

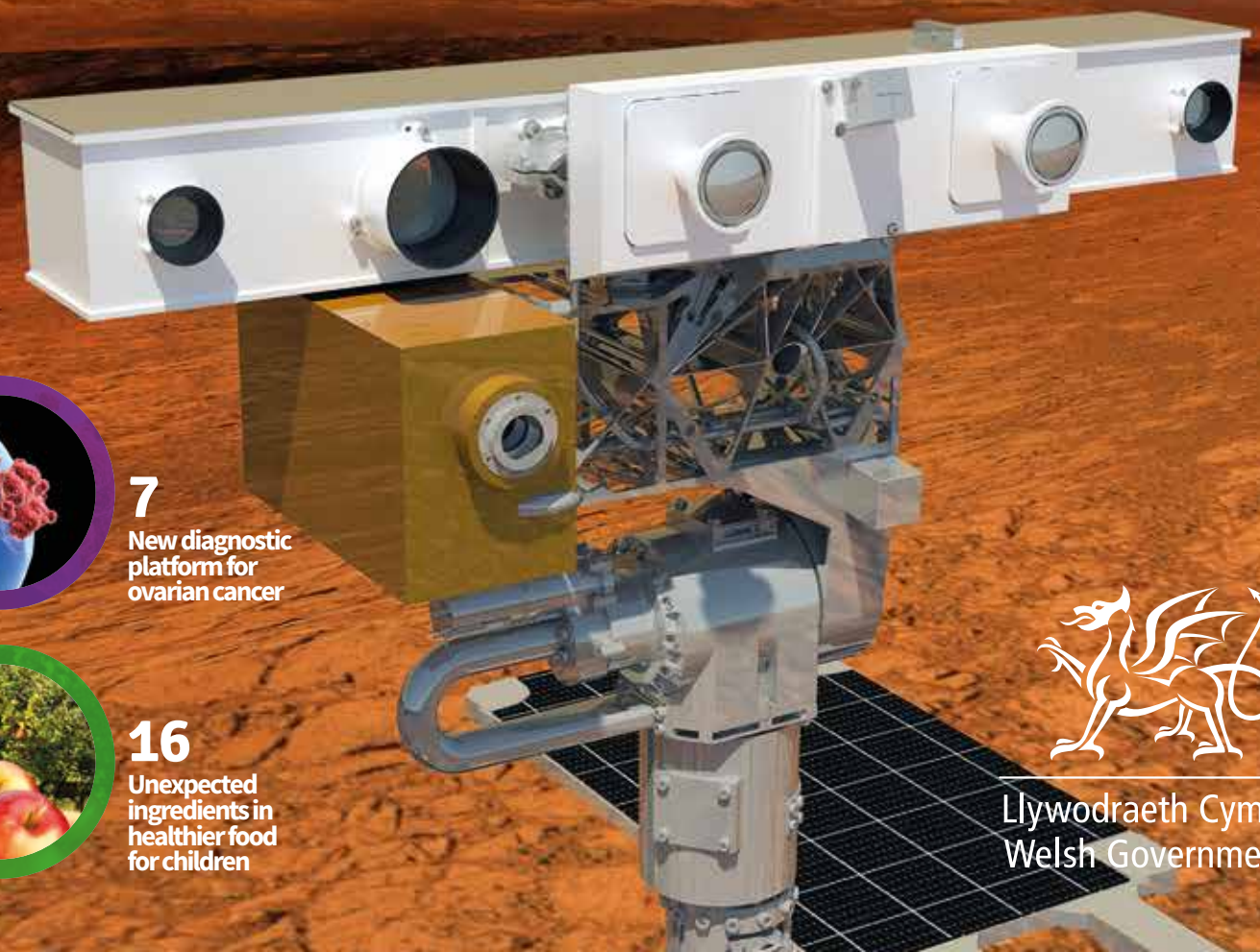
THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

# advances

WALES

## Welsh innovation for Mars mission

Computer generated visualisations produced by Aberystwyth University are helping scientists to plan for a rover's mission to Mars



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## “Every once in a while a new technology, an old problem and a big idea turn into innovation.”

Dean Kamen, Inventor/Engineer

Advances Wales explores new innovations in science, engineering and technology around Wales.

This edition features digital technology in Wales being used to plan for a mission to Mars (pages 12-13). Computer generated images and an interactive virtual model at Aberystwyth University are helping scientists to optimise the design of their rover before it is launched.

Also highlighted in this edition are Welsh companies obtaining vital agricultural data from satellites (pages 14-15) and improving the nutritional value of children's food with unexpected ingredients (pages 16-17).

Meanwhile, new medical innovations include a device for easier screening of a common heart condition (page 6), a diagnostic test for ovarian cancer (page 7) and technology for improved monitoring of epilepsy (page 8).

In the world of engineering, Welsh companies are putting innovative fire dampers to use in Chernobyl (page 10) and developing advanced technology to make 3D printing simpler (page 11). This edition also features new technologies that benefit the environment, including a method of recycling a type of paper that usually goes to waste (page 20).

This edition, and previous editions, of Advances Wales can also be found online.

**Sophie Davies**  
Editor

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## Digital system forecasts floods

**Method4 has created a new system for National Resources Wales to better forecast and plan for floods.**

The Flood Forecast Web Service provides up-to-date forecast data and flood warnings for Wales 24 hours a day. Designed to replace an aging forecast system, it brings together data from multiple sources and presents it in an easy-to-view format, allowing quicker, more informed decisions to be made.

Data is collected by Natural Resources Wales from over 200 locations, covering towns and cities, rivers and the coastline, and transmitted directly to a fully cloud-hosted platform. The data is then processed by forecasting specialists, who use it to generate a series of forecasted scenarios which are exported into the web service. This is able to extract, crosscheck and process the data for immediate display to NRW duty officers across Wales.

By keeping the platform and the web service separate, duty officers can have fast and direct access to the data that is most important to them, with no unnecessary complexity. Intuitive graphical presentations are able to highlight key data and make it easier to understand. A built-in messaging



system ensures that the latest data is available within seconds and that people on-location can be alerted to specific areas of interest by the forecasting head office.

Through the same interface, it is possible to see the big picture covering the whole of Wales, as well as the intricate details of individual forecasting stations, enabling a better understanding of current and future situations. Additional data from third parties such as the Met Office is also brought into the system

and can be used in the decision making process alongside the core flooding data.

As a result of the new system being implemented, decisions can be made quicker and more confidently as to whether flood alerts need to be issued around Wales. The Flood Forecast Web Service is playing a key role in keeping communities across Wales safe from flooding.

 [www.method4.co.uk](http://www.method4.co.uk)

## Virtual reality aid for medical procedures

**MedaPhor has been awarded funding to develop NeedleGuide, a new augmented reality imaging device for ultrasound-guided needling.**

Doctors use interventional needling in a variety of medical procedures including tissue biopsy and cannula insertion. For many of these procedures, the National Institute for Health and Care Excellence (NICE) has recommended that ultrasound guidance should always be used.

