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advances WALES

Health and safety goes digital

Cardiff-based company Atticus Digital has created a virtual reality power station for next-generation safety training

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Welsh Government

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Contents & Editorial

Research indicates that the digital sector in Wales now employs 40,000 people and is worth over £8.5 billion in turnover to the Welsh economy.

Wales is emerging as a leading UK digital technology centre with particular strengths in ICT, cyber, fintech and the creative industries. In 2015-16 digital tech companies accounted for a third of all inward investment to Wales, and a 2017 report found that the growing digital tech sector in Wales includes a 28% increase in the number of businesses.

This edition of Advances Wales focuses on digital technology and how it is transforming areas from health and education to policing and parenting.

Wales-based scientists are creating smart bandages that monitor how wounds are healing (page 14) and exploring how computer games could be used to treat Parkinson's disease (page 15). Development of a gaming app that tests vision will enable parents to measure their children's eyesight at home (pages 8-9).

Meanwhile, Welsh companies have built software to identify suspicious or criminal activity online (page 7) and to improve the way in which schools manage their students (page 12). A virtual reality experience is providing immersive health and safety training (page 6) and an augmented reality app is educating children about nature (pages 10-11).

Aside from these digital technologies, this edition also features research into snails to learn more about a deadly tropical disease (page 13) and a study of quahog clams to better understand the history of the oceans (page 20).

Advances Wales is also available online, where you can find previous editions that feature key developments in research and innovation in Wales.

Sophie Davies
Editor

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Advances Wales is a high-quality, quarterly 'transfer of technology' journal produced by Welsh Government to showcase new developments in science, engineering and technology from Wales. Devoted to concise reports and commentary, it provides a broad overview of the current technology research and development scene in Wales. 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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MATERIALS	FOOD	ELECTRONICS	PHYSICS
AGRICULTURE	ENGINEERING	COMMUNICATIONS	CHEMISTRY
ENVIRONMENT	MANUFACTURING	INFORMATION TECHNOLOGY	MEDICINE
ENERGY	EARTH SCIENCES	OPTO-ELECTRONICS	BIOTECHNOLOGY

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

Tudor shipwreck artefacts go digital

Researchers at Swansea University's College of Engineering have made interactive 3D models of human remains and other artefacts found on the Tudor warship Mary Rose.

Although many projects have captured museum collections digitally and then made them available online, the digital resources are rarely accurate enough to be used for in-depth research. Swansea University's project, in partnership with Oxford University and the Mary Rose Trust, has created photogrammetry models of skulls that are so accurate they can be used by researchers all over the world in place of real remains.

The unique digital resources have been made available to the public and to academics on the website Virtual Tudors. The research section of the site contains ten skulls from the Mary Rose, which osteologists are encouraged to examine. Human osteology, which is the scientific study of human skeletal remains, relies on visual inspection of bones and the majority of analysis is done with the naked eye. Osteologists are able to estimate human characteristics, including gender and ancestry, and identify certain diseases such as rickets and scurvy.

By capturing around 120 high quality still images per skull and then digitally combining these images in photogrammetric processing software, a photo-realistic 3D object was produced. The resulting images can be viewed and manipulated in real time on a computer or tablet and are of sufficiently high quality to enable digital osteological analysis of the skulls. The public area of the site contains interactive 3D models of a Mary Rose carpenter's skull, a selection of his tools and other objects from the ship including a carved wooden panel.

"This is an important study as museums and researchers digitise more and more of their collections. An optimised procedure and a scientific evaluation of the effectiveness of photogrammetry for use in research studies is crucial."

Dr Richard Johnston
Swansea University

www.swansea.ac.uk

New system to reduce road accidents

Powys-based Plant i has created a camera system that provides drivers of large vehicles and machinery with a 360 degree view, eliminating their blind spot.

The 360 Vision system has been developed with the aim of reducing the number of accidents causing injuries and fatalities on roads and construction sites. Common accidents in these areas include cyclists being hit on the nearside of heavy goods vehicles when they are in the driver's blind spot and construction workers being crushed by machinery when in the operator's blind spot.

Plant i's new system involves firstly mounting four high-quality, wide-angle cameras around the vehicle or machinery. Once the cameras are in place and the cables are covertly installed, they complete a calibration process using a software ECU which stitches the cameras' images together. This provides 360 degree visibility from the driver's seat. Six different views can be selected from the control switch, some of which are automatically selected when the indicators or reverse gear are selected.

Video data from the camera system is stored and can be viewed remotely using software on a computer or tablet. It is also sent to a Management Information Dashboard, allowing the fleet manager or insurer to measure driving patterns and identify situations where an accident nearly occurred. This information can then be used as a tool to improve driver training.

In addition the system monitors harsh acceleration, braking, cornering and speed. Using algorithms, accidents can be not only detected but also predicted, which enables further improvements to be made to driver training so that accidents can be prevented wherever possible.

With heavy goods vehicles and machinery often weighing over 40 tonnes, they can easily cause fatalities. Plant i's technology provides drivers and machinery operators with a much-needed bird's eye view, minimising their chances of missing someone or something in their blind spot and therefore lowering the risk of a serious accident.

www.plant-i.co.uk

Awards for digital companies and entrepreneurs

Winners across 12 categories have been crowned at the first WalesOnline Digital Awards.

The award for Best Digital Start-up was given to Delio Wealth, a Cardiff-based company with a white label platform solution for private assets, who are working with most of the UK's private banks as well as some of the biggest banks across Europe. Also in the finance arena, Wealthify won the Best Digital Innovation award for their online service that makes investing accessible to a wider audience.

Meanwhile, the award for Best Emerging Technology went to ThinkBooker, a cloud hosting system that makes online booking quicker and easier. Swansea-based Veeqo came top in the Best E-Commerce category with its multi-channel inventory management software for retailers. The CEO and founder of Veeqo, Matt Warren, was also named Digital Entrepreneur of the Year.

Two companies that feature in this edition of Advances, EduKey (page 12) and Jam Creative Studios (pages 10-11), received the awards for Best Use of Technology Within Education and Best Mobile App respectively. Simon Powell, founder of the InspireTec group, was crowned Digital Ambassador of the Year and Jackson Griffiths, an app/game developer for Webfibre, won the title of Young Digital Person of the Year.

