

THE JOURNAL

FOR SCIENCE, ENGINEERING AND TECHNOLOGY

# advances

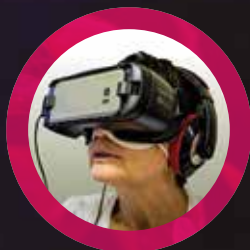
WALES

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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.

**“Once a new technology rolls over you, if you’re not part of the steamroller, you’re part of the road.”**

Stewart Brand, Writer & Entrepreneur

Advances Wales explores the latest developments in science, engineering and technology across Wales.

Innovations highlighted in this edition include a super-sensitive scanner to speed up airport security (page 17), an innovative way of recycling glass bottles to create decorative panels (page 16) and virtual reality technology helping patients to deal with pain, stress and anxiety (page 10-11).

Researchers at Welsh universities have undertaken groundbreaking research into how the brain prepares for complex actions (page 14) and how volcanic growth was critical to the formation of Panama (page 19). They are also working to unlock the mysteries of a relatively common genetic condition (page 12) and collaborating with ambulance staff to establish the best way to diagnose people suspected of having a heart attack (page 13).

Biotech companies featured in this edition are using slipper limpets to produce valuable biomaterials (page 7) and developing cleaning solutions that offer a natural alternative to chemicals (page 8-9).

Please return the enclosed reply slip so that we can provide you with Advances Wales in the language of your choosing. This edition, and previous editions, can also be viewed online.

**Sophie Davies**  
Editor

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Advances raises the profile of the technologies and expertise available from Wales in order to facilitate collaborative relationships between organisations and individuals interested in new technologies and innovation.

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## Welsh technology plays part in Mars mission

**NASA's InSight spacecraft, currently exploring Mars, was manufactured with UV laser wire marking technology developed by Spectrum Technologies.**

Researchers at the Bridgend-based company originally developed ultra violet (UV) laser wire marking in 1987 to meet the needs of the aerospace industry, and it is now accepted as the international standard. The process is a means of safely applying permanent identity codes to non-stick PTFE/Teflon and similar wire insulations, as well as fibre optics. It causes no damage and no change to the mechanical or electrical properties of the wire, whereas the old hot stamp ink marking method was an aggressive and damaging process.

In addition to their aerospace applications, Spectrum's UV laser wire markers are used in harness production for space systems, rail cars, military and specialist ground vehicles, yellow goods (construction and earth moving equipment) and other transportation, control systems and electrical products.

The company's technology was recently used to process and identify all of the wiring in the manufacture of the complex electrical wiring system for the InSight spacecraft, NASA's latest lander designed to explore the deep interior of Mars. The lander touched down on Mars in November 2018 and a two-year mission is planned.

The same technology from Wales is also being used in the manufacture of the Kennedy Space Center's Orion spacecraft.

*"We may only have played a small part in this interplanetary project but I and all the team at Spectrum are exceptionally proud and excited to be associated with the Mars InSight programme. InSight is truly leading edge and we look forward with anticipation to seeing what new knowledge it turns up while it explores Mars and its deep interior."*

**Dr Peter Dickinson**  
CEO of Spectrum Technologies



[www.spectrumtech.com](http://www.spectrumtech.com)

## New trap to prevent golf course damage

**Swansea-based biotech company Bionema has created a new insect trap to combat chafer beetles, which are responsible for significant damage to grass and turf.**

A report from agriculture and environmental consultancy ADAS calculated that chafer grubs cost UK golf courses up to £85 million a year from lost income and damage repair. The same report also highlighted that 40 per cent of racecourses are affected by the pest's damage.

Bionema's trap has been designed to attract and trap the beetles, whose larvae eat the roots of grasses, causing damage to lawns and turf and leaving visible sign of yellowish patches. The trap works by using a baiting liquid composed from naturally occurring plant essences that are very attractive to the pests.

In recent trials, five traps per hectare were deployed in golf courses and forest nurseries. Within four weeks, thousands of beetles had been captured, showing the potential to use mass trapping against them without the need for chemical insecticides.



*"Many traditional chemical pesticides that green keepers have relied on in the past have already been withdrawn due to their impact on human health and the environment. The new trap captures adult chafer beetles, preventing pests from reproducing and creating a potential cost saving in controlling the grubs later in the year. They are safe, easy to use, non-toxic and reusable, targeting specific pests to avoid harming beneficial insects."*

**Dr Minshad Ansari**  
Founder and CEO of Bionema



[www.bionema.com](http://www.bionema.com)

# Precision agriculture partnership launched

**Researchers at Aberystwyth University's Institute of Biological, Environmental and Rural Sciences (IBERS) have launched a new partnership with Coleg Cambria Llysfasi, encouraging farmers to incorporate cutting-edge innovations on their farms.**

The £370,000 PreciseAg project will research the use of 'precision livestock agriculture' or 'smart farming' tools on farms managed by Aberystwyth University and at Llysfasi.

Precision livestock farming involves using technology such as motion, temperature, pH and sound sensors to predict the behaviour, health, reproductive and physiological state of livestock. These tools can, for example, provide early warnings of disease and improve the ability of farmers to look after their livestock, in addition to increasing the efficiency of livestock enterprises.



