research project with HTC and ATiC, Energist is developing new equipment and practices to treat chronic acne. This has traditionally been treated with drugs, which can have long-term health effects on patients.

To validate the effectiveness of nitrogen plasma technology in treating chronic acne, the HTC is undertaking an in-vitro study, using it to treat porcine skin samples inoculated with a common bacteria associated with the pathophysiology of acne. In addition to this bacterial research study, the researchers will also investigate the diffusion rate of specific molecules through skin samples in response to the plasma treatment.

Using its user experience research laboratory, as well as mobile eye tracking and prototyping facilities, the ATiC team is conducting an in-depth study to investigate the ergonomics and controllability of the NeoGen Plasma device. This work includes a study of user comfort and fatigue for clinicians during procedures. It will also involve reviewing and capturing current treatment methods to ensure a better experience and outcome for patients.

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Swansea

Using hemp to treat inflammation

Scientists from Aberystwyth University are exploring whether hemp could form the basis of new animal disease treatments.

Aberystwyth University and TTS Pharma are investigating a hemp extract with properties that could help to create new treatments for inflammation. One particular condition that the extract could treat is endometritis, which involves inflammation of the uterus lining and usually occurs due to infection.

Following preliminary trials of novel compounds as anti-inflammatory treatments in cattle, researchers are now looking into the use of this hemp extract as a potential treatment for disease in several livestock animals. This work will benefit the farming industry and could also provide a foundation for future research into the health benefits of hemp in humans.

The development is part of a long-term partnership between Aberystwyth University and industry, researching a wide range of possible uses for hemp. The new approach to treating inflammation could have significant medical benefits and also reduce the need for antibiotics, thereby reducing the risk of bacteria developing resistance.



“Our in vitro models are being used to screen TTS products by assessing their anti-inflammatory properties. Ultimately, after further testing, we hope these may help treat bovine endometritis, which is a significant issue in the dairy industry. We are about to begin a new project that will investigate its use for equine and porcine endometritis, once again using in vitro models. Endometritis in cattle, pigs and horses causes infertility. However, the conditions occur at different parts of the breeding process in these animals, so studies are species specific.”

Dr Debbie Nash
Aberystwyth University
Institute of Biological, Environmental & Rural Sciences (IBERS)

Mark Tucker, Chief Executive Officer of TTS Pharma, added: “The results to date confirm our belief in hemp and its potential medical applications, if correctly developed, for both the animal and human healthcare markets. This kind of research helps us to understand the underlying mechanism of action and the specific diseases it is applicable to, across a range of different species, and helps us to ensure treatments are developed from credible research platforms.

“Aberystwyth University has all the resources necessary to evaluate the hemp plant, whether we are looking at the seed's genetics or the end clinical use. This partnership offers a fantastic opportunity for us to build that databank and generate the science base across the entire product lifecycle to share with the wider community.”

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Aberystwyth

Drone gets to the root of agricultural issue

A collaborative project at Menai Science Park (M-SParc) has led to the creation of a low-carbon solution for tackling weeds in agriculture.

Green Eagle is a custom-built drone which uses AI to identify weeds and tackle them one by one. It was developed by M-SParc with two tenant companies, Aerialworx and Fortytwoable, who are based at the science park.

On farms, weeds are usually tackled by diesel tractors spraying pesticide. The work covers acres of land, often needlessly because weeds may not be present across the entire area. It is a time-consuming process, and a lot of pesticide is required to cover a whole field. The process also comes with an exposure risk to the farmer, and a spillage risk to the environment, wildlife and livestock. There is a Code of Practice to ensure safety, but this increases the workload and the financial burden for the farmer.

The Green Eagle drone combines artificial intelligence (AI) and drone technology to accelerate the farming industry, reducing the costs, time, environmental impact and safety risks of tackling weeds. The drone has a camera built in, enabling development of an AI, or machine learning, database of common weeds. Once it learns what is a weed and what isn't, the drone can be sent out to fly and scan the field. Since it is able to recognise individual weeds on sight, it will only target the weeds with pesticide, rather than the entire field.

M-SParc, by Bangor University, assembled a team of specialists to tackle both the hardware and software sides of the project, as well as the



This targeted drone approach eliminates the need to spray large areas of land with pesticide, using diesel-hungry tractors, in order to tackle just a few problematic weeds. By implementing this new, more sustainable process on farms, the technology would contribute to reducing greenhouse gases and decarbonising the farming industry.

interface between them. AerialWorx specialise in drone technology, and they were paired with Fortytwoable, who specialise in software development and AI. The 'computer vision' was developed and trained to recognise weeds and then interface with the drone in order to stop and apply the pesticide before moving on. The technology was also tested at Coleg Cambria Llysfasi.