Other winners at the WalesOnline Digital Awards were creative agency Blue Stag for Best Digital Marketing Communication, video games company Wales Interactive for Best Global Reach, and Zone Art Networks (who featured in Advances Issue 79) for Best Hardware.

www.walesonline.co.uk

IN BRIEF

University launches drone technology degree

Glyndwr University has launched a new degree that will address the skills shortage in the growing drone technology industry, which is predicted to be worth more than £15 billion over the next 10 years. Drones are increasingly being used to monitor, research and conduct data gathering missions in agriculture, surveying, mining, forestry, ecology, archaeology and virtual reality gaming. The MSc in Unmanned Aircraft System Technology will equip its students with the knowledge to design, build and safely fly their own drones. The course will be taught from September 2017 and a piece of land at the Northop campus in Flintshire has been earmarked for drone testing.

Funding for AI software start-up

Artificial intelligence start-up Amplyfi, who featured in Issue 80, has gained £800,000 in an equity funding round led by Finance Wales. This brings the total funding secured by the company in the last few months to £1.2 million. Their flagship software, DataVoyant, is the first to combine Surface and Deep Web harvesting, Artificial Intelligence and data visualisation within a single platform. CEO Chris Ganje commented: "The future of business intelligence lies in delivering high performance, easy-to-use solutions driven by the most advanced AI capability. This latest round of funding will allow us to continue our exponential growth to meet the needs of our rapidly growing client base."

Awards for Swansea steel researchers

Two steel research projects led by Swansea University have received awards from the Royal Society, one of the world's most prestigious scientific organisations. The awards are to help turn research into real products, and only 11 projects across all UK universities and subjects are selected to be winners. The first of Swansea's winning projects was featured in Issue 80 and involves developing a new corrosion inhibitor for steel, as the one most commonly used is set to be banned from 2019. The second project is about making furnaces more efficient with new stirring techniques. Vice Chancellor Professor Richard B Davies said: "To win two Royal Society awards for our steel research is a magnificent achievement. It is further proof that Swansea is the natural home for innovation in the UK steel industry."

Compound semiconductor foundry for Newport

Plans have been announced to build a state-of-the-art, £38 million compound semiconductors foundry in Newport. The ten councils of the Cardiff City Region are to work together on creating a world-leading technology cluster in Newport, creating more than 2000 jobs. It will be supported by the £1.2 billion City Deal and new plans to turn Wales into a global centre of compound semiconductor expertise. The foundry, when opened, will lease space to companies working in compound semiconductor manufacturing and applications development. Compound semiconductors are essential in a range of technologies including wireless, smart phones, power stations, new imaging devices and driverless cars.

Design awards for healthcare technology

Huntleigh Healthcare has won two design awards for new products made in collaboration with design consultancy and research centre PDR. Firstly they received an iF design award for their new range of digital handheld Dopplers, which includes a Doppler for vascular assessment and an obstetric Doppler that monitors fetal heart rate. They went on to win a Red Dot Award for the Sonicaid Team 3 – an advanced fetal monitor designed to improve standards of obstetric care. Both of these awards receive thousands of entries from all over the world each year, and are prestigious hallmarks for identifying outstanding achievements in design.

Building the biggest language resource for modern Welsh

A groundbreaking project is creating a large scale, open access corpus of contemporary Welsh language.

The project, named CorCenCC (Corpws Cenedlaethol Cymraeg Cyfoes – The National Corpus of Contemporary Welsh), is a collaboration between Cardiff, Swansea, Bangor and Lancaster universities.

A corpus is a collection of language data taken from real-life contexts. It therefore allows users to identify and explore language as it is actually used, rather than relying on intuition or prescriptive accounts of how it 'should' be used. This is of benefit to a variety of people including teachers, language learners, publishers, translators and lexicographers. CorCenCC is the first general corpus to represent modern Welsh from a wide range of genres and environments.

With an aim of collecting 10 million words, researchers are seeking out examples of spoken, written and digital Welsh in many different domains, from the rugby pitch and the television studio to political speeches and academic textbooks. To build a language resource that is as natural and as representative of everyday Welsh as possible, the project is also making use of mobile and digital technologies to receive input from the public. A crowdsourcing app was launched in February 2017 so that anyone can contribute to the corpus. Through the app it is possible to share electronic samples including text messages, emails and blogs, as well as audio and video recordings.

"This project will provide us with real insight into how our language is evolving and how we use it. In my opinion this work is of real historic importance, not only linguistically but as a record of our essence as a nation and our place in the world."

Nia Parry
TV Presenter
S4C

Once complete, the final corpus will be available online for free in an easily searchable format. It will act as a language resource and aid the development of technologies such as predictive text production, word processing tools, machine translation, voice recognition and web search tools. Until now, the Welsh language has not had a comprehensive corpus facility to achieve and enable these developments.

www.corcencc.org

Launch of world's first online fashion trade show

Newport-based company BrandLab has launched a new digital platform for the fashion industry. The one-stop online system enables brands to showcase their collections to potential buyers via live streamed fashion shows on BrandLabTV. Buyers and retailers can order directly through an integrated payment system. Co-founder Daniel O'Connell explained: "The fashion business offers constant challenges, including a decline in attendance at wholesale fashion trade shows and the lack of an agile business to business ordering system. While working in fashion I saw how complicated it was to access brands, make orders and organise payments, all of which used different systems. BrandLab offers a one stop technological solution that makes fashion buying and selling an efficient, enjoyable experience."

Growth of North Wales Tech group

Over the past 18 months, North Wales Tech has created a community of almost 400 technology workers and enthusiasts in North Wales. From the 20 or so attendees at their first event back in December 2015 about internet connected Christmas Trees, the group has steadily grown and now has members from every county in North Wales, as well as some from over the border in the North West of England. Events organised by the group have featured a wide range of guest speakers and workshops have been run with support from silicon valley and local technology companies. The group is now interacting with local councils and regional investment organisations to raise awareness of the technology industry and skills that exist in North Wales.