*"The use of smart and precision farming technology is an essential part of future farming, which will ensure that we maximise efficiency from our resources at the same time as ensuring that our actions don't have negative impacts on the environment. Our work with Aberystwyth University will be of major benefit to Welsh and UK farming as a whole, through knowledge exchange of leading research into tangible solutions direct onto the farm. Students from both organisations will have major involvement in research projects and this will enable them to be better equipped for their future careers in the agricultural industry."*

**Iain Clarke**  
Head of Llysfasi



[www.aber.ac.uk](http://www.aber.ac.uk)

## IN BRIEF

### Partnership creates cyber centre

The University of South Wales, Welsh Government and global technology company Thales are working together to establish a £20m cyber centre which will sit at the heart of the Tech Valleys programme. This will be the first research and development facility of its kind in Wales, and will provide SMEs and microbusinesses with a base to test and develop their digital concepts. It will also provide a research lab in which multinational organisations can develop their technology, and will connect Wales to major technology centres across the globe. The University of South Wales will run an Advanced Cyber Institute at the centre, providing a base for academic research, and operate a Digital Education Centre, enabling SMEs, schools and individuals to develop the skills they need to protect themselves online.

### Growth for innovative concrete company

Welsh company Concrete Canvas, which exports its 'concrete on a roll' to over 40 countries, is expanding thanks to £200,000 of new funding. The grant will allow the company, whose flexible concrete impregnated fabric can be laid ten times faster than conventional concrete, to develop a cutting-edge Research and Development laboratory and testing facility at its Pontyclun site. This will create 25 new jobs over the next two years and help facilitate further growth. The company itself is investing over £1m into the expansion. The R&D laboratory and testing facility is expected to open alongside a new production facility in the third quarter of 2019.

### High-tech imaging system in development

Glyndŵr Innovations, Airbus Defence and Space, the University of Leicester and DL Optics are collaborating to design and build a hyperspectral imaging system which could revolutionise a diverse range of industries. The project follows a successful application to research and technology fund Airbus Endeavour Wales, and will see work carried out at the OpTIC Centre in St Asaph and at Airbus in Newport. Hyperspectral imaging is an emerging technology, using optical technology to analyse the composition of objects. It has applications in a variety of fields including agriculture, waste management and environmental enforcement. The academic and industry partners will create a prototype hyperspectral payload for airborne applications, expected to be built by mid-2019, whose data can be used to secure further funding to build a fully operational system for deployment on a satellite or a high altitude pseudo-satellite platform.

### Investment in compound semiconductors

The European Commission has recognised the importance of compound semiconductors by unlocking up to €1.75 billion for industry research and innovation. This paves the way for up to €6bn in private investment and will ultimately help bring new technology innovations to market. The UK element of the pan-European project involves three Welsh companies: IQE, Newport Wafer Fab and SPTS Technologies, along with Manchester-based IQS Ltd. Compound semiconductors are widely expected to revolutionise 21st century technologies as the silicon chip changed the latter half of the twentieth century. The South Wales semiconductor cluster, branded as CSconnected, is rapidly being recognised as a leading centre of expertise in the field.

### New material to reduce concussion risk

Researchers at Cardiff University have won a competition run by the NFL, the USA's American football league, to develop new helmet padding for players. The HeadHealthTech Challenge aims to find advanced solutions in protective equipment and technology that could improve safety and reduce concussion. The team from Cardiff University School of Engineering have been awarded around £90,000 and are the first recipients of the grant to be based outside of the USA. The engineers are developing a multi-layered, elastic material called C3 with high energy absorbency, which is designed to stiffen as any collision force increases. They are designing C3 with complex computer simulations and using advanced additive manufacturing (3D printing) to create the new material with precise geometry. Peter Theobald from Cardiff University explained: "Computational modelling allows us to analyse the performance of a wide range of geometries, to identify that which has the potential to protect the head against a greater breadth of collision speeds than current helmets."

# Ultraprecise ultrasound to transform new tech

**Scientists at Swansea University Department of Physics and the University of Queensland have developed a new, more sensitive method to measure ultrasound waves.**

Ultrasound has a wide range of applications, such as in medicine for examining pregnant women and for high-resolution biomedical imaging to detect tumours and other anomalies. It is also commonly used for spatial applications, including sonar imaging of underwater objects and navigation of unmanned aerial vehicles.

To improve these applications, scientists have now combined modern nanofabrication and nanophotonics techniques to build the first ultraprecise ultrasound sensors on a silicon chip. With the new technology, it is possible to measure ultrasound waves that apply tiny forces, comparable to the gravitational force on a virus, and this can be done with sensors smaller than a millimetre across.

According to lead author Dr Sahar Basiri-Esfahani at Swansea University, the impressive accuracy of the technology may change how we understand biology. She explained: "We'll soon have the ability to listen to the sound emitted by living bacteria and cells. This is a particularly attractive application, as it could fundamentally improve our understanding of how these small biological systems function. A deeper understanding of these biological systems may lead to new treatments, so we're looking forward to seeing what future applications emerge."



[www.swansea.ac.uk](http://www.swansea.ac.uk)



## Funding for cutting-edge photonics research

EU funding of £3.7m will go towards creating a world-class research network in Wales to help industry embrace cutting-edge technology. The Centre for Photonics Expertise project will establish collaborative research projects that encourage industries to embrace photonics technology in the use of lasers, sensors and fibre-optics. Led by Glyndŵr University, the three-year project will be delivered in partnership with South Wales, Bangor and Aberystwyth universities. They will also work with companies across West and North Wales and the South Wales Valleys in areas such as manufacturing, healthcare, telecommunications, energy and agriculture. Caroline Gray, director of Glyndŵr University's OpTIC Technology Centre, said: "The centre will bring together all areas of academic expertise across photonics technology, helping industry develop the next generation of processes and products, while boosting business growth and efficiency for the Welsh economy and future generations."