After a successful pilot, the team now intends to keep developing the system so that the Green Eagle drone can identify the weeds and a 'Green Robot' can then spray the weeds on the ground. This would allow the treatment to still be carried out in adverse weather conditions. The AI could be adapted to recognise native weeds in other continents, so the drone also has the potential to spread its wings across the world.



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Anglesey

Converting carbon into green chemicals

Researchers at the University of South Wales are developing a process to recycle carbon-containing waste into valuable platform chemicals.

Platform chemicals, such as Volatile Fatty Acids (VFAs), can be used as building blocks to manufacture a wide range of vital synthetic compounds and materials. Global demand for VFAs is constantly growing, but they are currently manufactured from fossil fuel based feedstocks such as oil and gas. For every tonne of them produced in this way, 3.3 tonnes of CO₂ are released into the atmosphere.

A team based at the University of South Wales' Sustainable Environment Research Centre is creating a new biorefining technology, known as H2ACE, which enables more environmentally friendly production of platform chemicals. It revolves around a microbial process that converts CO₂ in a microbial bioreactor, producing valuable green chemicals including VFAs. Therefore, it has the potential to change how we see CO₂, reframing it not as just a problematic pollutant, but as a valuable resource for green, sustainable chemical manufacture.

The value of VFAs depends on their purity and their concentration. Without an effective method of continuous separation and purification, full-scale microbial production has been held back. However, researchers are now developing advanced separation technology, which dramatically increases the purity of the VFAs being collected while retaining vital nutrients critical to the microbial biorefining processes. This level of continuous, selective extraction has not been demonstrated at an industrially relevant scale before. These advancements allow the dynamics and operating parameters of the bioreactor to be re-evaluated in new ways, resulting in a more productive and efficient process.

H2ACE is one of the technologies which make up the 'VFA Factory' concept in development at the university for the biorefining of waste streams. They are making use of novel microbial conversion processes, combined with continuous separation technologies, to produce and purify VFAs. In addition to producing them from waste gases, they are also working on technologies to produce them from high-solids biomass waste and from carbon monoxide rich substrates. The technology can also utilise renewable hydrogen to convert carbon dioxide into VFAs. The team

is developing pilot scale bioreactor systems for all of its new technologies and working with industrial partners such as Tata Steel and Welsh Water.



To meet environmental targets, industries need to find new ways of reducing, recovering and recycling their waste by-products. Biorefining technologies such as H2ACE can assist with this by capturing carbon and putting it to good use producing platform chemicals, instead of releasing it into the atmosphere.

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Glyntaff

Tag and trace technology for improved recycling

New digital technology is designed to make the recycling of containers and bottles, in exchange for a deposit, more cost-effective to implement and more convenient for consumers.



Polytag is a 'tag and trace' technology which allows packaging manufacturers and brands to assign unique individual codes to each unit of a product. Linked to a supporting IT platform, these codes can be read at any point of the product's lifecycle, via a consumer app or via different scanning and computer vision systems.

Several countries around the world operate Deposit Return Schemes (DRS), which can reduce littering and increase recycling rates. A deposit is added to the price of sale for containers, and once the container is returned, the consumer receives the deposit back. Polytag would enable the implementation of a fully digital DRS, avoiding some of the pitfalls that a typical, non-digital DRS can have.

A conventional DRS system relies on extensive deployment of Reverse Vending Machines, often at shops, where consumers can return their used containers and bottles. These bulky machines cost money to install and can create inconvenience for retailers, who then need to operate and maintain them. The system also requires a consumer change of habit, so uptake can vary.

On the other hand, a digital system has the potential to be integrated with current kerbside

collection (in the UK and Ireland, for example) or with recycling points (as in other parts of Europe). Using the new technology, consumers would be able to scan codes and claim deposits from their own homes. In turn, this ensures that vulnerable sections of the population would not be excluded from the scheme. Deployment would also be more cost-effective and convenient for retailers, because Reverse Vending Machines would not be required.

Polytag was created by the team behind Econpro, a Deeside-based waste management company specialising in problematic waste streams. Looking at the challenges and opportunities of the current recycling system, the team came up with the solution of a tag and tracing system that allows each piece of packaging to be uniquely identified.