NeedleGuide, which is in the early stages of development, combines existing technology developed by MedaPhor, with expertise brought through the company's recent acquisition of Intelligent Ultrasound Ltd.

The augmented reality headset projects the ultrasound view over the patient's anatomy, highlighting the pathway the needle needs to follow to the target. It then automatically tracks the needle tip to ensure that the operator is always

aware of the needle's position in relation to the key anatomical structures.

Key aims are to minimise the potential for user error, thereby improving patient safety, and offer the opportunity for considerable savings to hospitals. The new funding will help with the development process.

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



*“NeedleGuide has enormous potential to improve patient outcomes, as well as reduce the time and cost of these difficult procedures. We believe that this technology could reduce the cost of needling to all hospitals and have a significant impact globally as a new and world-leading digital health technology.”*

**Nicholas Sleep**  
MedaPhor



Llywodraeth Cymru  
Welsh Government

PHOTOGRAPHY Sourced from organisations featured, their representatives, and istock.



## New discovery in preventing organ fibrosis

**Researchers at Cardiff University and the Wales Kidney Research Unit have discovered a potential new method for preventing the process that causes scar formation in organs.**

The new research, in collaboration with the University of Exeter and the Cleveland Clinic Lerner Research Institute, involves altering the cells responsible for wound healing and tissue repair. It could lead to treatments that would prevent and even reverse organ fibrosis, which is a major cause of illness and death around the world.

During their laboratory tests, the research team found that a protein previously thought to simply break down sugar chains can be used to make alterations to the RNA of cells responsible for wound healing and tissue repair, radically affecting their function.

They discovered that the protein Hyaluronidase-2 can bind to RNA in a cell and alter its activity. In the case of cells responsible for fibrosis and scar formation, this technique can potentially be used to stop them from producing scar tissue. This opens up new research avenues in the study of fibrosis.

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

A particular interest for the Wales Kidney Research Unit is the prevention and/or reversal of chronic kidney disease, which currently cannot be reversed. Many patients ultimately require dialysis or kidney transplantation, and these treatments are associated with significant risks and complications. The next

phase of the research will be to further investigate the structure of Hyaluronidase-2 to identify what makes it travel to a cell nucleus and influence genetic material. In the future, the team hopes to develop synthetic proteins that mimic the beneficial effects of the protein for development in therapeutics.



## Interactive character helps children speak up

**Evoke Education has developed a computer-generated character to help adults better communicate with children.**

Working with the Centre of Excellence in Mobile and Emerging Technologies (CEMET), which is based at the University of South Wales, the company has created a system which allows adults to talk to children via 'Moe the Monkey'.

In one room, the adult wears a headset that enables them to speak as Moe and they can control the character's emotions with a remote control, making Moe smile or frown. Moe appears to the child on a screen in another room, moving and talking in real time. Motion capture technology picks up the operator's movements and a screen allows them to see and hear the child, allowing a conversation to occur.

The idea is that children will feel more comfortable communicating with the computer-generated monkey than with an adult. As a result, Moe could be put to use by the police as a way of more easily gaining statements from child witnesses.

The interactive character also has potential as a learning tool in schools. Early trials have shown that pupils respond well to Moe and that many were excited to listen to what it had to say. Results demonstrated that pupils who took part in the trials were eager to carry out tasks that Moe set for them and were able to retain information that it had given them when tested later.



*"The children see it as 'woah, I'm talking to a monkey', whereas actually they're talking to the teacher, the social worker, the policeman or anyone else who needs to engage with them. We've spoken to psychologists about it and they've said that children would really engage, open up and say things they wouldn't say to an adult."*

**David Hinton**  
Evoke Education

 [www.evoke-education.com](http://www.evoke-education.com)

### IN BRIEF

#### Opening of steel research and innovation centre

A major step forward has been taken to future-proof steel in Wales and the UK with the opening of a new Steel and Metals Institute at Swansea University. The world leading research and innovation centre will work in collaboration with industry and other UK and global centres of excellence to create a steel and metals industry fit for the 21st Century. Swansea University, with its long history of steels and metals research and its proximity to primary steel making in Port Talbot is a natural home for innovation in this area. The Institute has been created as a result of the strategic partnership between Tata Steel and Swansea University. Tata has donated research equipment and is providing 45 industry R&D staff to work alongside 20 new University research staff.

#### Rescue dog gets 3D printed leg

The Wales Centre for Advanced Batch Manufacture (CBM), established by the University of Wales Trinity Saint David, has made a 3D printed leg for a dog that could hardly walk, giving him a new lease of life. Rescue dog Duke, an Irish retriever, was born with a birth defect in his front right leg and faced having it amputated. Using CT scan data of the deformed limb, medical engineers at CBM were able to capture 3D data specific to its complex geometry, which ensured the design would be a perfect, bespoke fit and maximise comfort. Following initial sketches and 3D CAD modelling, prototypes were made and tested on the dog so that the final design could be refined. Thanks to his new state-of-the-art prosthetic, Duke can now walk on four legs for the first time.

#### VR used for cystic fibrosis treatment

Virtual reality headsets are being used to help people going through treatment for cystic fibrosis. The first trial of its kind in the UK is being carried out at Llandough Hospital in Vale of Glamorgan. Cystic fibrosis affects around 400 people in Wales and the trial at the Wales Adult Cystic Fibrosis Centre aims to reduce pain levels and anxiety among sufferers. Patients are immersed in safari experiences and can explore their surroundings as a distraction therapy. There is also a virtual cycling experience to motivate patients to exercise in the hospital as part of their treatment. The Centre is now working with Swansea University to create games that patients can play against each other, and the company behind the project, Orchard, is planning to use wearable technology to monitor how a patient is feeling and then adjust the VR experience for maximum benefit.

#### Funding for software firm

Cardiff-based software company Paperclip has secured more than £500,000 of funding from backers such as the Development Bank of Wales and business angel investors including the founder of GoCompare. The company's software platform allows users to buy, sell, swap and give away second-hand goods with nearby Paperclip users. They also have a business-to-business idea that they believe could change the enterprise marketplace industry. Paperclip's chief executive Rich Woolley said: "Our marketplace platform is growing fast, with continued user uptake and enterprise partner releases doubling by the month, alongside a growing pipeline with some big names. 2017 was a big year for us; we grew from three of us working in a flat to a team of 16. We're all excited to make 2018 another record breaking year."

#### Wave energy prototype unveiled

Swansea-based Marine Power Systems has unveiled a quarter-scale prototype of its new device, WaveSub, which is designed to harness energy from ocean waves. The company has been developing the technology over the past nine years and can now move on to sea-based trials. The full-scale WaveSub device will measure 100 metres long and generate 5MW of electricity, which is enough to power around 5,000 homes. Dr Graham Foster, Chief Technology Officer of Marine Power Systems, said: "The WaveSub is the only device that currently addresses what we see as the four key challenges of wave energy generation. Our techno-economic forecasting suggests that in time, the WaveSub will be in a strong position to compete with other renewable energy technologies including offshore wind."