## New unit to modernise healthcare

Cardiff & Vale University Health Board is to receive £30.8m funding for a new unit that will provide patients with specialist neuro and spinal rehabilitation. The unit will be based at University Hospital Llandough, with the funding contributing towards a 26-bed spinal cord injury rehabilitation ward, 24-bed specialist neuro rehabilitation ward and a critical care service providing long-term ventilation support to neuroscience and high spinal injury patients. There will also be high specification therapy support services including a purpose built hydrotherapy unit, improved accommodation to provide better privacy for patients, and enhanced independent living facilities to promote earlier discharge to the community. It will also enable Acute and Intermediate Care services for elderly patients to move to a single site with the centralisation and consolidation of Outpatient Physiotherapy, together with Occupational Therapy, and Speech and Language Therapy services into a single refurbished clinic.

## Network for cleaner, greener, smarter steel

A new £35 million research network will see steelmakers and university experts work together on a seven-year research programme to transform the UK steel sector. The network, called SUSTAIN, is led by Swansea University, partnered with the Universities of Sheffield and Warwick, and involves more than 20 partners across the UK steel industry, including companies, trade bodies, academic experts and research organisations. This is the first time that UK steel producers and representatives from the manufacturing sector have lined up behind a co-ordinated programme of research. The aim of SUSTAIN is to transform the whole steel supply chain, making it cleaner, greener, smarter and more responsive to the fast-changing needs of customers. Its work will concentrate on two areas – zero waste iron and steelmaking, with the aim of making the industry carbon-neutral by 2040, and smart steel processing.

## Awards recognition for science parks

Two new Welsh science parks have been shortlisted for awards from the UK Science Park Association (UKSPA), both included in the Most Successful Project category. M-SPARC in Anglesey, a wholly owned subsidiary of Bangor University, was established to drive growth in knowledge based science, with an early focus on the low carbon energy, environment and ICT sectors. Since it opened in March 2018, the 24 businesses located there have created 24 new jobs, six student placements and four graduate employment opportunities, and also grown their company turnover. Aberystwyth Innovation and Enterprise Campus (AberInnovation), due to open in summer 2020, intends to provide world-leading facilities and expertise within the bioscience, agri-tech and food & drink sectors.

## Cobot specialist doubles in size

Reeco Automation, which featured in Advances 85, has doubled the number of staff employed at its Mid-Wales headquarters after securing a number of high-profile customers including Ford, Rolls Royce, Honeywell and Unilever. The company is a turnkey solutions provider for collaborative robots, known as cobots, integrating technology into production lines with the aim of complementing the work of humans and improving speed of production, efficiency and safety. Llewelyn Rees, Managing Director of Reeco, commented: "We are experiencing rapid growth as more and more organisations are appreciating the way in which cobots can complement their human workforce – transforming the way they do things. While much of our work has been with large multinationals, we are also partnering with ambitious SMEs which are harnessing increasing automation into their production processes."

# New waste management app

Online environmental consultancy Green Edge Applications has created WasteApp, a web-based application to connect producers of waste with the waste industry.

**W**hen organisations need to dispose of waste, it can be time-consuming to find a suitable waste treatment site that will take it off their hands. WasteApp was created to speed up this process by making all of the necessary information available in one place.

The app processes details of waste sites and the types of waste they are able to accept. It then translates this information into search tools, enabling users to find waste treatment facilities based on their chosen waste type or by waste activity type. Search results are rated based on the quality of the input data sources. Data entry and data clean-up tools have been designed to ensure that the data is entered into the database efficiently and accurately, and duplicate entries can be avoided.

In addition to allowing waste-producing organisations to more easily source sites that

can meet their specific requirements, the app can benefit companies within the waste industry by making their details easier to find. Once registered, and this process involves checking their own site details, waste processes and waste types, their rating will improve as the app has more confidence in the information used in the searches. They will have an enhanced listing, feature higher in the search results and receive direct enquiries from search tool users.

WasteApp has been launched as a 'beta' release so that developers can obtain feedback during the next phases of development. Future plans



*"I developed WasteApp because organisations were frequently asking me where and how to recycle particular wastes when I was working as a Regulatory Officer for Natural Resources Wales and as an Environmental Consultant. Whilst I could generally answer this, the process of identifying waste treatment options required a long trawl through a large number of permits, finding sites who were authorised to accept the waste and then investigating whether they could recycle or recover it."*

**Jane Hall**  
Director  
Green Edge Applications

include improving the usability of the app and providing regulatory checks on waste sites to support supply chain management.

The app was primarily created to address hazardous or difficult types of waste, such as chemical industry waste. However it can also be used to identify waste sites for more general waste streams, such as waste from construction and demolition sites, food waste and office waste. Significant environmental benefits can be gained from making waste disposal quicker and easier.

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**Chepstow**



# Producing biomaterials from slipper limpets

**Mikota is using the invasive slipper limpet to produce biomaterials including hemocyanin and collagen.**

**T**he slipper limpet is an invasive, non-native species living off the UK coastline. Biotechnology and medical device company Mikota, based in Pembroke Dock, has identified a way to use the slipper limpet as a new and novel source of hemocyanin and collagen.

The company is harvesting slipper limpets from the Welsh coast, extracting their blood and purifying out hemocyanin for use as a protein adjuvant in the anti-cancer, immunology and anti-body markets. They



While hemocyanin has been extracted from other marine creatures before, this is the first time that slipper limpets have been used in this way. The present gold standard for hemocyanin, KLH, is sourced from the giant keyhole limpet. However, this species is under threat, so the slipper limpet offers a timely alternative.