The company is embarking on a Digital Deposit Return Scheme Pilot in Conwy, with support from Wrap Cymru. The objective of this pilot is to test their system that digitises the return of deposits on drinks bottles. This will come as part of new legislation in 2024.

Further aspects of the system will be developed in the Advanced Manufacturing Research Centre Cymru in Broughton. This work will include optimising the unique identifier's printing process, ensuring that production lines maintain current speeds and that the chosen inks are durable throughout the product lifecycle. It

will also involve further development of the IT platform and the consumer-facing app to ensure it is easy for the general public to use.



It is hoped that the system will enable future recycling legislation at a lower cost and with a lower carbon footprint. As a result, more ambitious targets could be set for recycling both locally and nationally. The consumers, through the app, will be able to understand how they can recycle based on their geographical location. It will also be an enabling technology for a more circular packaging economy, keeping valuable resources in use and out of the environment.

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Deeside

Analysing the long-term impact of wildfires

Research from Swansea University has provided new insights into a persistent danger that exists after wildfires.

Every year, an estimated four percent of the world's vegetated land surface burns, leaving more than 250 megatonnes of carbonised plants behind. For the first time, wildfire experts from Swansea University have now measured environmentally persistent free radicals (EPFR) in these charcoals and found very elevated concentrations, in some cases even up to five years after the fire.

EPFR are significant because they can generate reactive oxygen species, which have many different negative effects in living organisms. There, they could pose a persistent hidden danger to the environment after wildfires.

Professor Stefan Doerr from Swansea University explained: "This can be especially relevant in those ecosystems which are not adapted to fire but are seeing more fire lately because of climate change, such as tropical rainforests or the Arctic tundra. With global warming and other human impacts leading to larger and more severe fires in many parts of the world, understanding their implications on fire-impacted ecosystems is urgent."



The team is conducting global research into the effects of fire on environmental processes such as the carbon cycle and erosion and, as a result, have collected a variety of charcoal samples from forest, shrubland and grassland fires in different climatic zones. Field campaigns have been carried out in many regions including Canada, Europe and South Africa. A wide range of samples has been vital to prove this is a ubiquitous phenomenon.

The samples were sent to the University of Vienna for analysis, along with information on the timing, duration and intensity of the fires. Electron spin resonance (ESR) spectroscopy then made it possible to



Dr Cristina Santin taking charcoal samples after fire in boreal Canada.

quantify the environmentally persistent free radicals in the studied material and to identify their adjacent chemical structures. The Swansea team was also able to provide expertise on the context of environmental impacts of fires.

Although the research has provided fresh insights, it has also raised new questions, because the discovery that EPFR occur in such high concentrations and remain stable over several years was surprising. In future studies, the team is planning to assess the consequences this may have for the environment.



“Our research shows charcoal is ubiquitous in the environment, so the fact that it has EPFR means this is a topic that clearly needs further investigation.”

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Swansea

Restoring native oysters to Welsh waters

Native oysters have been returned to waters in River Conwy with the aim of bringing them back from the brink of extinction.

Sometimes called ‘ocean superheroes’, native oysters provide significant benefits to coastal waters by helping to clean the seas and acting as an important habitat for marine wildlife. However, native oyster populations have declined by 95 per cent due to human activities, meaning their benefits to the ocean have largely been lost.

1,300 native oysters have now been introduced to River Conwy waters as part of an ambitious restoration project. Nurseries have been suspended underneath marina pontoons in Conwy Marina and Deganwy Marina, creating a micro habitat that will act

as a maternity ward to the next generation of oysters. The oysters in the nurseries will soon begin to reproduce, releasing millions of baby oysters known as larvae into the ocean.

The Wild Oysters Project is a partnership between ZSL (Zoological Society of London), Blue Marine Foundation (BLUE) and British Marine. The project has partnered locally with Bangor University’s School of Ocean Sciences, and a local project officer will help to monitor and care for the newly placed oysters.



Celine Gamble, Wild Oysters Project Manager, ZSL, explained: “Conwy Bay is a designated Special Area of Conservation, with unique underwater habitats and important marine plants and wildlife, making it the perfect location to restore 1,300 native oysters into protective nurseries to help habitats thrive.

“Now the oysters are in their new home in the marinas, they will almost immediately begin their important work, each filtering 200 litres of water per day. The oysters will start to produce the next generation of the oyster population, releasing larvae which will then be carried out by the water hydrodynamics and settle onto the seabed.