#### Bringing advanced medical therapies to Wales

A health consortium, jointly led by the Welsh Blood Service on behalf of NHS Wales and the National Institute for Health Research Birmingham Biomedical Research Centre, has been awarded £7.3 million of funding to ensure that more patients benefit from a new generation of breakthrough therapies. £1.5 million will come directly to NHS Wales and £550,000 to Trakcel, a Welsh software company with scheduling/tracking software for advanced therapies. Advanced treatments, such as cell and gene therapies, show great promise for patients with chronic and terminal conditions that currently cannot be cured. Unlike conventional medicines, these new approaches often aim to selectively remove, repair, replace, regenerate and re-engineer a patient's own genes, cells and tissues to restore normal function. As part of the project, the first advanced therapy treatment sites in Wales will be established within Abertawe Bro Morgannwg and Cardiff & Vale University Health Boards.

#### First nuclear research institute in Wales

The first nuclear research institute in Wales has opened at Bangor University. The Nuclear Futures Institute has been established as part of the Sêr Cymru programme, which aims to attract world-leading researchers to Wales. Professor Jo Rycroft-Malone, Pro Vice-Chancellor for Research at Bangor University, said: "We are very excited about the potential that the Nuclear Futures Institute will offer for the University, our future students, and also to businesses active in the nuclear and other energy-related areas who are being increasingly attracted to North Wales. We also will be launching degree programmes which will meet regional needs within Wales and in the wider UK energy sector and will be highly relevant to other advanced manufacturing industries."

#### Awards success for telescope projects

Researchers at Glyndwr University's OpTIC Technology Centre in St Asaph are celebrating a double awards success for their work on two major telescope projects. At Insider's Business and Education Partnership Awards, the Precision Optical Systems Group from Glyndwr Innovations won the Research and Development Award. In collaboration with Liverpool and Durham Universities, they have developed technology for the fabrication of low-cost mirror segments for the Cherenkov Telescope Array, which will be the world's largest and most sensitive high-energy gamma-ray observatory once completed. The team also won the New Product Award for their ultra-lightweight, high-resolution telescope for ground imaging applications. Gwylwr, as the final telescope product is known, is designed to be mounted on a High Altitude Pseudo Satellite platform to deliver high-resolution images from high altitudes.

#### Collaboration for electric vehicle battery development

The Centre for Automotive and Power System Engineering (CAPSE) at the University of South Wales is collaborating with Ricardo on electric vehicle battery systems research and development. The collaboration will provide Ricardo with access to the facilities and the support of the major investment in battery systems development by CAPSE, while also enabling the University to benefit from Ricardo's knowledge and experience of the challenges of both research and production-intent programmes. Jonathan Williams, director of CAPSE, commented: "Our mission is to support businesses and other organisations to develop the next generation of low carbon technologies, and in doing so support the creation of new jobs and economic opportunities. Ricardo will bring valuable industrial experience of the development of electric vehicle systems and we look forward to working with them."

#### Funding for digital health startup

Caerphilly-based healthcare company Signum Health has received £400,000 of backing from the Development Bank of Wales. The company, which launched in 2016, uses artificial intelligence and cloud-based technology to deliver remote health care and support within local communities. The company is headed up by primary care and public health expert Victoria Norman, who has first-hand experience of GP surgeries. This is the second round of investment the company has raised and brings their total funding to £600,000. Chief executive Victoria Norman said: "This latest round of investment will help us to take Signum Health to the next stage of its development. We are already helping GPs surgeries around the UK and we can't wait to see Signum Health used in every surgery in the country."

# Simplifying detection of a common heart condition

Melys AFS has developed a device for easier screening and detection of the common heart condition atrial fibrillation.

**Atrial fibrillation (AF) is a heart condition that causes an irregular and often abnormally fast heart rate. It carries an increased risk of stroke and the global cost of AF associated stroke is significant. In the UK alone, around 1.2 million people have this heart condition.**

This risk of stroke can be reduced through the use of anticoagulant medication, but many AF sufferers are not diagnosed or treated until after a stroke has already occurred. Screening is recommended on an opportunistic basis through manual checking of the pulse. However, this is often not done and there is

also a level of human error that can result in inaccurate findings. Once a patient has been screened using this technology, the final diagnosis is made using a 12-lead electrocardiogram.

Whitland-based company Melys AFS has developed a screening device which can detect AF with just 8 per cent false positive results and no false negative results. The screening technique involves a finger-sensor instrument, as used in pulse oximetry tests, that utilises the principle of photoplethysmography. This means that it is non-invasive and takes measurements at the skin's surface.

A patient's pulse rhythm is measured by fitting the sensor around the tip of their index finger and recording the pulse waveform pattern for 15 seconds. A 'score' is then given, indicating the likelihood of the patient having AF. The recorded pulse waveform is analysed using specifically developed software and compared against a 'perfect' pulse waveform. Through mathematical analysis, the software measures the deviation of the pulse from this perfect waveform and presents this as the 'score'.

The device can be used in any environment where a patient is able to sit comfortably without moving. A hospital visit is not



The technology is able to detect AF with an accuracy of 92 per cent, with the remaining 8 per cent being mostly other heart rhythm issues of less significance which the technology also detects. If the device detects AF in a patient, the next stage would be an electrocardiogram for confirmation, followed by advice on treatment options to reduce the risk of stroke.

required, as patients can be tested in a GP surgery, a pharmacy or even at home. Its simplicity also means that it can be used without the supervision of medical or nursing staff, which reduces costs, increases opportunity and eliminates human error. As well as a desktop monitor, the device is now also compatible with phones and tablets when used with a bluetooth finger sensor, making it even simpler to use and cutting costs further.

By making AF screening easier and more accessible, the technology has the potential to increase early detection of the condition and therefore prevent many AF related strokes.

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Whitland

# New diagnostic platform for ovarian cancer

Scientists from Swansea University have developed a graphene biosensor-based diagnostic test to evaluate ovarian cancer biomarkers.

**Epigenetics refers to a natural biological process involved in controlling the expression of genes. Failure to correctly control a gene can result in the development of diseases such as cancer. Therefore by identifying certain epigenetic marks in patients, signs of cancer can be detected.**

Dr Sofia Teixeira, a Research Fellow in the College of Engineering and the Centre for NanoHealth, has worked with the Reproductive Biology and Gynaecological Oncology research group in Swansea University Medical School to develop a novel diagnostic device. It is designed to enable the selective detection of epigenetic marks linked with early stage ovarian cancer development. Compared to what is currently used in the hospital environment, this test will be quicker and less expensive, and it also has the advantage of being portable.

The new device makes use of a highly sensitive graphene-based Electrochemical Impedance Spectroscopy (EIS) sensor. This enables rapid analysis, is compatible with miniaturisation

and can be manufactured at industrial scale using screen printing technologies.