Mikota's activities provide an avenue for disposal of slipper limpets from aquaculture clean up and fishing activities. By commercialising the invasive slipper limpet, the company is turning a pest into high value biomaterials.

If slipper limpets colonise an area, they can create a toxic environment for other marine life. Therefore, harvesting them can have significant environmental benefits. Slipper limpets have a particularly negative impact on native oyster beds, so by reducing their population, new life can be given to beds that have effectively died off and to those that are under increasing pressure.

Mikota is currently working with a Welsh university and seeking more research partnerships and collaborations in order to further explore and exploit the potential of its products. The company is also developing a range of products and medical devices in the fields of regenerative medicine, advanced wound care, anti-adhesion and orthopedics.

are also extracting collagen from the limpets to make a range of products including solubilised, powder, sponge and fibrillar collagen. Collagen is used in a wide range of applications and medical devices, in areas including advanced wound care and bone and nerve reconstruction.

When trying to control or eradicate an invasive species, the cost of management, removal and disposal can be a problem.



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**Pembroke Dock**

# Natural cleaning to combat biocide resistance

Genesis Biosciences have developed new cleaning solutions that offer a natural alternative to chemicals and tackle the issue of biocide resistance.

**The cleaning industry is dominated by harsh and sometimes dangerous chemical solutions. Cardiff-based Genesis Biosciences have been looking to nature's own toolbox in order to create safer, more environmentally responsible cleaning products.**

The company's probiotic cleaning range, Evogen Professional, was developed specifically for the professional cleaning and facilities management sector. Unlike chemical cleaners, which offer short-term benefits, the probiotic cleaners contain consortiums of *Bacillus* microorganisms, which help to build an active biofilm on the application surface. They continue to break down soiling and malodorous compounds after initial application, resulting in more effective and prolonged efficacy and odour control. This reduces the frequency of cleaning required and also the labour costs of having to reapply the cleaning products.

Traditional biocides are present in a lot of conventional chemical cleaners, and research has shown that biocide residues in the environment create a pressure that selects for bacteria with greater



As the beneficial bacteria in the cleaning solutions replicate in the application area, they degrade the organic soiling on the surface, competing with any harmful bacteria present for available growth nutrients. Through this mechanism, the level of pathogenic bacteria present can be reduced naturally by means of competitive exclusion. Furthermore, because the *Bacillus* spores remain on and in the surface after application, they continue to work for as long as there are nutrients for them.

tolerance to these conditions. Similar to the current situation with antibiotics, there is a growing concern that the wide and indiscriminate use of such biocides may contribute to resistance in microorganisms.





This poses a threat to human health, as pathogenic bacteria that are resistant to these biocides will be able to grow and spread despite treatment with disinfectant products. Even the emergence of harmless resistant bacteria could indirectly cause problems, because their resistant genes could be transferred to harmful bacteria.

In recent scientific studies, cleaning solutions containing beneficial *Bacillus* strains of bacteria have been shown to significantly reduce the number of harmful bacteria on a range of surfaces. Through mechanisms including competitive exclusion

and the production of natural antimicrobial compounds, these beneficial bacteria were able to maintain low surface pathogen loads and affect the populations of pathogens harbouring antimicrobial resistant genes.

Genesis Biosciences apply genetic screening and molecular microbiological techniques to characterise the metabolic activity of different naturally occurring *Bacillus* bacteria. Using this information, they are able to select specific strains and create consortiums that degrade specific waste types and combat pathogenic organisms. These application-specific bacterial

consortiums are formulated with environmentally responsible chemistries to create innovative 'eco-benign' cleaning solutions.

Research has shown that indiscriminate use of harsh chemicals not only leads to a rise in issues like asthma and allergies, but also carries the risk of enhancing biocide resistance. With new, natural alternatives, the cleaning industry is able to become safer and more environmentally friendly.



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**Cardiff**

# Distraction therapy with virtual reality

**Rescape Innovation has developed technology to help patients deal with pain, stress and anxiety by distracting the brain.**

**According to recent estimations, up to 28 million people in the UK are living with chronic pain. These people are usually treated with a prescription of painkillers, putting strain on the NHS as well as on the patients themselves.**

Cardiff-based company Rescape Innovation has created a virtual reality distraction therapy solution, known as DR.VR, to support pain, anxiety and stress management. The company initially worked with a group of patients at the All Wales Adult Cystic Fibrosis Centre to develop the technology. People with cystic fibrosis are often treated in isolation, due to the threat of infection, where they can experience anxiety, breathlessness and pain.

When developing the platform, there were several challenges to overcome. For example, VR can be difficult to use when you have little or no experience,

presenting a potential barrier for patients and healthcare professionals, and Wi-Fi in healthcare settings can be unreliable. Also, VR experiences have the potential to cause dizziness and motion sickness if they are not designed correctly, which would limit the number of patients able to use the system. In the case of cystic fibrosis patients, infection control is of paramount importance, so the equipment must be kept clean.

The team developed a closed system in which the VR headset and the experiences are controlled by a tablet. All of the experiences are held on the device to ensure they can be used in any location within the hospital and no Wi-Fi is required. By disabling the functions on the headset and allowing everything to be controlled through a tablet, the technology was made easier to implement and healthcare staff did not require any training outside of the initial demonstration.

In addition to using the tablet to control the experiences, the device also collects data.

The doctors wanted to be able to collate each patient's anxiety and stress levels pre- and post-experience and then store the data effectively. The company developed two apps, one for the tablet and one for the VR device, and connected them to allow the data to be transferred and accessed in real time with a straightforward process.

