

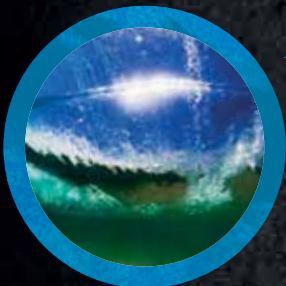
THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

# advances

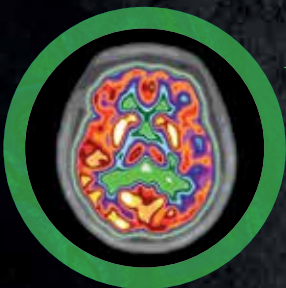
WALES

## Teaching robots to learn

How Welsh scientists are teaching humanoid robots through child learning techniques



**13** Unique technology developed to harness marine energy



**17** Advanced scanner can detect tumours that are just millimetres in size



Llywodraeth Cymru  
Welsh Government

3	<b>News</b>
6	<b>Environment</b> Mapping a renewable future
8	<b>Electronics</b> Teaching robots to learn
10 11 12	<b>Information Technology</b> Going is good for equine analysis Space-time tracking Sign of things to come for digital
13	<b>Energy</b> In depth approach to wave energy
14 15	<b>Biotechnology</b> Bacteria help for healthier hearts Recycling radioisotopes
16 17	<b>Medicine</b> Taking the pressure off PET project
18	<b>Opto-Electronics</b> 3D scanning for record breaking wingsuit
20	<b>Physics</b> Big Bang balance

### “Intelligence is the ability to adapt to change.”

Stephen Hawking

The world is changing rapidly. We must respond and continue to move things forward; to progress and to advance.

Scientists, engineers and manufacturers in Wales are responding to our fast-evolving world with cutting edge research and innovative new technologies. This edition includes a range of digital developments and research and development of renewable technologies that both respond to and continue to disrupt the scientific and technological landscape.

Wales' scientists are working on world-leading experiments to challenge existing physics theories (page 20), and teaching humanoid robots to learn and adapt in the way a human child would (page 8), contributing to extraordinary global advancements in science, engineering and technology.

The previous bioscience edition of Advances explored how collaboration can spark new ideas and innovation, with examples of how combined strength and skills can be used to respond to scientific challenges. Industry, research and clinical collaborations were at the centre of new technology for monitoring of patient vital signs, research using genetics for predictions of clinical outcomes, and identification of an enzyme that affects cognitive and memory disorders.

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

**Tess Coughlan-Allen**  
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.

**Editorial Board:** Lucas Brown, Claire Harvey, Simon Cooper, Gareth Browning, Marcia Jones, Clive Thomas, Richard Johnston, Jon Merrey.

**For information on how to contribute features contact the editor, Tess**

**Coughlan Allen tel +44 (0)29 2047 3456**, email [advances@teamworksdsgn.com](mailto:advances@teamworksdsgn.com).

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#### Advances Wales contact

To receive a regular free copy of Advances Wales, change contact details or to obtain free back issues please contact Jennifer Clark, Welsh Government, QED, Main Avenue, Treforest Industrial Estate, RCT, CF37 5YR, Wales, UK  
Tel +44 (0)3000 61 6040 Email [innovation@wales.gsi.gov.uk](mailto:innovation@wales.gsi.gov.uk)

Information regarding the international offices of the Welsh Government can be obtained by telephoning +44 (0)3000 6 03000 from the UK or online at [www.wales.com/business/overseas-offices](http://www.wales.com/business/overseas-offices).

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**Welsh Government**

Advances Wales publishes news and features in the following areas

MATERIALS	FOOD	ELECTRONICS	PHYSICS
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ENVIRONMENT	MANUFACTURING	INFORMATION TECHNOLOGY	MEDICINE
ENERGY	EARTH SCIENCES	OPTO-ELECTRONICS	BIOTECHNOLOGY

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

## Advertisers get up close and personal with solar powered beacon

**Newport-based GCell specialises in photovoltaic technology and creates indoor wireless beaconing and smart sensor devices that are powered by a renewable energy source.**

With an iBeacon network, any brand, retailer, app, or platform will be able to understand exactly where a customer is in the brick and mortar environment. This provides an opportunity to send customers highly contextual, hyper-local, meaningful messages and advertisements on their smartphones.