To test a patient's sample, it is placed on the EIS sensor, completing a circuit. A current is then run through this circuit and the resistance is measured. This value is compared to a bank of already defined biomarkers, which can identify if anything in the sample is a cause for concern. Multiple samples are taken for comparison to ensure accuracy.

Bringing together the fields of nanoscience and clinical diagnostics, the technology takes advantage of the enhanced sensitivity capabilities of EIS compared to current testing methods. It is hoped that it will provide a more accurate way of diagnosing ovarian cancer from biopsies and blood samples, and offer a novel method for monitoring patient response to certain drug treatments.



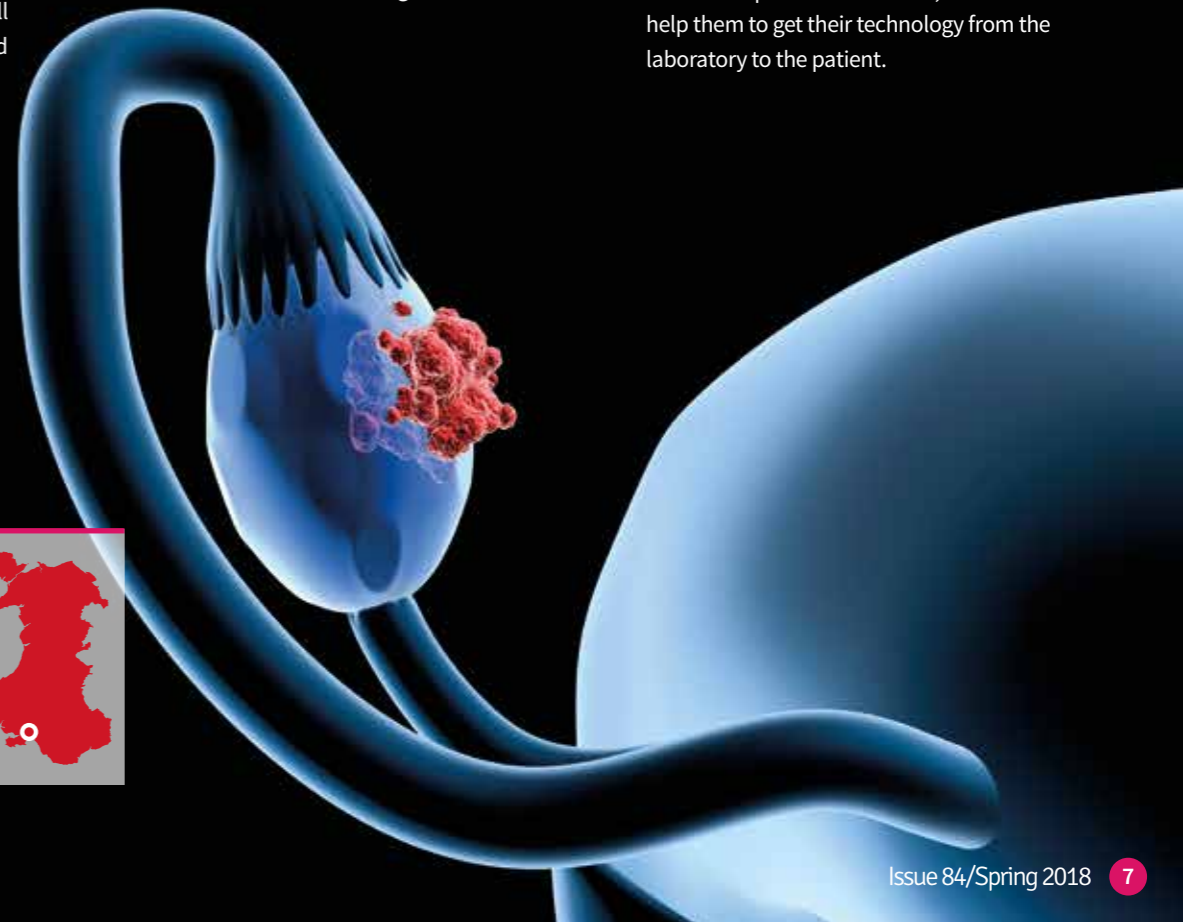
A technical expert is not required to operate the test, which makes it more convenient to use and allows costs to be reduced. Its portability also allows for greater flexibility in terms of patient monitoring after diagnosis.

With these advantages, the device will be able to improve the process of diagnosing ovarian cancer, benefiting both clinicians and patients. The Swansea research team, together with partners at the International Iberian Nanotechnology Laboratory in Portugal, recently won the i3S Hovine Capital Health Innovation prize for their work, which will now help them to get their technology from the laboratory to the patient.

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Swansea



# Technology to improve management of epilepsy

Digital health technology from Aparito is being used to improve the way in which epilepsy is monitored and managed.

**Epilepsy is one of the most common neurological disorders worldwide, affecting over 65 million people. Research has shown that the prevalence of epilepsy in low to middle income countries is substantially greater than in more resourced countries and that it mostly affects younger people.**

Wrexham-based company Aparito is using a combination of mobile health solutions and wearable devices to collect valuable data from children with epilepsy. The technology is currently being put to use in South Africa, where there is a lack of such data and resources for management of epilepsy are extremely limited. By gathering and analysing the new data, strategies could be developed to optimise care for children suffering from epilepsy in low-resource settings.

The company's mobile health solution allows children with epilepsy and their parents to input health data via a disease-specific app,

giving them a platform to share important information about their condition. For instance, the app can be used to report seizures, record that medication has been taken and log general observations on quality of life.

When clinicians or researchers want to gather data from patients for monitoring purposes, this is typically done at hospital. However, these appointments only provide basic snapshots of a patient's health. Seizures are also particularly difficult to capture during hospitalisation. Aparito's platform provides clinicians and researchers with a more in-depth insight into daily life for patients, outside of a hospital setting. By digitally connecting patients to their clinicians, it also means that fewer in-person appointments are required, saving time and resources.

To collect thorough information, a paired wearable device is used for remote monitoring in real-time. It operates constantly, passively recording biometric data from the wearer. The data captured by the device can be

tailored according to disease, and in the case of epilepsy, can explore seizure detection and events leading up to a seizure.

It is often challenging to capture consistent, reliable health data from children, because if a monitoring device is bulky, uncomfortable or difficult to use, the child will simply reject it. This trend has a negative impact on research and on the outcomes of clinical trials. Aparito has introduced wearable devices that are smaller and more attractive to wear, with a longer battery life and no input from patients required. Therefore the devices are easier for children to use, so more accurate results can be gained.

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Wrexham



# Rainstorm generator explores impact of climate change

A scientist from Cardiff University has created a rainstorm generator which can simulate extreme rainfall conditions under a variety of climate change scenarios.

**E**xtrême, sudden rainstorms, also known as convective precipitation, are generated when the Earth's surface is sufficiently heated that moisture rises quickly into the atmosphere and condenses very rapidly.