The hard-plastic headset can be wiped down and disinfected, in contrast to some other headsets



*“What has been demonstrated here is the solution... a useful adjunct in the normal treatment of some of the symptoms we see in cystic fibrosis patients. Pain, anxiety and breathlessness are some of the common symptoms this has relieved. This would be of use in other settings and we are going to continue to use this and work with Rescape to support our patients' care.”*

**Dr Jamie Duckers**  
Consultant in Cystic Fibrosis and General Medicine  
Cardiff and Vale Health Board

which are unsuitable for use in a healthcare setting due to the materials used. VR Sanitary Masks were also provided to meet the strict infection control guidelines and to ensure there was no irritation for the patients.

Six experiences were created to cover a wide demographic. They were all produced in 4K with a static 360 camera, ruling out motion sickness and also ensuring a closed system where only these approved experiences could be viewed. Patients can use the system to travel around the cities of the world, swim under the oceans, come face to face with the animal kingdom and relax in some of the most beautiful settings in the



world. There are also some experiences for more adventurous patients, where they can try surfing, skydiving and other adrenaline fuelled activities.

Each experience lasts 7.5 minutes and requires the patient to be a participant rather than just a viewer, thereby increasing engagement. When the mind is distracted by an immersive experience, stimuli from reality can become subdued. This

means that pain, anxiety and stress can all feel reduced when a patient is immersed in virtual reality.

Trials were conducted with cystic fibrosis patients (aged between 17-54 years old) who were experiencing a lot of stress and anxiety.

The results showed significant improvements in anxiety and stress levels following the VR distraction therapy.

DR.VR has now been used in 31 healthcare institutions across the UK, with 30 more orders placed, and the company has also had global interest in the technology from Norway, Australia and South Africa.



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Cardiff

# Unlocking the mysteries of 22q

Researchers at Cardiff University are working to understand a relatively common genetic condition that most people have never heard of.

**The genetic condition known as 22q, or 22q11.2 Deletion Syndrome, is thought to be the second most common behind Down's Syndrome. Estimates for the number of people affected by it have ranged between one in 4,000 and one in 2,000 live births, but the actual figure is believed to be higher, because not all individuals may be diagnosed.**

A wide variety of health issues are associated with the syndrome, such as heart conditions, immune problems, palatal defects and speech delays. It can also cause developmental problems and learning disabilities. Children with 22q may have a higher chance of experiencing mental health problems such as autism, ADHD and anxiety disorder, while adults are at increased risk of depression and schizophrenia. The problems can vary significantly from one person to the next. Some people are only mildly affected and may not even realise they have the syndrome, while others need support throughout their lives.

Based at Cardiff University's Division of Psychological Medicine and Clinical Neurosciences, the ECHO study aims to identify the challenges faced by people with this condition. The team is studying individuals around the UK and examining development at all stages, including preschool years, childhood, adolescence and adulthood.

The researchers found that 55 per cent of the children with the deletion involved in the study meet criteria for a mental health condition, compared to just 11 per cent of siblings without the condition. They also discovered that children with the deletion are more likely to underperform on tests of attention, planning and reaction time. By following children into the teenage years, they found that these issues persist through development.

Furthermore, the team determined that 81 per cent of the children with the deletion have movement and coordination difficulties, compared to 6 per cent of their siblings. A separate study of parents of children with the condition found that 42 per cent first learned about the risk of mental health problems

associated with the syndrome from the internet, with only 27 per cent learning this information from a clinician.

The team at Cardiff University is part of the International Brain and Behaviour Consortium, which is working to better understand the symptoms of 22q, so that the appropriate diagnosis and support can be offered to affected families.



*"Despite 22q now being considered as one of the most common genetic conditions, there is still much to be learnt about what this means for those affected. Our research is expanding knowledge on the mental health aspects associated with the syndrome, to help identify how children and adults can be best supported during their lives. It is clear from our research so far that there is still a lack of awareness – among the medical community as well as the public. Our work is part of a drive to change that."*

**Professor Marianne van den Bree**  
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Cardiff

# Study to improve heart attack treatment

Swansea University researchers are collaborating with ambulance staff in Wales on a new study to establish the best way to diagnose people suspected of having a heart attack.

**H**ear attack symptoms vary from one person to another. The most common signs are pain or discomfort in the chest, but others can include pain in the arm, neck, and jaw, or feelings of sickness, light-headedness or shortness of breath.



A pre-hospital electrocardiogram (ECG) is a test that paramedics can perform on someone with acute chest pain. The device measures electrical activity in the heart through a series of wires attached to the patient's chest. The test, which takes about 10 minutes to perform, can diagnose a heart attack.

Currently when someone has a suspected heart attack, ambulance crews can perform a pre-hospital ECG. Ambulance staff can then use the results to decide how to treat the patient and whether they should be taken to a specialist heart centre. Therefore they play a crucial role in initiating the correct care in a timely manner.

Previous research demonstrated that people who received the test were more likely to survive, but that around a third of patients suffering from a heart attack did not have the test performed, with women and older people being less likely to receive it. However, since that work was conducted, the preferred way to treat a heart

attack has changed, so the Welsh Ambulance Service is now exploring this with researchers from Swansea University Medical School, as well as academics at Kingston University and St George's, University of London and University of Leeds.