The G100 indoor solar powered technology uses a renewable energy source to enable broadcasting at the Apple iBeacon standard of 100-milliseconds advertising rate for the life of the product. This allows application developers to target users and navigate more accurately. The number of beacons deployed worldwide has exceeded 6 million. The technology is used throughout airports, cinemas, hotels, galleries, retail stores and sports stadia to allow the broadcasting of Bluetooth signals, which a smart phone can receive and understand. This makes it possible for brands and venues to communicate with audiences at a precise location at the time of their visit.

Utilising its expertise in energy harvesting, the company plans to overcome one of the major challenges constraining the mass adoption of these systems.



"We have been patiently watching the iBeacon ecosystem mature. We quickly recognised that battery-life is one of the biggest challenges for industry growth due to the high servicing costs. Initially, Beacon hardware vendors used small coin cell batteries typically lasting less than a year. Each time a beacon requires a replacement battery there is an associated service cost, and that adds to the total cost of ownership."

**Barry Jenkins, GCell**



[www.ibeacon.solar](http://www.ibeacon.solar)

## Digital developments for Welsh dozen



**Elidir Health has developed technology in partnership with North Wales' Betsi Cadwaladr University Health Board together with support from Welsh Government through an Innovate UK SBRI Challenge. Using a fresh approach that combines expertise and design, the company has created a practical mobile application that can be used in a modern healthcare environment.**

The latest app, CHAI, helps nurses spend more time with patients and less time on administrative duties. It is user-friendly, saves time and increases patient satisfaction.

The company has won a place at the digital dozen 2016 alongside other successful innovative companies who showcased their technology at the Digital 2016 conference in Newport in June 2016.

The innovative technologies from the digital dozen include:

- RWA, an e-learning solution developed in Blaenavon and Pembrokeshire that is now used by 8,000 insurance brokers in the UK
- Wealthify, an online investment service developed in Cardiff that is aimed at making investing accessible and affordable
- A connected all-in-one diabetes management system based on a micro-pump patch created by Swansea-based Cellnovo
- Artificial intelligence technology to identify cyber or technology threats to business developed by Cardiff-based Amplyfi Ltd
- LinguaSkin, a product that enables a multilingual interface to be created for websites and apps created by Newport's Interceptor Solutions
- Noddlepod, a community-based learning tool for people to share knowledge, support and learn from each other, developed in Caerphilly



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



# SmartKem's semiconductor makes flexible electronics a reality

**Flexible electronics for the Internet of things are now a reality thanks to new technology created by North Wales company SmartKem Ltd, with the help of Bangor University.**

SmartKem is a developer of semiconductors for the manufacture of flexible displays and electronics. The company recently set a new world record in digital circuit performance with its solution processed organic semiconductor, tru-FLEX®.

Research on the company's semiconductor material has been supported by scientists at Bangor University's School of Electronic Engineering, who have demonstrated that it operates in electronic form at the frequencies required to make high-speed flexible electronics a reality. The results demonstrate that the historic barrier of transistor speed for realising fast, solution-printed electronics, no longer exists.

A new speed of operation of electronics opens up a wide range of application possibilities, which could drive forward complex flexible electronics for RFID or



NFC labels and sensors. The flexibility and durability of the technology platform, with the potential for high volume print production, means electronic bar codes could be applied to fast moving consumer goods.

"This is a great result and a testament to our capability in material and transistor expertise. This emphasises the enabling nature of materials innovation in driving forward the potential of flexible electronics, not just for application to smart, flexible electronics for the Internet of Things, for instance, but also the unique position it holds in enabling the growth of the flexible display industry. Bangor's assistance on this project has been essential, without their expertise we would not have been able to achieve such a fantastic result."

**Steve Kelly**  
CEO and Founder of SmartKem



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

## IN BRIEF

### Video game developer to create 70 new Welsh jobs

Brighton-based game developer Relentless is planning to open a new studio in Wales, creating 70 jobs. The news comes as Wales develops a growing reputation as a centre for digital media. The company is also collaborating with multi-national organisation Hasbro, which has a distribution service in Newport, South Wales, to develop multiple new projects. It will be the second major inward investment for a games development studio that will create skilled jobs and attract investment to Wales from a global entertainment company.

### Axiom trebles size of Swansea factory

Stainless steel specialist, Axiom Process, has trebled the size of its Swansea factory to 30,000 square foot to allow increased production capacity. All processes have been integrated into the new facility, with the aim of driving customer benefits such as improved delivery times. The company has also invested in inspection facilities and testing procedures to meet validation requirements. As well as its hygienic stainless steel fabrication, Axiom also operates in the field of membrane and filtration technologies, which are used for effluent treatment and product purification. The new facility includes a dedicated wet test area and laboratory services for customers wishing to conduct pilot plant trials and evaluate membrane filtration for any liquid process separation requirements.