Convective precipitation plays a key role in controlling the amount of water running into rivers and the flow of the rivers themselves, as well as the amount of water that is supplied to vegetation and human populations. It can also lead to flooding in populated areas, which can have disastrous consequences. However, little is known about how convective precipitation will be affected by future climate change.

To address this challenge, Dr Michael Singer from Cardiff University's School of Earth and Ocean Sciences collaborated with Dr Katerina Michaelides from the University of Bristol to develop a model called STORM. It is able to simulate individual rainstorms over a particular river basin, considering a number of different climate change scenarios over many decades. The model can be applied to any area, using information on where rainfall previously occurred and how much fell on a per-minute basis.

In their study, the duo applied the model to the Walnut Gulch Experimental Watershed in Arizona, which has extensive long-term historical rainfall data. A watershed is an area of land that separates waters flowing to different rivers, basins or seas.

The team found that over the last six decades there had been an increase in rainfall within the region overall, but that each storm was less intense and less water fell. Therefore the water was coming in smaller, more frequent bursts. This lower intensity rainfall implied less runoff over the surface and consequently a decline in runoff over the whole basin.

STORM's results for such a scenario of climate change agreed with the historical data that there had been a decline in runoff within this ephemeral stream, which is a stream that flows only briefly during and following a period of rainfall in the immediate area. These results go against previous notions of how rainfall should respond to atmospheric warming.

It is hoped that STORM will enable scientists to better understand and predict the effects of climate change and help to prepare for the

extreme consequences of large rainstorms, such as flooding. The research team is now planning to apply the model to other areas, in order to investigate how climate change will affect the magnitude and frequency of river runoff.

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Cardiff



# Providing safety in Chernobyl

Flamgard Calidair has developed innovative fire dampers to help protect the world's largest moving structure in Chernobyl.



**In the aftermath of the 1986 Chernobyl disaster, a structure made of concrete and steel, known as the sarcophagus, was quickly built in order to contain the worst of the radiation. Almost 20 years later, the Ukrainian government approved a design for a new structure which would offer a more long-term solution to the problem.**

To avoid exposing workers to radiation, it was decided that the new structure should be built away from the disaster site and then moved into position, over the sarcophagus, once complete. The 108m high, arch-shaped Chernobyl New Safe Confinement is now the world's largest moving structure. It is designed to ensure that the remains of the disaster site are safe and environmentally secure for at least 100 years. It will also facilitate monitoring and demolition of the original sarcophagus via entry points, engineering areas and access to the site inside.

Pontypool-based manufacturer Flamgard Calidair was selected to provide innovative



fire dampers for the Chernobyl New Safe Confinement. Fire dampers are installed in most commercial, industrial or large-scale residential buildings with ducted ventilation systems, as they prevent the spread of smoke and fire throughout the entire facility via the ducted system by automatically snapping shut. In high-risk facilities with oil and gas, nuclear and petrochemical applications, these fire dampers are particularly vital safety devices.

Working with Swansea University, the company explored the potential of alternative



*"The story of Chernobyl is one of history's most tragic. But while the neighbouring town of Pripyat is still an unoccupied ghost town exclusion zone, there is some hope for the future of the Chernobyl site with this project. In engineering terms, there can be few live projects in the world right now that are as important and as ambitious as the New Safe Confinement."*

**Steve Edwards**  
Managing Director  
Flamgard Calidair

materials to endure high temperatures. The use of 3D modelling and Computational Fluid Dynamic modelling allowed them to theoretically test various options before real world fire and leakage testing verified performance expectations.

The new fire dampers are made up of advanced material combinations to achieve a better thermal insulation performance, while also maintaining ultra low leakage rates and structural integrity for a long lifespan. If, in a worst-case scenario, a fire were to break out in a contaminated area, the heat, contaminants, smoke and gases would all be contained within that area due to the low leakage and thermal insulation properties of the dampers.

Over the course of the huge multinational project, Flamgard Calidair has made significant technological advances in the way it develops fire dampers, many of which will be applied to future nuclear projects in the UK and abroad.

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Pontypool



# New 3D printing technology on track

ITERATE is developing an advanced technology to make 3D printing simpler and more cost-effective.



**New technology from product development company ITERATE will combine deposition of polymer-based materials with electrically conductive inks. This will remove the need for wires to be used in complex electro-mechanical product assemblies.**

There is currently a need for 3D printing machines that are able to accurately and reliably deposit polymer and conductive inks with production-grade results. Existing 3D print technology is based on a Cartesian co-ordinate system, which deposits one layer of material on top of another in a single plane to create a 3D object. However, this method has limitations that can affect surface finish, geometric tolerance and robustness.

The Chepstow-based company is working with industry and academic partners including Printed Electronics Ltd, C Enterprise and the University of Warwick to develop the new technology. Once available, it will be used across a wide range of sectors, from aerospace and automotive to medical and consumer applications.

In the healthcare sector, 3D printers are currently being used to produce prosthetics, but these can be difficult to assemble. The new technology will allow conductive tracks to be printed within the prosthetic build, which means that it will be possible to produce a near-functioning unit that could be used almost straight off the print bed. By replacing wires with conductive tracks, product weight is reduced and assembly is made easier, reducing product cost in the long run.

The technology will also provide an opportunity to 'pick and place' electronic modules when a part is being built. This means that such electronics can be fully encapsulated within a 3D printed object, offering a greater level of stability and reliability.

While existing 3D printers use a three-axis build platform, the new technology will use five-axis. The introduction of the additional axis will enable forms to be created that are far more complex and have a higher structural integrity with a better quality finish. These attributes make the technology more suitable as a manufacturing process rather than a prototyping process.



*"3D printing is still a fair way off becoming a mass production process. This new technology in development will take us one step closer, and could help accelerate growth in many sectors and industries."*