The researchers will examine UK-wide data on the treatment of heart attack patients to determine if use of the pre-hospital ECG is still associated with improved survival rates for heart attack patients. When their original work was conducted, clot-busting drugs were the principal treatment for a heart attack. Today, on the other hand, primary angioplasty (in which a blocked artery is widened using a stent) is the preferred treatment.

They will also carry out chart reviews and focus groups with ambulance staff from three ambulance services, including the Welsh Ambulance Trust, to understand when they use the test and the decision making



*"I have attended patients who have reported symptoms such as dizziness, lethargy, being generally unwell or even a fall, and on rare occasions this has turned out to be a heart attack. As paramedics, we are trained to focus on what the patient tells us in order for us to make a good diagnosis, however this study could highlight new areas for us to pay close attention to. If the data shows new areas of concern, we are likely to carry out many more ECGs, diagnosing more heart attacks earlier, which could make a significant difference to the long-term outcome of the patient."*

**Nigel Rees**

Head of Research and Innovation  
Welsh Ambulance Service

process behind it. By gaining insight into what prompts ambulance crews to use ECGs, they hope to be able to improve guidance on when they could be used more effectively.

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Swansea

# Tracking how the brain prepares for complex actions

**Groundbreaking research into how the brain prepares for complex actions could lead to the development of new interventions for people who have a stutter or dyspraxia.**

**Neuroscientists at Bangor University and University College London (UCL) have, for the first time, identified the processes which occur in the human brain milliseconds before a complex action such as speech, handwriting, sports and playing a musical instrument.**

The team measured tiny magnetic fields outside the heads of the research participants, which allowed them to identify the unique patterns that make up each sequence before it is executed. By recording ongoing neural signals on a millisecond-by-millisecond basis, they were able to track brain activity as participants prepared and then moved their fingers from memory. Using machine learning, the neuroscientists were able to decode which elements of the sequence the participants retrieved from memory before the initiation

of the first movement. This 'brain-reading' approach revealed that the nervous system prepares complex actions in the milliseconds beforehand by 'stacking' them in the correct order.

Dr Katja Kornysheva, the lead author of the paper, explains how they discovered this effect: "Although theoretical models and invasive animal work from decades ago predicted these findings, no direct demonstration of this mechanism has been reported in humans, and it was not clear whether a non-invasive technique would work at all. Seeing the results was very exciting.

"The ability to access the content and structure of sequence preparation through non-invasive techniques offers new possibilities in brain-computer interface technologies (neurotechnologies developed for medical assistive applications). It could also serve as a tool for neurofeedback in disorders of higher motor control, where individuals have trouble putting together movements into fluent sequences. However, we still need to answer many questions about this neural mechanism of sequence preparation, such as whether it can also be found in other action domains such as speech production,

as well as how long-term training will affect the preparation of actions that make up a sequence."

The research also revealed that the concurrent ordered stacking of actions before their initiation is a signal shared across sequences. Co-author Professor Neil Burgess explains: "To our surprise we also found that this preparatory pattern is primarily reflecting a template for position (first, second, third and so on) which can be reused across sequences – like cabinet drawers into which one can put different objects. This is a way for the brain to be efficient and flexible, by providing a blueprint for new sequences and staying organised."



**They also identified differences between neural patterns that lead to a more skilled, as opposed to a more error-prone, execution. By reviewing the brain impulses, they could see that when participants were producing the sequences correctly and accurately, with no errors, each action was spaced and ordered in advance of being executed. However, when mistakes occurred, the stacking of actions was visibly less well-defined. It appeared that the more closely bunched together and the less defined the actions were, the more participants committed errors in sequence production and timing.**





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**Bangor**

# Making art from recycled glass

Oseng-Rees Reflection has developed an innovative way of recycling glass bottles to make sustainable, decorative panels for architectural applications.

Once the contents of glass bottles have been consumed, they tend to be put in a mixed colour glass skip and collected for recycling. These bottles typically end up being downcycled to make low value products such as filter beds and aggregates. Oseng-Rees Reflection, based in Swansea, is now upcycling recycled glass bottles into a sustainable material that is aesthetically pleasing and suitable for interior and architectural installations, wall panels and tiles.

The company uses fusion as a manufacturing process, which is considered energy-saving in comparison to re-melting. The company's founder, Dr Tyra Oseng-Rees, has developed a unique firing process in which she controls the transformation of the glass into a crystalline material with minimal flaws and a smooth surface texture.

Although all glass bottles are made from the same soda-lime silicate glass and can appear to be the same type of glass in both shape and/or colour, they are not always compatible with each other during a fusion process. Fusing two pieces of glass together requires the use of heat. The material softens, but keeps its original shape, and subsequently bonds into one solid piece. The typical temperature for fusion is between 700-900 Celsius. Re-melting of glass uses temperatures between 1,200-1,500 Celsius, and is usually required to create a new homogenous batch for glass bottle manufacturing.

Following the company's alternative manufacturing process, the recycled glass material no longer looks or acts like glass.

It is opaque with a translucent appearance, and the material has become stronger and more stable. If the glass breaks, it does not shatter into hazardous shards but behaves like a stone or ceramic material. It is still hydrophobic and does not absorb water in the same way ceramic materials can do.

Testing was conducted to prove the material's strength and stability. The recycled glass material is made of 100 per cent glass, with no additives such as glue, resin or concrete, and can be recycled again after end of use. The material was designed to be sustainable, re-producible and suitable for mass manufacturing.

The process starts with collection of end-consumer bottles based on their colour and origin. The bottles are then cleaned, crushed and manufactured into large panels, before edge prepping and polishing takes place. Although all waste glass can be reprocessed, individual bottles are selected based on the intended aesthetics of the panel.