Cyber security centre of excellence for Cardiff

A new research centre for cyber security has been announced by Cardiff University and Airbus. The Centre of Excellence in Cyber Security Analytics will be located at Cardiff University's School of Computer Science and Informatics and will be the first centre of its kind in Europe. Together with experts from Airbus, researchers will carry out world-leading studies into machine learning, data analytics and artificial intelligence for cyber attack detection. This research will aim to protect corporate IT networks, intellectual property and critical national infrastructure. The centre will also develop industry-relevant academic programmes in cyber security at the university, in an attempt to fill the skills gap that currently exists in the field.

Software platform for UK Ministry of Defence

Moleculomics, a spin-out company of Swansea University's Institute of Life Science, has created an in silico drug discovery software platform for the UK Ministry of Defence. The tool named TargetPath, developed for the identification of protein antibiotic or anti-bacterial target within a pathogen, will be used by scientists for the development of antimicrobials to meet the UK's current and future defence and security needs. CEO Dr Jonathan Mullins commented: "We are very pleased to have successfully delivered such a large and ambitious project. Populated with over 28 million detailed molecular interactions, this platform represents a world first in terms of communicating molecular information at this scale".

Investment in software start-up

Cardiff-based IT consultancy and software firm DevOpsGuys is targeting £100 million turnover following £1 million investment. They are looking to reach the targeted turnover over the next five years, following the new funding from Santander Corporate & Commercial. DevOpsGuys was set up in 2013, when its founders saw an opening within the market to build an IT Development and Operations (DevOps) business from the bottom up. The company won the award for Creative and Digital Start-up of the Year at the 2016 Wales Start-up awards.

Virtual reality enhances health and safety training

Cardiff-based Atticus Digital created a virtual reality (VR) power station so that EDF Energy could provide its employees with next-generation safety training.

The purpose of risk perception training is to help workers assess safety hazards and minimise the possibility of an accident occurring in the workplace. In a power station, a potentially dangerous environment, this training is especially pertinent.

EDF Energy was looking for a way to effectively train its employees in dealing with serious safety hazards, without actually putting them at risk in the process. Atticus Digital's solution was to build a VR power station, where employees could put their health and safety training into action with no risk of harm.

To create an accurate, realistic environment for the simulation, the Welsh company mapped an EDF facility using 360° images, which they then converted into a precise 3D environment. In addition to ensuring comprehensive gameplay, it was also vital to check that the simulation followed legal safety codes and adhered to the correct procedures for dealing with the various hazards. They examined the energy giant's extensive data and used this to build and customise the VR experience for specific employee roles and duties.

Using a headset, employees navigate a 360° computer generated simulation of the power station, complete with hazards that need to be identified and addressed by following the right safety procedures. The simulation allows participants to interact with and control various items within the environment. They start in a tutorial room where they learn the different controls and interactions they must perform during the training. This is followed by a briefing video.

The training really begins as employees step out into a corridor where they can look around and explore the space. The controllers allow participants to teleport around the space, pick up items and interact with the environment. Hazards include rubbish not placed in bins, missing or out-of-test-date fire extinguishers, open grating and coiled power leads. When employees identify a hazard they must follow the procedure of raising a condition report, which they do using the trigger button on the controller. They then choose the appropriate action needed to mitigate the risk from a scroll-down menu of options.

"We wanted a fun, immersive and engaging app to deliver a key safety message to our industrial work force. Atticus Digital took our idea on risk perception and made it reality. Since we have rolled out this app everyone in our organisation has seen the potential for future projects."

Sean Newton
Operations Training Group Head
EDF Energy

Before starting the training experience, employees enter their name and payroll number for data collection. This allows their percentage scores to be recorded at the end, with a list of the hazards that they either identified or missed. Employees can see where they went wrong and are therefore able to learn where they need to improve. Team leaders and managers can also use this to get a good idea of areas where further training might be needed. An algorithm captures the performance data for analysis and export, in order to provide accurate results of the training.

Based on the success of this project, Atticus Digital is now planning more VR safety projects that include dealing with fire hazards using fire extinguishers and emergency evacuation procedures.

Profile

Product
Health and safety training in virtual reality

Applications
Training employees to deal with safety hazards in a VR power station

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Spider crawls around the Dark Web

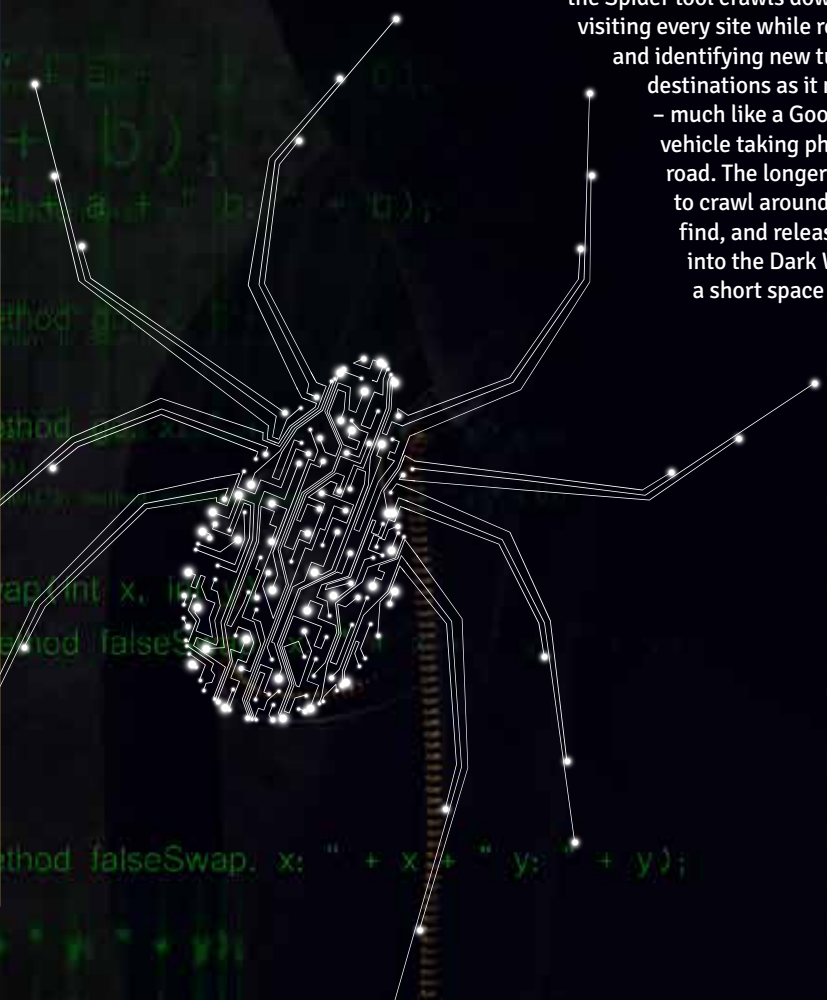
Pervade Software has developed a tool that searches the Dark Web for suspicious or criminal activity.