“In turn we hope that the project will help to create cleaner water, healthier fisheries and plentiful marine biodiversity in Britain.”

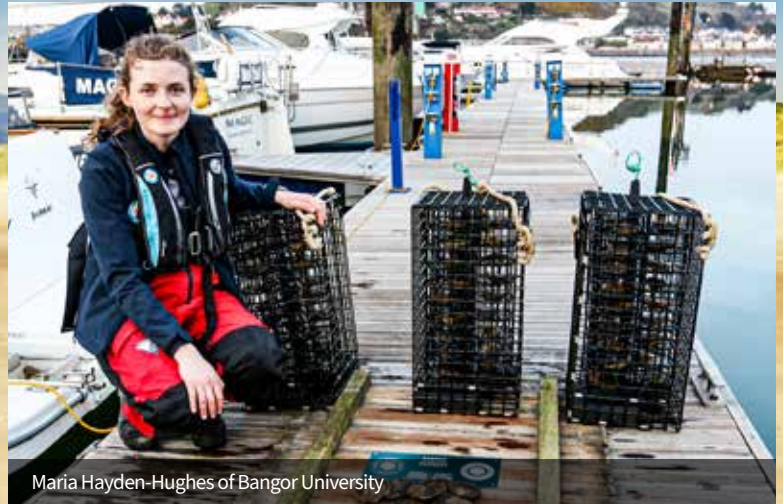
Native oyster populations, local to Conwy Bay in the Menai Strait near Caernarfon and Bangor, were highly prevalent in the 18th and 19th centuries, with Welsh oyster boats reportedly landing 8,000 oysters daily. Oysters once thrived in the local area, forming an important part of the local marine ecosystem.

Morven Robertson, BLUE’s Senior UK Projects Manager, said: “It is vital in the current climate emergency and biodiversity crisis that nature receives the help it needs to bounce back. The Wild Oysters project will give the marine environment a chance to recover, which is not only important for nature and climate, but also the people that rely on it.”



“My primary role is to educate, enthuse and engage surrounding communities to Conwy Bay. These oyster nurseries act as an outdoor classroom for local school children, groups, students and citizen scientists, providing a ‘window’ into the ocean to inspire the next generation to protect and care for the marine environment. It is hoped that The Wild Oysters Project will help to restore this historically important species, reignite interest in the native oyster, and contribute to fighting the climate crisis by supporting an ocean full of life.”

Maria Hayden-Hughes
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Bangor

First 3D recreation of unique material

Scientists from Cardiff University have created the first 3D replica of a material known as a spin-ice, taking a step towards the creation of powerful devices that can harness magnetic charge.

Spin-ice materials are unusual because they possess so-called defects which behave like the single pole of a magnet. These single pole magnets, also known as magnetic monopoles, do not exist in nature, because whenever a magnetic material is cut into two, it always creates a new magnet with both a north and south pole.

Scientists have long been looking for evidence of naturally occurring magnetic monopoles, and in recent years, some have managed to produce artificial versions through the creation of two-dimensional spin-ice materials. Although these structures have successfully demonstrated a magnetic monopole, it is impossible to obtain the same physics when the material is confined to a single plane. The specific 3D geometry of the spin-ice lattice is key to its unusual ability to create tiny structures that mimic magnetic monopoles.

In a new study, a team led by scientists at Cardiff University has created the first 3D replica of a spin-ice material, using a sophisticated type of 3D printing and processing. This printing technology allowed them to tailor the geometry of the

artificial spin-ice, meaning they can control the way the magnetic monopoles are formed and moved around in the systems. Being able to manipulate the mini monopole magnets in three dimensions could open up a wide range of applications, from enhanced computer storage to the creation of advanced computing networks that mimic the neural structure of the human brain.



The artificial spin-ice was created using techniques in which tiny nanowires were stacked into four layers in a lattice structure, which itself measured less than a human hair's width. A special type of microscopy known as magnetic force microscopy, which is sensitive to magnetism, was then used to visualise the magnetic charges present on the device, allowing the team to track the movement of the single pole magnets across the structure.

Dr Sam Ladak, from Cardiff University's School of Physics and Astronomy, explained: "Ultimately, this work could provide a means to produce novel magnetic metamaterials, where the material properties are tuned by controlling the 3D geometry of an artificial lattice. Magnetic storage devices, such as a hard disk drive or magnetic random access memory devices, is another area that could be massively impacted by this breakthrough.