As recycling schemes are based around large-scale collections, bottles end up being mixed together and crushed before they



*"This new innovation is already changing people's perceptions of what recycled bottle glass can look like. When the public look at the material, they have rarely guessed its origin and it has been compared to a high-end stone material such as marble. The bar staff who did the colour separation also felt included and invested in the process, so it became a co-op. It has the potential to challenge attitudes towards waste separation and shows how aesthetically pleasing upcycled products can add to the circular economy."*

**Dr Tyra Oseng-Rees**  
Founder and Director  
Oseng-Rees Reflection

reach material reclamation facilities. By then the glass has lost, to some extent, its re-sale value for the bottle industry. The company has overcome this by reaching an agreement with local bars and pubs. Bar staff sort empty bottles into special bins by colour and they are then collected directly from the end-consumer, ready for processing.

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Swansea



# High-tech scanner to speed up airport security

Sequestim Ltd and Cardiff University have developed a super-sensitive passenger scanner for airports.

**Globally, around 12 million passengers travel by plane every day on 120,000 flights. Passenger numbers are expected to double in 20 years, putting airport security facilities under immense pressure.**

To reduce this pressure, Sequestim Ltd and Cardiff University scientists have collaborated to create a walk-through scanner that uses space technology to speed up airport security, while simultaneously revealing more hidden security threats.

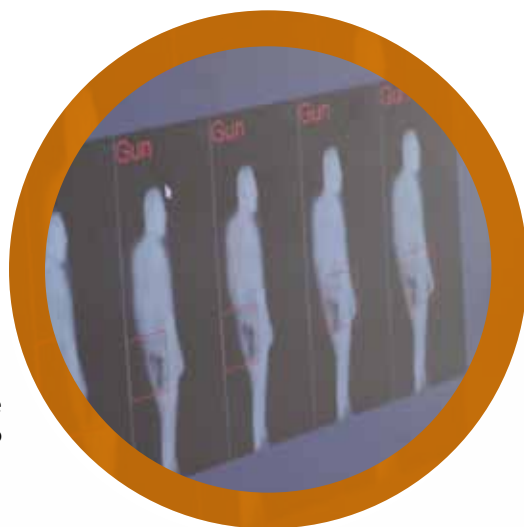
Originally developed to study the furthest reaches of the universe, the technology used in the scanner is so sensitive that it can see a 100W light bulb at a distance of 500,000 miles, which is twice the distance from Earth to the Moon. The scanner quickly 'learns' the difference between items that can and cannot be taken onto an aircraft, reducing the risk of false alarms which inconvenience passengers and slow down screening.

It also makes the security screening process quicker as it does not require passengers to keep still, in contrast with existing scanners, so they can simply walk normally through security without stopping or having to adopt a certain pose to be scanned. There is also no need for passengers to remove outer clothing such as coats, or personal items such as phones.

The scanner detects millimetre-waves, which are like visible light but at a wavelength more than one thousand times longer. Any concealed items show up very clearly as a shadow because the human body, due to its heat, acts like a light bulb for the scanner. No anatomical details show up in the scanner images, so there are no ethical issues. When the new technology is eventually used in the real world, the system is intended to be completely automatic.

As it is able to screen people on the move and takes only a few seconds to do its work, the technology has the potential to significantly cut queues at airport terminals. It could also improve the effectiveness of security and therefore help to keep passengers safe.

The ability of the scanner to reveal hidden objects has also attracted interest from other organisations including Border Force, which is responsible for the UK's frontline border control operations at air, sea and rail ports. In the future, such security could be used in other mass gathering places like railway stations, stadia and shopping malls. The camera was recently trialled at Cardiff Airport, so that key members of industry, the Centre for the Protection of National Infrastructure, the Civil Aviation Authority and other government bodies including Border Force could see the technology in action.



*It might be a year or two before we see the technology being used, but I am excited about the impact it might have. Perhaps in the near future we can enjoy the experience of travelling safely by air again, and not be forced to feel like we are all guilty until proved innocent when we go through airport security.*

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**Cardiff**

# Exploring the landscape of Wales

Living Wales is using earth observation data to provide valuable information about the landscape of Wales.

**T**hrough Earth observations, a new innovation project led by Aberystwyth University is capturing the state and dynamics of the Welsh landscape in near real time, historically and into the future.

Researchers involved in the Living Wales project are making use of a wide range of satellite, airborne (including drone) and ground datasets to routinely retrieve environmental variables and to generate land cover and change maps for multiple points in time. The aim is to make this detailed information on changing states of the Welsh landscape open and accessible to the public, increasing knowledge of past and present changes occurring across the country.

The project has been developed to encourage positive actions on the environment

for the wellbeing of current and future generations. Envisaged benefits include better measurement, monitoring and planning of the use of natural resources (such as soil, vegetation and water), thereby supporting their long-term maintenance and also enhancement.

Routine provision of information on landscape dynamics through Living Wales will benefit the agricultural and forestry sectors by offering new insights into how environmental change and management impacts on production. By retrieving biomass in vegetation across Wales, it provides information relevant to the national reporting of greenhouse gases and mitigation of emissions.



The project is expected to encourage investment in and uptake of high level computing facilities and commercial software development. These would support integrated analysis of Earth observation data, advancement of ground and airborne technologies, including mobile applications and drones, and development of new capability in space technologies and businesses. Increased commitment to research is also encouraged through development of monitoring capability and systems which could be relevant and transferable to other countries and regions as well.