The Dark Web refers to areas of the internet that cannot be found using a typical search engine such as Google, Bing or Yahoo. Criminals, paedophiles, terrorists and hackers use anonymous servers in these 'dark' areas in order to avoid being found by the police.

If an index of these sites and the content on these servers can be created, it will become significantly more difficult for criminals to hide their online activity. Being able to search the Dark Web, just as you can search something like Google, would allow threats and risks to be recognised before they become more serious.

Pervade Software's new 'Spider' tool is able to crawl around the dark web, indexing everything or searching for specific content. Many organisations have attempted to identify the content of servers in the Dark Web in the past, including large IT security companies and intelligence agencies. The most successful attempt resulted in 2,300 sites being identified by name and location over a period of two weeks. The new Spider technology has been tested by the police and was found to be capable of indexing all of the content on 7,200 sites in just 40 minutes.

In previous attempts, other software has attempted to analyse traffic flowing between sites in a way similar to standing on a bridge and watching cars travel along a motorway. This method only monitored the 'cars' on one small stretch of road and tried to guess their destination. In comparison, the Spider tool crawls down every road, visiting every site while recording content and identifying new turnings and destinations as it maps the route – much like a Google Street View vehicle taking photos along every road. The longer the Spider is left to crawl around, the more it will find, and releasing 1,000 Spiders into the Dark Web can index it in a short space of time.



With the ability to index the Dark Web, the police become able to more quickly map illegal sites, identify criminals and take action against them. The software company is currently working with a police commissioner's office to locate child pornography sites and take them all offline for a weekend, in order to demonstrate that it can be done.

Searching the Dark Web also means being able to identify key words or phrases that can provide clues of future crimes. For instance, a computer gaming company could search for any reference to their product codes, which would indicate that their products are being sold illegally on the black market. Another example would be searching the Dark Web for the names of prominent people, such as politicians or celebrities, to identify possible threats to their safety.

By lighting up the Dark Web and preventing people from committing crimes anonymously, the Spider tool has the potential to make a big impact in the fight against cyber crime and strike a major blow against organised crime. The technology is now being used in over 80 countries, while being managed and further developed from Pervade Software's headquarters in Cardiff.

Profile

Product
Software that crawls the Dark Web

Applications
Identifying suspicious or criminal activity

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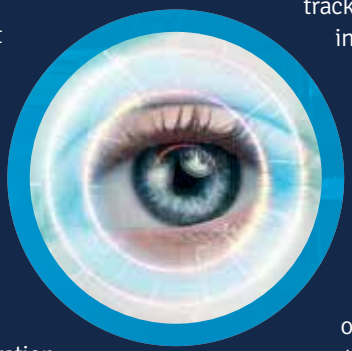
Gaming app tests vision at home

Vision Game Labs has created a game that measures vision and enables home screening for children as young as two.

Nowadays many cases of blindness are preventable. However early detection and identification of vision problems are vital to boost the chances of a positive outcome.

Children's vision can be particularly difficult to test for a number of reasons. A lack of concentration or inability to read a letter chart can sometimes lead to less accurate results. This in turn leads to further appointments and unnecessary strain on NHS resources. Currently routine checks should be done on all four year old children in Wales, but this doesn't always happen.

Dr Stephanie Campbell, an optometrist, and Dr Luke Anderson, an eye surgeon, set up Vision Game Labs to address the lack of eyesight testing in small children and ensure that any vision problems they may have are identified early. They came up with the idea of enabling parents to test children's eyesight in their own home with a specially designed game. This was created in collaboration with CEMET – the Centre of Excellence in Mobile and Emerging Technologies at the University of South Wales.



Their app is a hide-and-seek iPad game featuring aliens. The technology within the app interacts with a fiducial marker to track the child's head position in relation to the front facing iPad camera. General eye tests function based on distance, so the team worked to find an alternative. The game makes use of vanishing optotypes, typically used to test different aspects of eyesight, which the child cannot see when they pass their threshold of vision. To keep the child interested, the game involves colourful animation which was designed by Cardiff-based Bait Studio.

Data and test results are collected by the app, allowing optomotrists and parents to

determine if there has been any decline in vision. It also has artificial neural network capability, which means that it can be trained to identify certain eye problems in particular.

> "Through the use of gaming and data technology, the application puts the assessment of vision directly into the hands of children and their parents."
>
> **Luke Anderson**
> **Co-founder**
> **Vision Game Labs**

The app enables children as young as two to be screened for eye problems, when they are usually not tested until the age of four or older. In addition to testing children's vision, the technology can be used across all age ranges and to monitor for major causes of vision loss such as macula degeneration and cataracts. Home monitoring with this new technology has the potential to revolutionise initial eye screening and contribute to efficiencies in health services. The app will undergo clinical testing in an NHS site later this year.

Profile

Product
Gaming app with aliens

Applications
Testing vision at home

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Augmented reality app brings fairies to bluebell woods

Jam Creative Studios built an augmented reality (AR) app for the Woodland Trust, with the aim of encouraging families to go out for walks in the woods and learn more about nature.

The Woodland Trust was eager to get families with children enjoying the bluebell woods in springtime, while also teaching them about the importance of protecting native bluebells by sticking to paths and not trampling all over them. Cowbridge-based agency Jam Creative Studios designed an AR mobile app that was rolled out across 25 Woodland Trust sites around the UK.

The 'Nature Detectives Family Trail' app was created specifically with children aged four to seven in mind. It features two animated characters, Blue and Belle, telling the tale of a clumsy giant who keeps trampling the bluebells and destroying the springtime magic that they collect. The woodland fairies appear to fly into view from the trees via image tracking AR at key points along the trail.

Image recognition is used to trigger virtual content (animations) to appear within the camera view of the device. Trigger images are typically asymmetrical with strong contrast and prominent feature points. During the recognition process, the camera feed is passed through the AR code which looks for these feature points, comparing them to preset image data sets. When it reaches a similarity threshold, the AR content is triggered.