**Gethin Jones**  
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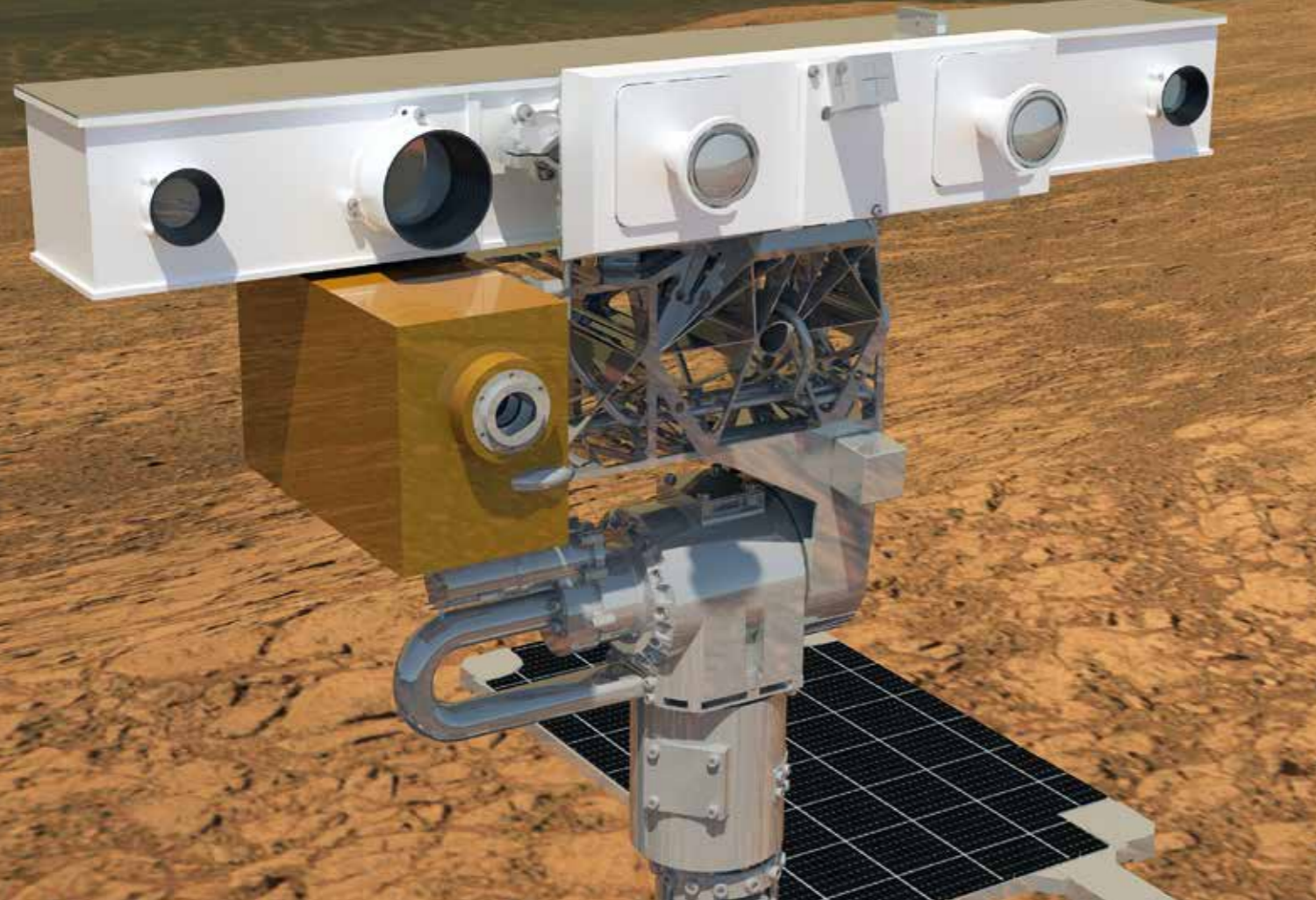
# Virtual model for Mars mission planning

Computer generated visualisations produced by Aberystwyth University are helping scientists to plan for a rover's mission to Mars.

The 2020 ESA / Roscosmos ExoMars mission will see a rover travel across the surface of Mars to search for signs of life and take high resolution colour images of its findings. Computer generated images and an interactive virtual model created by Dr Helen Miles, a computer scientist at Aberystwyth University, are now aiding scientists to optimise the design of the rover and prepare for its mission.



The Rover Inspection Mirror



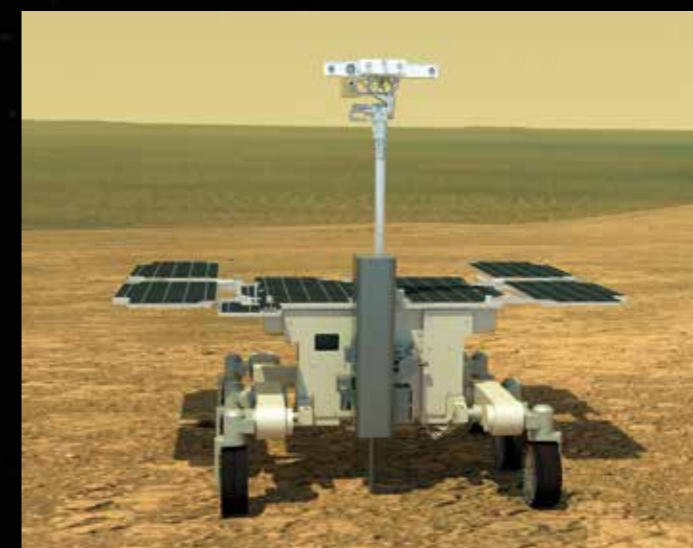
Once complete, the ExoMars rover will be fitted with an advanced panoramic camera system, called PanCam, led by University College London's Mullard Space Science Laboratory which includes parts developed and manufactured by Aberystwyth University. The high-tech camera (which featured in Advances Issue 70) will capture highly detailed 3D models of the surface of Mars as scientists search for signs of life. From its high vantage point above the rover, the camera will also be used to help mission planners navigate the surface of Mars.

PanCam will be able to see parts of the rover which would otherwise be hidden by using the Rover Inspection Mirror. For instance, when the rover's drill is collecting a sample of

Martian rock, the mirror allows the camera to see where the sample is collected, underneath the drill box. The mirror was developed at Aberystwyth University, along with several other flight hardware items including a calibration target for colours and fiducial markers for geometry, which will be crucial for the in-situ calibration of the camera.

Dr Helen Miles, from Aberystwyth University's Department of Computer Science, has created a virtual environment in order to inspect the rover and generate simulated images from the camera. These images can predict, with a high degree of accuracy, which parts of the rover will be visible via the camera.

The computer generated images enable the mission team to make sure all of the hardware is placed in optimum locations on the rover, and to plan how the hardware will be used during the mission. As a result, they can check for and avoid potential problems at this early stage, in advance of the launch, rather than encountering them when the rover is actually on Mars.



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Aberystwyth

# Obtaining agricultural data from satellites

**Technology developed by Environment Systems is using data from satellites to improve agriculture in Latin America.**

**L**ed by Aberystwyth-based company Environment Systems, E04cultivar is an international collaborative project involving partners in the UK, Peru and Colombia. The project is part of the UK Space Agency's International Partnerships Programme, which puts space knowledge and expertise to use in developing countries.

In Peru and Colombia, agriculture represents between 10 and 15 per cent of GDP and employs up to 30 per cent of the population, meaning it is a key driver of development. However, agricultural supply chains in this part of the world face complex production challenges, ranging from agronomy issues to lack of resilience in the face of climate change.

Although sources of satellite imagery already exist in the region, it has not been possible to access and process the data necessary to deliver agricultural data to growers. This is because processing satellite imagery is technically complex, requires large-scale data handling and needs to be done to a consistent, repeatable standard.

Environment Systems has developed a cloud-based service that is capable of processing satellite imagery and providing in-depth agricultural data for immediate use. Growers currently rely on a limited number of staff to monitor very large areas of crop through

periodic in-field checks. With the new digital system, they have access to data, maps and images that they can use for remote crop monitoring. They can view information about a particular growing area, a farm or even an individual field.