### Investment for new treatments for chronic skin conditions

Curapel, a healthcare company developing innovative new products for eczema and psoriasis as well as skin pigmentation conditions, has set up its headquarters in Cardiff and received £350,000 equity investment to help it develop treatments for chronic skin conditions. Formulated from safe and natural ingredients, Curapel's products are patent protected and all in late-stage product development, with clinical testing set to continue through 2016. Curapel will now use this equity investment to develop and commercialise its products.

### Swansea University launches Centre for Biomathematics

Swansea University has launched its latest research project, the Centre for Biomathematics, based in the College of Science. The Centre provides a cross-community, interdisciplinary focus for experts with interests in the interface between mathematics and biology or medicine. It aims to foster collaboration for new developments in both fields. Co-Directors Dr Luca Borger and Dr Elaine Crooks said: "By exploiting complementary and wide-ranging knowledge across disciplines, the Centre aims to develop novel biologically-informed predictive mathematical and statistical models and computational approaches to tackle topical questions in biology and medicine and, hopefully, at the same time lead to new theoretical developments in mathematics and computer science."

### Engineering company opens new Port Talbot site

Braithwaite Engineers, a company from South Wales with a heritage dating back to the 1880s, is investing in the future of steel fabrication in Port Talbot, creating new jobs for skilled people. Historically, the company was a pioneer in heavy engineering, building railways, bridges, piers and steel framed buildings worldwide, including in India, where Braithwaite built much of the railway network and rolling stock. The company has produced sectional water storage tanks since the 1920s at its Neptune Works in Newport, which continue to be used in the UK and exported internationally. The company is now returning to its engineering roots by establishing a structural steelwork fabrication facility at a site in Baglan, Port Talbot. With a 25,000 square foot factory, a three and half acre secure yard and a crane with the capacity to lift 30 tonne units, the company have a new workshop with exceptional versatility.

# Innovation and Impact Awards celebrate Summer of Innovation

**Five pioneering partnerships that have transformed policy and practice in healthcare, business, and society have been celebrated by Cardiff University at the Innovation and Impact Awards.**

The awards form part of Cardiff's Summer of Innovation. Running from June to early October 2016, the Summer of Innovation will shine a light on recent research projects and partnerships.

The Cardiff University Innovation and Impact Awards winners are:

## **Innovation in Healthcare Award**

Tiziana Life Sciences with the School of Bioscience and the School of Pharmacy and Pharmaceutical Sciences for developing a new drug for metastatic breast cancer using a novel inhibitor of Bcl3 as an anti-cancer agent.

## **Business Innovation Award**

Panelina World Transport Limited with Cardiff Business School for creating Lean inventories, a project that helps businesses accurately forecast demand for their products.

## **Impact on Policy Award**

Welsh Government with the School of Social Sciences for ground-breaking work to help tackle violence against women, domestic abuse and sexual violence in Wales and helping to shape new legislation.

## **Social Impact Award**

Welsh Government with the School of Geography and Planning for their innovative research that has changed the way Wales supports homeless people and dramatically increased the number of homeless people assisted each year.

## **International Impact Award**

Johnson Matthey with Cardiff Catalysis Institute for harnessing the power of gold as a cleaner, greener commercial catalyst, which can replace harmful mercury catalysts that are used in the PVC production process.



"This year's shortlisted winners highlight the impact of research not just on healthcare and industry, but on wider society and government policy. They are all outstanding examples of why our world-leading research matters, not just in terms of driving the economy, but in shaping wider society in Wales and beyond."

**Professor Colin Riordan**  
Vice Chancellor  
Cardiff University



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

## Cardiff University scientist tells Parliament to train the brain

Dr Emma Yhnell, a research associate from Cardiff, recently attended Parliament to present her novel approach to combating Huntington's disease to a range of politicians and experts as part of the SET for Britain competition. Around 12,000 people in England and Wales live with Huntington's disease. The disease has no cure and becomes progressively worse over time, affecting movement, cognition and behaviour. By training the brain with specially designed computer games, Dr Yhnell hopes that people with Huntington's disease might be able to improve their cognitive skills and regain some control of their muscular movement. Dr Yhnell said: "What better place to talk about science and research than in the Houses of Parliament. Although my research is focused on Huntington's disease, using games to train the brain can also be helpful in other diseases and for individuals who want to keep their brains fit and healthy."