Many AR apps rely on image recognition alone to trigger content, which means that when the camera view loses the trigger image, the AR content is also lost. This would not have been ideal for an app intended to be used by energetic young

children, so Jam Creative Studios decided to take a different approach. As soon as the trigger image is recognised, the app uses data generated by internal sensors to determine the phone's movement, thus enabling users to look around while the AR triggered virtual objects remain in position. Consequently it becomes more believable for the app users that the fairies are really there in the woods.

Children are encouraged to interact with their environment through hands-on activities and in-app games to complete around the woods. For instance, they are asked to collect virtual AR bluebell chimes by tapping their screen and to recite magical spells for the app to detect. As a reward for completing the trail, and in return for giving the Woodland Trust some contact details, families receive a Nature Detectives pack in the post, containing an AR trigger image that provides a final animation and game.

With over 4000 downloads over a four-week period, the app has proved to be popular this spring. By giving families with children an incentive to visit Woodland Trust sites and learn to respect them, the ancient woodlands can be better preserved for future generations.

Profile

Product
Augmented reality app for the Woodland Trust

Applications
Teaching children about nature and making family days out more fun

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AI-driven seating plans put schools top of the class

Innovative software for schools from EduKey is helping teachers to create optimal seating plans and monitor children's behaviour.

Class Charts makes use of artificial intelligence (AI) and analytics that allow teachers to save time, reduce their workload and more effectively manage their pupils. The Pembrokeshire-based company behind the platform was founded by an experienced teacher and a software developer.

Bad behaviour in the classroom can be a huge barrier to learning, with just one disruptive influence affecting the focus of everyone else. In Class Charts, teachers are able to record comments about the behaviour of individual pupils. They can make note of negative actions such as shouting out or refusing to do tasks, as well as positives such as good progress, teamwork and self-motivation. These options are customisable so that schools can choose their own criteria.

The AI-driven platform uses pupil data to generate seating plans, automatically designed to minimise disruption and optimise productivity. This is particularly useful to newly qualified, supply and cover teachers who enter the classroom with no previous knowledge of the children they need to teach. Seating plans can be quickly rearranged and key information about pupils is displayed in an easy-to-view format. As a result, teachers can get an overview of the whole class at a glance in order to quickly identify disruptive influences, high achievers and so on.

In addition to classroom seating plans, the software is able to produce instant reports, which enables teachers to view the progress of a class or even an individual pupil over time. For example, they can see a weekly breakdown of their class' behaviour to determine if any improvements have been made. Heads of year, heads of subject and head teachers also have access to analytics showing year-wide, subject-wide or school-wide behaviour. This means they can save a significant amount of time as it is made easier to recognise problems and reward achievement. Updates can be provided in real time, giving head teachers a better understanding of what is really happening in their school.

Schools have the option to involve parents in the system too, because an app can be downloaded which displays the progress of their child or children. Many parents know little about their children's behaviour at school until they attend an annual parents' evening, so the app gives them the opportunity to be updated more often and more thoroughly than they typically would be.

In the 2017 BETT Awards for education technology, Class Charts won in the category of 'ICT Leadership and Management Solutions'.

> "Data is analysed daily by mentors and teachers to allow for fantastic attitudes to be praised and poor behaving students to be picked up and dealt with. The live activity feed has allowed us to be proactive in dealing with negative behaviour, and the AI function allows for staff to see which students are not a good combination and split up any negative partnerships whilst encouraging those which are positive. We have now had our first OFSTED monitoring visit since starting to use the software and the inspector was extremely pleased with the improvements and progress we have made."
>
> **The head of a secondary school in Derby**

Profile

Product
Software for schools

Applications
Creating optimal seating plans and monitoring behaviour

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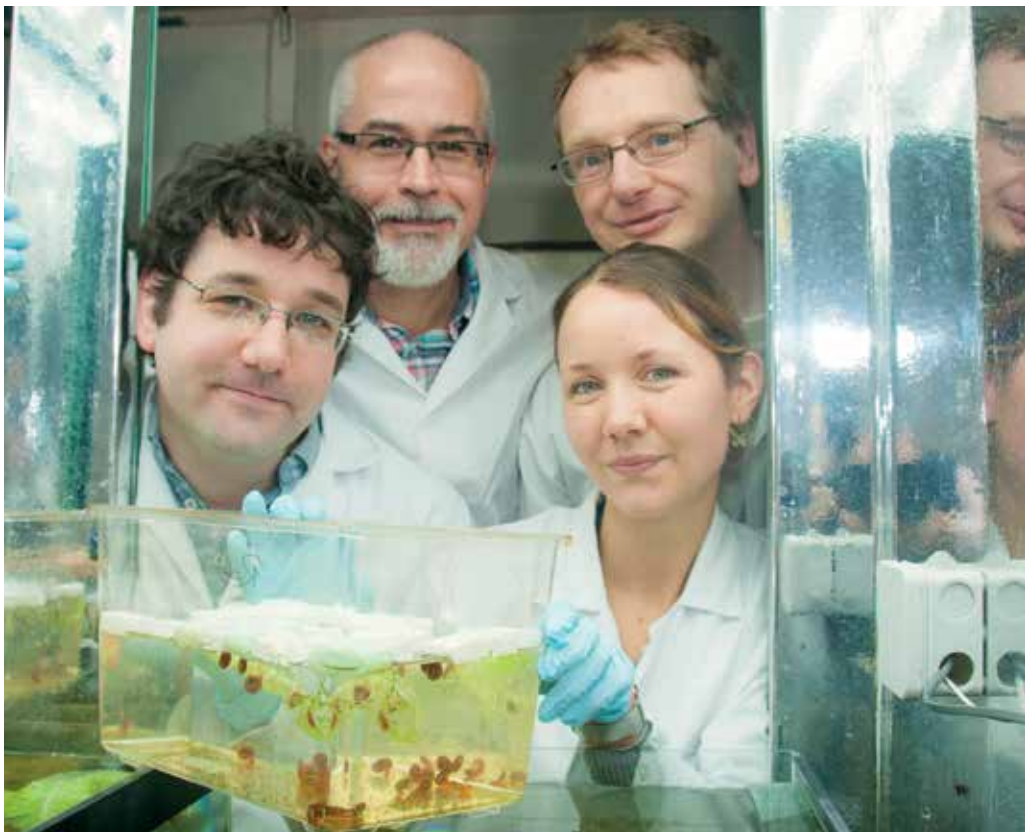
Snail study combats deadly tropical disease

Scientists at Aberystwyth University have studied the biology of a snail species that is responsible for passing on a deadly parasite killing 200,000 people every year.