Knowledge of past land cover and use can also be used to better conserve and restore faunal and floral diversity, and contribute to efforts aimed at reversing biodiversity declines. The historical assessments and real time monitoring of the distribution and condition of landscapes can further ensure resilience to human-induced and natural events and processes, including those associated with climate change.

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Aberystwyth

# New evidence of how Panama was born

Scientists from Cardiff University have found new evidence that volcanic growth was critical to the formation of Panama.

**The Isthmus of Panama is a narrow piece of land that lies between the Caribbean Sea and the Pacific Ocean and links North and South America. It is believed to have fully formed around 2.8 million years ago, but scientists are still unsure about the processes and timescales that led up to this.**

Up until now, many researchers have thought that it was created through the collision of two of Earth's tectonic plates, the South American Plate and the Caribbean Plate, which pushed underwater volcanoes up from the sea floor and eventually forced some areas above sea level. However, new field investigation, geochemical analysis and dating of old volcanoes in the Panama Canal area have now provided evidence that there was significant volcanic activity taking place during a critical phase of the Isthmus of Panama's emergence.

This research, conducted in close collaboration with the Panama Canal Authority, allowed scientists from Cardiff University to determine that several volcanic events took place in this area around 20 million years ago. The study

identified several (previously uncharted) volcanic centres in the Canal area, which formed in coastal to submarine environments.

The growth of volcanoes in the Canal area is thought to have been particularly significant for the formation because it was constructed in a shallow area of Panama, which is believed to have remained underwater for the major part of the geological history of the region. This suggests that the formation of the volcanoes along the Canal could have played an important role in the rise of the Isthmus above sea level.



*"The formation of the Isthmus of Panama is without doubt one of the most significant geological events to have happened on Earth, particularly because of its role in shaping large scale weather patterns, creating the Arctic ice cap and triggering widespread biodiversity across continents. We've provided evidence to show that volcanic activity was critical to its formation and responsible for many of the geological features that we see around the region to this day. Through our collaboration with the Panama Canal Authority, we are also now increasingly realising that better understanding this volcanic activity has interesting practical implications to help geotechnical management of the Panama Canal".*

**Dr David Buchs**

Lead author of the study  
Cardiff University

Scientists are keen to discover exactly how the Isthmus of Panama formed, given its significant role in shaping weather patterns and biodiversity across the world. Before a landmass existed between North and South America, water moved freely between the Atlantic and Pacific oceans, but this changed when Panama formed, forcing warm Caribbean waters northwards to form what is now known as the Gulf Stream, thus creating much warmer climates in north-western Europe.

The formation also played a major role in Earth's biodiversity, making it easier for animals and plants to migrate between the continents. In North America, the opossum, armadillo and porcupine all trace back to ancestors that came across the land bridge from South America. Likewise, the ancestors of bears, cats, dogs, horses, llamas, and raccoons all made the trek south.

The findings of the study are a significant step towards a better understanding of the volcanic evolution of the Canal area and how it helped form the Isthmus of Panama. In addition, the study is an important component of continuing collaboration between Cardiff University and the Panama Canal Authority to investigate how changes in old volcanic activity could be related to contrasted geotechnical properties of the Canal slopes.

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**Cardiff**

# Battery monitoring for non-technical users

Engineers at Tarian Technology have developed a new battery monitoring system that can be viewed remotely and requires no training to use.

**S**tandby batteries are widely used across industry to provide power when the mains electricity fails. Although they may seem rather low tech, they are used in high tech industries such as computer data centres to keep the internet running and even in power stations to keep the control and monitoring system running when the grid fails.



Example of standby batteries



A battery in a standby application can be made up of many strings of individual cells or blocs. Voltages can be in the range 48VDC up to 600VDC, with currents ranging from a few amps to thousands of amps, which can be dangerous for untrained staff. The battery is usually contained within a secured battery room, where only suitably qualified and experienced personnel are permitted entry.

Status monitoring the condition of batteries is vital to maintain their efficiency and efficacy. Nobody wants to discover that when the power has failed, the standby battery is useless. Although there are a number of monitoring systems currently available, they can be expensive and provide so much information that it needs a trained operator to understand the results.

Engineers at Welshpool-based company Tarian Technology were asked by Northern Industrial Battery Services (NiBS) to develop a battery monitor system that could be viewed from outside the battery room and would provide information in a form that even untrained people could understand easily. They identified three key parameters that need to be measured in a standby battery system – current, voltage and temperature.

The current of a battery can vary widely. While charging, the initial current flowing into the battery can be hundreds of amps. As the battery reaches a fully charged state, this current will go down to just a few milliamps. This is known as the ‘float’ charge. The current should never drop to zero as this could indicate that the system has become disconnected. When ‘on load’ the flow of current is out of the battery and can be thousands of amps.

The voltage of a battery should remain constant within close limits when on float charge. If it goes outside of this small range, it is an indication that something is wrong. Temperature is also important to the lifetime of the battery. Working a battery outside of its manufacturer’s nominal temperature specification will reduce its performance, as well as invalidating any guarantee.



Engineers developed sensors for each of the three key parameters. The voltage sensor is qualified to 1000VDC without exposing the operators to dangerous voltages. The current sensor can withstand the very high charge and load currents, but can still measure down to milliamps to detect disconnects.

The temperature sensor is small enough to slip between the batteries of a battery pack to get a good reading of the temperature. These sensor values are displayed on a remote screen outside the battery room and are colour coded so that warning levels and alarm levels are instantly visible. This means that anyone can read the display and know either that the battery is in good health or that there is a problem, which can then be reported.

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**Welshpool**