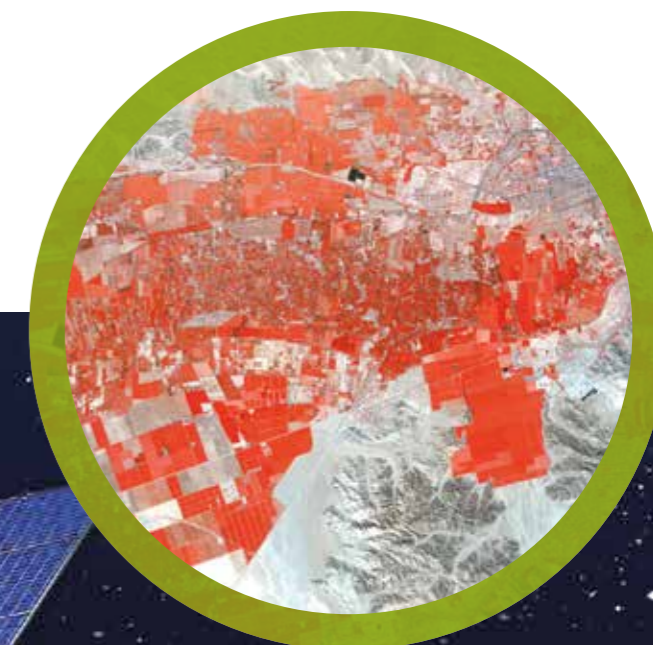
sustainable. As a result, they will be able to increase production and meet supply chain needs, leading to economic growth.

As part of the project, three Latin American students are studying PhDs in UK partner universities, including two at Aberystwyth University, conducting research designed to support the future development of the satellite data services.

By gaining access to reliable, timely data about their crops, growers can make more informed decisions and adapt their farming practices to be more effective and



The analysis-ready satellite data enables growers to better monitor and measure agricultural productivity, environmental activity and changes over time. The project is exploring the value of this system for crops such as asparagus, grapes, potatoes and bananas by enabling new ways of regularly monitoring aspects of crop status, such as crop vigour, or signs of plant stress. It is also enabling measures of production status, including growth stage, harvest timing and yield estimates.



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**Aberystwyth**



# Unexpected ingredients in healthier food for children

Welsh companies are developing innovative methods to improve the diets of children and tackle childhood obesity.

**By the age of 11, more than 40 per cent of Welsh children are either overweight or obese. Research shows that the vast majority of obese children tend to grow up to become obese adults, increasing their risk of developing serious conditions in adulthood including heart disease, cancer and type 2 diabetes. In addition to these health risks, obesity also has a significant impact on the economy.**

Under the Small Business Research Initiative (SBRI), Pennotec and Bug Farm Foods are undertaking two projects with the aim of making food and drink healthier for children by reducing levels of salt, sugar and saturated fat, as well as increasing vitamins, minerals and fibre.

By-products of food and beverage manufacture that are fit for human consumption can be used as the basis of innovative food ingredients. Pwllheli-based company Pennotec is exploring the potential of such by-products to improve the nutritional composition of foods that are particularly enjoyed by children whilst reducing cost.

The company is collecting and preserving apple pomace, a by-product of apple juice and cider production operations which is available in large quantities in Wales and has until now been overlooked as a food ingredient. This raw material is now being evaluated for its potential to replace certain high-calorie ingredients and enhance fibre content in



Apple pomace

popular school menu food items, ranging from meat and gravy to cakes and sauces.

A key aim of the project is to make food and drink healthier and cheaper, without sacrificing flavour. It also intends to address the global issue of food wastage by making use of resources which are usually disposed of, bringing a number of environmental and cost benefits.

The project is being undertaken in collaboration with Bangor University's BioComposites Centre, Coleg Menai's Food Technology Centre and CyberColloids Ltd of Cork.

Bug Farm Foods, based in Pembrokeshire, is conducting research into the emerging industry of insects as food. By 2050, meat production is predicted to double due to the Earth's growing population, but this amount of livestock would have a significant negative impact on the environment. As a result, there is a global need for alternative protein sources, and insects are a possible solution.

Many insects breed quickly and require very little space or water, which makes insect farming highly sustainable and efficient. They can produce an equivalent amount of protein to beef with 25 times less feed and a fraction of the water and energy.



Since insects are nutritious and healthy, insect protein is especially suited to children. Insect powder can contain more than 65 per cent protein, has the perfect balance of omega 3: omega 6 fatty acids, and contains all nine essential amino acids. It also has good iron content and is low in sugar and extremely low in saturated fat.

The team at Bug Farm Foods are investigating the potential of food products aimed at children which are made with insect powder. They are examining insect species combinations and developing recipes, with a focus on improving nutrition while also reducing fat, sugar and salt and increasing shelf life. As insect species have different nutritional profiles, they are seeking to identify the optimum species mix.

It is hoped that insect powder can be incorporated into certain food products, which can then be trialled in a select number

of schools with child, parent and catering involvement. To ensure that the new food products are appealing to children, the company is working to optimise the taste and texture in addition to making them appear fun and original.

Following successful feasibility studies, Pennotec and Bug Farm Foods have both been awarded further funding to develop their innovative food solutions.



Insects as food

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St Davids

# Identifying river creatures from DNA

New research led by Bangor University shows that environmental DNA survives for less than two days in small fast-flowing rivers and can therefore provide highly localised and current information on river dwelling creatures.

**Environmental DNA (eDNA) sampling involves taking environmental samples such as water, soil or pollen, and screening for remnants of DNA originating from the species present. It is being increasingly adopted in biodiversity assessments, because it requires less expertise than existing methods and it uses far less manpower and can reduce costs.**

This technique can be used to identify creatures ranging from the microscopic to larger fish and mammals. However, once a

creature has been identified, it is not possible to say exactly how long ago it was actually present. The DNA remnants could have come from a long-dead creature or from something much more recent.

A team led by Bangor University's Molecular Ecology and Fisheries Genetics Laboratory investigated how long aquatic eDNA in rivers was detectable at the source of production and how far the signal could travel. Partners in the research included Cardiff University and the NERC Centre for Ecology & Hydrology in Bangor and Wallingford, along with members of the University of Birmingham, the University of Sydney, Cornell University and the University of California Riverside.

Their experiment involved introducing eDNA from different species into globally unique experimental streams near Llyn Brianne in Mid Wales. Results showed that the introduced material persisted for just two days, and this time frame was even shorter in more acidic upland waters. DNA from very different species, such as water-fleas, mayfly nymphs and the European eel, lasted for similar periods, giving further confidence to the accuracy and reliability of the results for different types of animals.



This discovery is a major step in the development and validation of eDNA as an environmental management tool. It takes researchers one step further to understanding how these new techniques can be used to improve the national scale monitoring of river quality and biodiversity.