"As current devices use only two out of the three dimensions available, this limits the amount of information that can be stored. Since the monopoles can be moved around the 3D lattice using a magnetic field, it may be possible to create a true 3D storage device based upon magnetic charge."

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Cardiff

Smart, energy efficient driving system for electric vehicles

ePropelled has developed new technology to improve the energy efficiency of electric vehicles.

An electric vehicle (EV) is normally driven by an electric motor, powered by a battery pack. Due to this limited on-board power source, EVs typically have a reduced driving range in comparison to traditional vehicles.

The new ePropelled electronic magnetic gearing (EMG) technology is designed to improve the energy efficiency from an EV's battery pack and increase the driving range from a single charge. It also reduces the size of the battery pack, and therefore the cost, in order to make the vehicles more affordable.

Almost all electric motors have copper wire coil windings wrapped around an iron core. When current flows through these windings, it creates an electromagnetic field which either opposes or attracts the magnetic field provided by permanent magnets mounted on the rotor of a motor. The rotor is attached to a drive shaft. Interaction between the electromagnetic field in the windings and the permanent magnet field produces torque (rotation). This is how electric motors convert

electrical energy into mechanical energy. The design of the windings depends on the requirements of the motor.

The EV propulsion system created by ePropelled includes an innovative motor design with reconfigurable windings, allowing the vehicle to be driven in a more energy efficient way. A software controlled switch matrix enables reconfiguration of the motor windings in real time and we call this electronic magnetic gearing. This means that the magnetic field pattern and other parameters of the electric machine, as well as the power electronics drive, can change to best meet the needs of the vehicle as it is being driven. For example, the propulsion system produces a high starting torque with a lower current draw from the battery pack when accelerating from a stop.

The technology allows EVs to make better use of available energy. It reduces current draw from the battery and reduces winding losses, which extends the vehicle's driving range by up to 25 per cent, and it improves the life of

the battery by reducing the depth of discharge. There is no deep field weakening required at any speed, further improving efficiency, and the constant power region of the total speed range is also extended. Battery and propulsion system temperatures are also reduced, thereby increasing system reliability.



A rising number of vehicles, including cars, buses, trucks and bikes, are being powered by electric propulsion. ePropelled is developing its technology to help these vehicles drive smarter, farther and more efficiently. In addition to the automotive industry, the system also has potential for wind power generation, marine and aerospace applications.



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Cardiff

Increasing the flight time of tethered drones

Two Welsh companies have collaborated to create an innovative tethered drone which is able to stay in the air for longer.

Traditionally, the development of unmanned aerial vehicles and drones has focused on the provision of better image and sensor quality. As this technology has improved, there has been a growing need for a consistent, reliable and continuous power supply to boost flight time and provide a stable platform for the new technologies.

Exsel Electronics, based in Welshpool, and Drone Evolution, based in Caerphilly (who featured in Advances Issue 90), have been working together to develop a tethered drone system which can maintain continuous flight for longer than previously possible. With the Skywire system, their drones now have the ability to stay in the air for several hours.

At the heart of the system is the Freedom Power Supply, which takes 12vDC or 24vDC supply in (typically from a vehicle) and powers the drone at between 100vDC and 500vDC, at a consumption of up to 3kw. An innovative cooling system allows the power supply to provide constant power to the drone, untroubled by length of operation or its surrounding environment. The companies envisage that the power supply could be used to power or charge a variety of devices where higher DC voltages or multiple lower voltages are required.

The power supply plugs directly into a ground-based tethered reel. This portable device automatically controls the height of the drone by reeling out or reeling in the weather-shielded power cable, up to heights of 100 metres. The result is a lightweight aerial power supply, allowing greater payloads and increased operating heights, since there is no need for the drone to carry a heavy battery pack in flight. Data is securely transmitted via the cable which



This smart tethered drone system was created to offer consistent aerial intelligence, surveillance and reconnaissance (ISR) capabilities. With no need to replace batteries, tethered drones can be deployed to a variety of scenarios that are currently not viable with a battery-powered drone. For example, they could safely hover for hours at public events, offering a wide area of coverage, and could be used to monitor crowd safety at large outdoor events such as football matches, golf tournaments or music festivals. They could also be deployed quickly to remote areas, which would be helpful to disaster relief efforts, and could provide real-time live video coverage of unfolding events for the emergency services.

also carries the power to the drone, and it is controlled via a portable tablet.