A research team at the Barrett Centre for Helminth Control has been studying the snail 'Biomphalaria glabrata' which carries a species of parasitic worm responsible for the disease schistosomiasis. This tropical disease is often asymptomatic at first, but the parasite can remain in the body for many years and may cause major damage to organs such as the bladder, kidneys and liver.



Currently, more than 200 million people living in Africa, Asia and South America are infected by the dangerous blood fluke worm. People are susceptible to infection when they bathe, play, swim, wash, fish or walk through water that is contaminated by the parasite released from the aquatic snail. There is no vaccine available for schistosomiasis, which means that anyone exposed to contaminated water is at risk.

With the World Health Organisation's goal to eliminate schistosomiasis as a global health problem by 2025, there is now renewed emphasis on snail control in endemic areas. To gain a better understanding of the parasite's snail host, the Aberystwyth team has worked to identify and characterise the microorganisms that live within them.

Simple single-cell animals have previously been detected within the snail's tissues, but the new findings represent the first discovery of co-inhabiting microbes. These symbiotic organisms play important roles in the developmental biology of the snail, much like those facilitated by the microorganisms that live in or on humans. This opens up the possibility of controlling schistosomiasis by encouraging or engineering these natural microbes to turn against the snail, thereby reducing snail numbers and parasite transmission in endemic areas.

The scientists also managed to identify a set of genes in the snail that are involved in the control of normal biological processes, including reproduction. They went on to show that the parasite is able to re-programme the normal functioning of these snail control genes. It could be possible to combat the parasite by manipulating these genes, so that energy can be taken away from snail reproduction and instead utilised to boost snail immunity.

The Aberystwyth team is now working with international partners, in order to extend their findings and form practical solutions for controlling snail numbers in the areas most at risk of schistosomiasis. Their work will be vital in the development of new, urgently needed strategies for controlling the deadly tropical disease and improving the lives of those suffering from it.

Profile

Product
Research into the biology of a snail species

Applications
Developing strategies to control tropical disease

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Creating smart bandages for wound treatment

Swansea University scientists are developing smart bandages that detect how wounds are healing and send progress updates to doctors.

The current method of monitoring a bandaged wound is for the patient to visit their doctor after a certain period of time for examination. However not everyone, and not every type of wound, requires the same amount of time to heal. Wounds can also become infected between appointments and this goes unnoticed until the bandages are removed.

Scientists at Swansea University's Institute of Life Science, in partnership with the Welsh Wound Innovation Centre and ARCH, are creating next-generation bandages that allow more thorough monitoring of wounds. The work forms part of the Swansea Bay City Deal which aims to create a 5G test hub for digital innovation.

Nanotechnology has enabled the production of tiny sensors which can be put inside the bandages to sense the state of a wound, detecting complications such as infection and blood clotting. The bandages will then use real-time 5G technology to wirelessly send data to the doctor, who can assess how well the wound is healing.

If the patient keeps track of their own health (including activity and diet) on their smartphone, this data can also be combined with intelligence from the bandages. The doctor can use the information to understand why a wound might be healing particularly slowly and to tailor treatment for individual patients. In addition, it means that the patient can take a more active role in their own treatment.

The high-tech bandages need to be produced at a cost that is affordable for the health service. For this reason, 3D printers at the Institute of Life Science will be used to produce them, effectively bringing down the cost. Trials for the bandages are expected to be underway within the next year.

5G stands for 'fifth generation' and refers to the next generation of mobile wireless technology

"In traditional medicine, a clinician might see a patient and then prescribe the treatment approach for a month or three months. What the future holds is a world where there's the ability to vary the treatment to the individual, the lifestyle and the pattern of life. This is a multi-technology approach, with nanotechnology, nanoelectronics, printing and coating biochemistry all interconnecting through 5G infrastructure, allowing us tomorrow and in the future to deliver health care for a wound patient that delivers better outcomes and better quality of life."

Professor Marc Clement
Institute of Life Science
Swansea University

Profile

Product
Smart bandages

Applications
Monitoring how wounds are healing and communicating with doctors

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Brain stimulating computer games to help Parkinson's

Bangor University's School of Psychology is researching the potential benefits of brain stimulating computer games in the treatment of Parkinson's disease.

Parkinson's is a degenerative disease of the nervous system characterised by muscle rigidity, tremors, poor balance and slow movement. It is a condition that can affect every aspect of a person's life, gradually taking away control of their body and reducing independence.

In partnership with Betsi Cadwaladr University Health Board and the Walton Centre in Liverpool, researchers at Bangor University are studying the effects of touch screen spatial reasoning games on the area of the brain that controls movement. The games involve the brain quickly calculating an object's dimensions from different orientations and rearranging it to fit into a space provided. By having Parkinson's patients perform these simple computer based tasks, the neurological experts are aiming to stimulate specific parts of the brain affected by the disease, which could then lead to improved motor function.

An initial study recorded the movement ability of 16 Parkinson's patients prior to playing the touch screen games and then reassessed their motor function afterwards to note any improvement. It was found that the 16 volunteers were able to move faster and initiate movement more easily following a period of cognitive stimulation on the computer games. A second study of 60 people is now set to examine the potential benefits in more detail. Responses will be recorded over a longer time frame to determine whether the approach continues to produce a clinical benefit. If this produces further promising results, the next stage would then involve testing hundreds of people across multiple sites.

Many people with Parkinson's disease already practise non-drug therapies, such as regular physiotherapy, speech exercises and relaxation techniques, in order to improve movement and ease stiff muscles. These therapies can relieve symptoms that aren't improved with the use of medication and are beneficial for physical and emotional wellbeing. National charity Parkinson's UK has said it is keen to see the results of Bangor University's research and find out what potential there is in using emerging technologies, such as brain training, to improve symptoms of the condition.