A key challenge now is to determine the accuracy of the eDNA method in describing species communities over time and across different habitats. The research team is testing their methods in natural river systems, intensively sampling the River Conwy in North Wales and additional locations in Europe and the USA.

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Bangor



# Harnessing solar energy in the walls of buildings

Technology developed by Energy Transitions enables the walls of buildings to harness solar energy as a heated air flow.

**Solar air heaters have been used for warming the ventilation air supply of buildings for over 100 years. The current generation of solar air heaters are robust, low cost and dependable, making them ideal for industrial buildings, but they are rarely aesthetically pleasing.**

Energy Transitions created their new technology, which they have named Steel Zero, to be a high-performing solar air heating system that is also architecturally attractive. The system utilises coloured stainless steel as a building façade (exterior) material, which acts as a solar absorber. It has small perforations through which air, heated by the absorber surface, is drawn by a fan. The heated air passes through a gap between the façade and the wall of the building and goes into the building via a duct.



*"Governments around the world are encouraging, and in some countries mandating, the development of low energy buildings as part of their efforts to reduce carbon emissions. Our new technology will help advance the concept of architecturally attractive low energy buildings."*

**John Blower**  
 Chief Executive  
 Energy Transitions

The solar air heating technology incorporates an efficient 'selective' surface coating that absorbs a high percentage of available solar radiation, but loses only a small percentage of energy as thermal radiation to the atmosphere. This enables it to be significantly

more efficient than other solar air heating systems. The company is currently developing ways to use the technology in combination with heat pumps.

The new technology is being developed to significantly reduce the reliance of buildings on the use of fossil fuels to provide space and water heating and cooling. It can be used within the walls of residences, commercial buildings such as hotels and leisure centres, or to provide process heat within industry. The high air temperatures that can be generated means that it can be used in agriculture and industrial drying.

Steel Zero has potential applications worldwide, and the Pontypridd-based company behind it has received interest from North America as well as across Europe. They are also currently developing a joint venture in Jiangsu province in China, and participating

in a project in which the technology will be used within a façade system that incorporates insulation, renewable energy technology, ventilation components and new windows within a modular design for refurbishment of buildings.

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Pontypridd



# A sticky problem solved

**Techlan has developed an innovative solution to the problem of disposing of silicon coated release paper waste.**

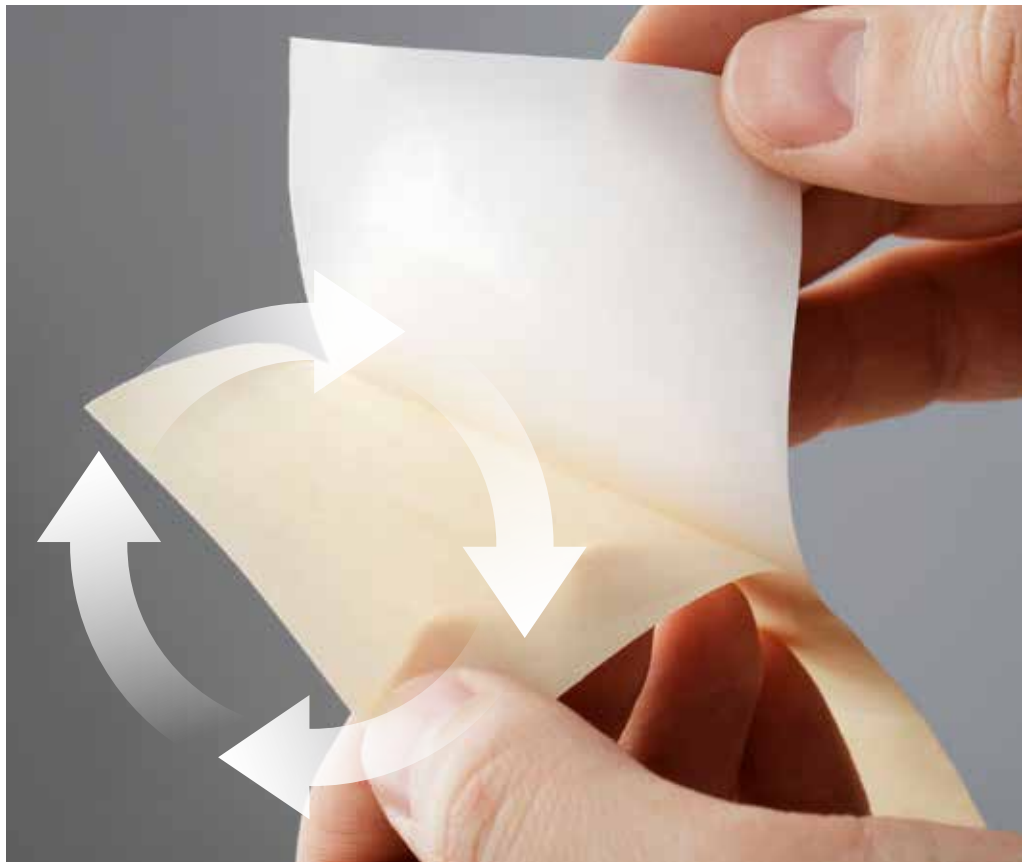
**Silicon coated release paper is used as a backing liner for sticky products, supporting the adhesive until it is peeled away. It is widely used in the print industry, in the manufacture of adhesive backed products such as stickers, labels and signs.**

Aircraft, wind turbines and high performance cars are made from resin based composite materials. The manufacture of these composites uses thousands of tons of silicon coated release paper annually. After just one use, this high value paper is discarded as a waste product.

Despite the paper itself coming from sustainable sources, the silicon coating makes it a difficult material to recycle. Typically, used release paper is rewound into rolls and sent away for disposal, either via landfill or incineration. As a result, huge volumes of this costly, high quality paper goes to waste. It makes little economic sense and has a negative impact on the environment.

Swansea-based company Techlan has developed an environmentally friendly method of recycling waste silicon coated release paper. Working with WRAP Cymru, it has developed an innovative process that cleans the paper by removing any residual contaminant from its surface. The process uses little energy and none of the harmful chemicals associated with traditional recycling methods.

During the process, advanced optical scanning inspection equipment is used to verify the cleanliness and quality of the recycled paper. This camera-based system can identify faults,



defects and contaminants down to a particle size of 175 microns, while the technology is running at speeds in excess of 150 metres per minute.

The technology manages to clean the paper without degrading its surface characteristics or changing its structure, which means that the recycled product matches the quality of virgin paper. This is an example of the 'Circular Economy', giving a second or even a third use to raw materials that were previously used just once. Between January and September 2017,

Techlan diverted almost 250 tonnes of silicone release paper waste from landfill.

The waste producer benefits from the process as it allows them to dispose of their waste release paper in a low cost, environmentally friendly manner. Meanwhile, the second user of the recycled release paper gains access to a raw material that is high quality and significantly cheaper than virgin paper.



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