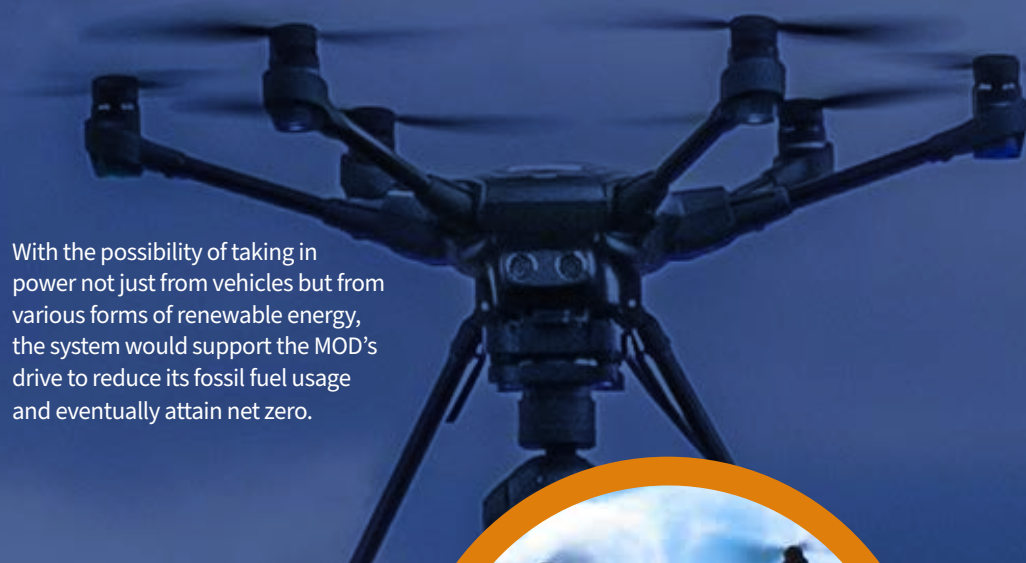
Originally developed for the Ministry of Defence (MOD), the system is designed to be hard-wearing, lightweight and easily



transported. The enhanced ISR capabilities allow rapid tactical decisions to be made, based on the tethered drone's real-time footage. The system can also be easily integrated into military vehicles.

Development work is now underway to enable alternative green energy power supplies, as well as increased optics and sensors for beyond line-of-sight capability.

With the possibility of taking in power not just from vehicles but from various forms of renewable energy, the system would support the MOD's drive to reduce its fossil fuel usage and eventually attain net zero.



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Welshpool

Rendering technology improves the field of view

Fovotec has developed new rendering technology to provide more realistic, expanded views of 3D spaces.

Standard technologies for 3D visualisation have certain restrictions and limitations, including high levels of distortion and limited fields of view. On average, the field of view they offer is up to 110°.

New rendering technology FovoRender uses a technique based on human vision to provide a wider field of view, reaching up to 180°. The software was developed by Fovotec, a spin-out from Cardiff Metropolitan University, and has now been released into the real-time visualisation industry following ten years of research at the university.

The technology allows users to fit more space into the same screen area (up to six times the space) with less distortion compared to a standard render. This visual improvement can create deeper, more immersive content for those looking at it. The aim is

to change the way we view images via our screens, and it could be put to use in many industries which rely on visualisation tools.

For example, the software could help architects to make better informed design decisions, by enabling their renders to show greater space and be more realistic. Architects could use it to minimise mistakes while they are still in the design process, and this would ultimately reduce costs. The technology could also be used to help deliver virtual tours of a development.

In the automotive industry, an increasing number of dealerships are reducing their costs by shutting down physical showrooms and selling online only. Using product visualisation tools, the new rendering technology could improve this online customer experience, allowing people to reach almost the same level of real-life visual experience via their standard flat screen at home.

The Covid-19 pandemic has also significantly changed the way that people shop, making online shopping an even more widely adopted practice than before. However, it can be frustrating for customers to receive a product that is different to what they expected, because the online product images were not accurate enough to create a realistic expectation. With the new rendering technology, this risk of unhappy customers could be reduced with more accurate 3D representations of products online.



“This technology will change the way 3D artists work and how users experience 3D space. It breaks with 600 years of imaging geometry tradition, based on linear perspective, to open up virtual spaces that are based on the way humans see, rather than cameras. We can't wait to see what imaging professionals worldwide create with it.”

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