"One of the exciting aspects of the research is that the approach is so simple and can be available on any computer device whether phone, tablet or PC. It's a completely non-pharmacological intervention. At the moment, for most individuals, treatment of Parkinson's involves drug-based therapy, which comes with side effects. Our hope is that this could be something that can complement drug-based intervention and improve treatment outcomes, and quality of life, for people with Parkinson's. The idea that a range of basic tasks could deliver clinical benefits is exciting. If successful, the approach may potentially be applied to other conditions involving motor dysfunctions such as stroke and other degenerative diseases."

Professor Charles Leek
School of Psychology
Bangor University

Profile

Product
Computer games research

Applications
Potential treatment for Parkinson's disease

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Creating a more flexible power grid for cleaner energy generation

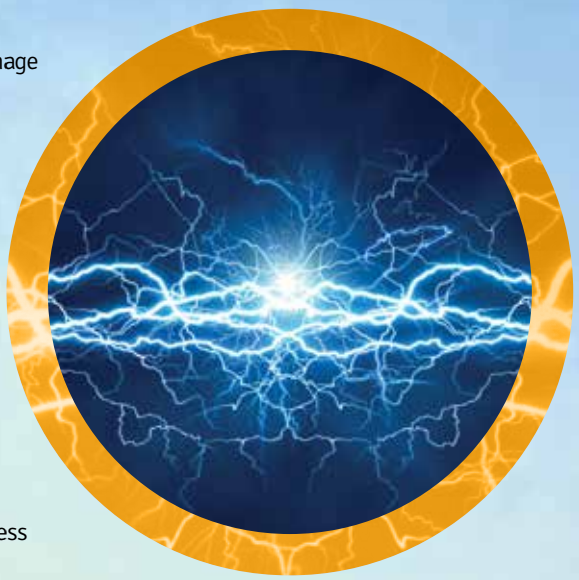
New fault current limiting technology enables combined heat and power for smart cities.

In support of global initiatives such as the Paris Agreement, a vast majority of countries are moving towards decarbonising energy. However they are facing the challenge of connecting cleaner, lower carbon generation to an electrical infrastructure that was conceived more than 100 years ago and has not needed to undergo significant changes until now.

The UK's power grid is both simple and logical, feeding electricity generated from large power stations into a high voltage backbone transmission system (the National Grid), and then distributing it at lower voltages (by the Distribution Network Operators) into geographic regions supplying industry and consumers. In order to meet new demands and make the power system 'greener', a different type of grid is required – one with the capacity to incorporate distributed energy sources at different points in the network.

Combined Heat and Power is one example of a game-changing electricity generation method. Instead of having individual gas boilers in homes, waste heat from a power plant is used to pipe hot water into a building for both space heating and hot water. New methods such as this are more environmentally friendly and more energy efficient than traditional methods, but can be difficult to implement. This is because electrical network constraints, such as fault levels, can act as a barrier to the connection of distributed energy sources, so FaultCurrent Ltd has developed technology to help extend the capacity of the existing grid.

In a power system, a fault current is any abnormal electric current. Failure to manage fault currents can lead to catastrophic damage for grid components such as transformers. Engineers originally designed the power grid to include some allowance for additional fault currents, but this 'headroom' can be small, especially in cities. It is rarely possible to connect new lower carbon generation without significant network upgrades, which are costly and time-consuming and put the network at risk while work is being completed.



FaultCurrent Ltd was founded as a business spinout from ground-breaking research undertaken at Cardiff University's Wolfson Centre for Magnetics. The company's unique fault current limiting technology, when connected into the power grid, can create up to 40% additional fault level headroom allowing lower carbon generation to be connected with little effort or risk.

Like other fault current limiters that have been developed and trialled over the last ten years, the principles of magnetics are at the core of the new technology. However, instead of using complex methods to create magnetic fields such as superconducting or electrically powered DC-biased magnetic techniques, they have found a way of using simple, low-cost ferrite magnets to create a unique low-maintenance system.

A large number of permanently charged ferrite magnets are arranged around 24 individual coils placed on steel limbs. Under normal conditions, the charged magnets saturate the steel limbs, contributing a low resistance to the network when 'in service' current flows. If an abnormal fault level momentarily flows, the steel is forced out of saturation and instantly turns the device into a higher resistance state. This allows time for the power system's existing infrastructure to react and isolate the fault. Once the fault is cleared, the electrical steel limbs return to being saturated and the device quickly resets to its low resistance state, ready to protect the network again. The technology requires no auxiliary power sources, specialist cooling or controls.

A full-scale prototype has been tested at the KEMA laboratories in the Netherlands, and a process of production engineering is now being undertaken prior to field testing on a live power system. FaultCurrent Ltd has signed a manufacturing agreement with Eriez Magnetics in South Wales, and the manufacturer's US-based parent company has taken an equity stake. Their objective is to be able to ship commercial units by the end of 2018.

"By extending the fault carrying capacity of existing power networks, our innovative technology helps to address the global challenge of managing fault levels, and in doing so enables a more flexible grid which can easily deal with the connection of lower carbon distributed energy generation."

Martin Ansell
Chairman and CEO
FaultCurrent Ltd

Profile

Product
Fault current limiting technology

Applications
Extending the capacity of the existing power grid

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Energy monitoring unit for a sustainable future

A company based in Bangor has developed open-source energy monitoring tools to help people better understand their use of energy and address the challenge of sustainable energy.

Typically people do not take an active part in their energy system, simply getting their energy from a huge corporation and receiving a bill at the end of the month or quarter. OpenEnergyMonitor tools allow users to become more aware of, and keep a closer eye on, their own energy consumption.

The emonPi is a web-connected, Raspberry Pi-based unit, which monitors energy through clip-on CT sensors, AC voltage sensors and optical pulse counting. Using the tool, it is possible to log and view energy consumption on a computer or mobile device and therefore track it even while out of the house. In addition to displaying real-time, live information, the app shows historic data so that people can monitor their consumption over time and identify any trends. Visualisation tools convert the data into easy-to-view graphs. Taking inspiration from the Raspberry Pi Foundation, the emonPi is fully manufactured and assembled in Wales.

Aside from monitoring energy consumption, the unit is also able to monitor energy generation. For example, households with solar panels can see how much energy they are producing in real-time and review historic production. They can also determine what percentage of the electricity that they have used on a particular day came from their solar panels. The Welsh company is currently working with John Cantor Heat Pumps Ltd in order to make a system fully capable of monitoring heat pumps. This would help de-mystify heat pump operation, improve their performance by diagnosing any problems early and enable a better understanding of how a potentially key zero-carbon heating solution works.

The company is involved in the Cyd Ynni - Ynni Lleol energy project, in which 100 households in Bethesda, North Wales, have joined forces to purchase the power generated by their local hydro plant for half the usual price. As part of this UK-first project, the software company developed a platform that allows people to see how much energy they are using both individually and as a community, and also to see when the local hydro plant is running. This enables them to make decisions such as to use the dishwasher or washing machine when it has just been raining and the hydro plant is therefore generating power.

OpenEnergyMonitor has also built an online learning resource to help others who want to build their own energy monitor and understand the bigger picture of sustainable energy. Through an online forum, they have grown an active community of users, enthusiasts and developers, all working to improve the platform.

> "The next 20 years will see a revolution in our energy systems as we switch away from fossil fuels to a zero carbon energy supply. By using energy monitoring, modelling and assessment tools we can take an informed approach to working out what are the best energy saving measures to apply. We can then use ongoing monitoring data to ensure solutions meet their expected performance over time."
>
> **Glyn Hudson**
> **Co-founder**
> **OpenEnergyMonitor**

Profile

Product
Energy monitoring unit

Applications
Monitoring household energy consumption

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New materials developed for waterproofing and antifouling

Scientists from the Energy Safety Research Institute at Swansea University are creating new 'greener' materials for waterproofing and antifouling.

Materials that attract water, such as surfaces across which it spreads evenly, are known as hydrophilic. On the other hand those that repel water, causing droplets to form, are known as hydrophobic.

Hydrophilic and hydrophobic materials are defined by the angle between a water droplet's edge and the surface underneath it, which is known as the contact angle. If the droplet spreads, the contact angle must be less than 90 degrees and the surface is hydrophilic. If the droplet forms a sphere that barely touches the surface, the contact angle must be more than 90 degrees and the surface is hydrophobic or water repellent.

The ability to modify the hydrophilicity and hydrophobicity of surfaces is in demand. This is due to the extensive range of potential applications, from antifouling and antifogging with hydrophilic surfaces to waterproofing and anti-icing with hydrophobic surfaces. Surface energy and surface structure are the main parameters essential for designing and fabricating surfaces with a tunable capability to attract or repel water. Hydrophilic and hydrophobic surfaces are currently obtained using various physical and chemical methods to achieve rough surfaces with the desired surface energy. These include plasma treatment and electrochemical methods.

Swansea University scientists have now demonstrated that hydrophobic surfaces can be obtained using relatively short-chained, highly branched hydrocarbon chains. This has the potential to be a safer, greener replacement for the more expensive, hazardous fluorocarbons commonly used for waterproofing and antifouling. As a result, the undesirable environmental and commercial consequences of using fluorocarbons could be eliminated.

The new materials can be applied to a variety of surfaces through spray or spin coating, providing a texture to the surface as well as the chemical functionality that can alter the surface from hydrophilic to hydrophobic based on the choice of tailored functionality. They can also reduce the interfacial tension of oil-water emulsions by behaving as surface active agents. Understanding oil-water emulsions is crucial in enhanced oil recovery techniques that are used in producing oil from wells which have been exploited for long periods.

The team is now working to improve the material's durability on various substrates and looking at large-scale application to surfaces.

Antifouling = preventing the accumulation of unwanted matter on wet surfaces such as the bottom of a boat

Profile

Product
Materials for waterproofing and antifouling

Applications
Replacing more expensive, hazardous materials

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Longest living animal reveals ocean secrets

A study of the longest living animal on Earth, the quahog clam, has provided researchers at Cardiff University with an unprecedented insight into climate change.

The quahog clam, also known as a hard clam or chowder clam, is an edible mollusc native to the continental shelf seas of North America and Europe. It can live for over 500 years and the growth rings found in its shell enable analysis of how the oceans have changed over time.

Researchers at Cardiff University's School of Earth and Ocean Sciences, working in partnership with Bangor University, analysed 21 live and fossilised clam shells from the North Iceland Shelf, 263 feet deep into the ocean. The age of the clams was determined through radiocarbon dating and by counting the annual growth rings in their shells. Chemical components of the shells known as isotopes, in particular oxygen isotopes, were then measured to examine changes in the ocean's temperature and salinity (saltiness) from AD 953 until the year 2000.

Using this information, the research team managed to piece together the history of the North Atlantic Ocean more precisely than ever before. By comparing the new findings with existing records of solar variability, volcanic eruptions and atmospheric air temperatures, they were also able to construct a bigger picture and investigate the links between them.

The results of the study show that before the industrial period (pre AD 1800), natural changes in the North Atlantic Ocean mediated the response of the atmosphere to variations in the sun's activity and volcanic eruptions, which subsequently impacted the weather. On the other hand, during the industrial period (post AD 1800), changes in the North Atlantic Ocean have been occurring at the same time as, or even lagging behind, changes in the atmosphere instead of happening beforehand. According to the experts, this notable shift in the relationship between the ocean and the Earth's atmosphere is likely due to the large amounts of greenhouse gases emitted by humans since the industrial revolution.

Until now, research into the history of oceans has only been able to cover the past 100 years or so using direct observations. Reconstructions using marine sediment cores have allowed researchers to go further into the past, but with significant age uncertainties.

> "The development of absolutely dated marine archives such as the North Icelandic record provide invaluable information for developing our understanding for how the climate system naturally operates. It shows that the changes we have seen over the 20th century are unprecedented when compared to variability over the entire last millennium. With this information we will be able to better understand and predict the likely future changes in the climate system in response to the increasing human influence."
>
> **Dr David Reynolds**
> **Lead author of the study**

Research involving quahog clams, such as Cardiff University's study, has the potential to transform the field and enable more in-depth exploration of the role that the oceans play in the wider climate system. It can help experts to develop a better understanding of the mechanisms that drive the climate and therefore build more robust predictions for the future.

Profile

Product
Quahog clam research

Applications
Providing information on the history of the oceans and the Earth's climate

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