## Jellagen Pty Ltd completes a new £1.5 million equity investment

Jellagen Pty Ltd, a medical-technology company exploiting jellyfish collagen, has announced the completion of an £1.5m equity investment from Angels in Medcity and London Business Angels, Finance Wales, xénos, the Wales Business Angel Network and other existing investors. The company uses jellyfish to provide the market with a next generation collagen biomaterial, which is safer and more technically versatile than current sources of mammalian derived collagen. Collagen is used in the manufacture of biomaterials due to its ability to form strong fibres and be used in many forms, including membranes. Read more about the technology in Issue 74 of Advances Wales on page 10.

## Novel disease controls in aquaculture to deliver poverty reduction

Swansea University has been successful in attracting over £2m funding, as part of a consortium of nine research institutes and universities in India, the UK and Bangladesh. The group will work towards alleviating poverty within poor farming communities in Bangladesh and India by controlling disease risk in fish and crustacean aquaculture. Infectious disease outbreaks limit the necessary sustainable expansion of the aquaculture industry to meet the challenges of global food security and poverty alleviation. The consortium will engage with local farming communities in Bangladesh and India to identify their experience of poverty and the socioeconomic impact of two key disease outbreaks of Asian aquaculture. The team will also develop a better understanding of the host pathogen interaction for the diseases, with the intention of developing future novel intervention methods with which to tackle infection, reduce disease risk, improve food security and alleviate poverty.

## Turnover hits £40m for Made In Wales winner

Electronics manufacturer Axiom, based in Newport, has reported a record-breaking year with turnover passing the £40m mark. The results, representing the sixth year of sustained growth, were said to be the result of success for the business across the medical, industrial, security, defence and aerospace sectors it serves. The company was named as Manufacturer of the Year at Insider's 2015 Made in Wales Awards, being praised for growing sales four times as fast as the market average over five years and taking on 65 staff in the space of one year. David Davies, Managing Director at Axiom, said: "While we are proud to have broken the £40m milestone, we believe that our success is best represented by the fact that we continually exceed the expectations our customers place on the service we provide."

## Hayakawa relocates in Wrexham

Hayakawa, a quality-focused electronics specialist that manufactures and supplies high performance electronic cabling and wire harness solutions, has moved to larger premises in Wrexham, doubling the size of its operational facility. The company works across a range of sectors including automotive, rail, renewables, lighting and manufacturing. The relocation is expected to provide more space to drive on-going growth, enable the company to rapidly respond to market demands, and create new jobs by the end of 2016. Managing Director, Phill Harry, said: "Demand for high quality wire harnesses has been increasing across a number of sectors, including commercial vehicles and UK manufacturing. Moving to larger premises enables us to respond to this demand quickly whilst supporting the needs of our expanding workforce."



# Mapping a renewable future

Sonar mapping project allows scientists to understand the impact of climate change and renewable energy generation on the seabed

**S**EACAMS is a Bangor University-led project that has mapped hundreds of miles of seabed using sonar to research the impacts of climate change and measure the impact of new marine renewable technologies.

Sonar mapping uses a complex array of individual sound pulses to work out distances, using travel time to calculate depth. Sonar can be used to navigate, communicate with and/or detect objects on or under the surface of the water, such as other vessels.

Over the years, the technology has evolved and been integrated into acoustic multibeam surveying systems to provide swath bathymetry. These systems use a triangular formation of sonar beams to impact on and bounce back from the seabed, providing improved accuracy and higher levels of detail and resolution.

The SEACAMS team have been working closely with the marine renewable energy sector to better understand the marine environment in terms of climate change and its potential to provide renewable energy. Previous studies have involved collaboration with Marine Current Turbines to help maximise the renewable energy potential by predicting factors such as tidal currents and wave heights, featured in Issue 71 of *Advances Wales* on page 3.

Before technology that generates renewable energy under the sea can be introduced, it is necessary to investigate how such devices could impact and influence the



Mapping the seabed is a complicated process due to the dynamic nature of the system, which is influenced by tides, waves and storms.

environment, including marine ecosystems. The scientists behind this project hope to support the developers associated with marine renewable energy generation schemes. The project will also help to develop sustainable fisheries and improve the understanding of the impact of climate change on the seabed.



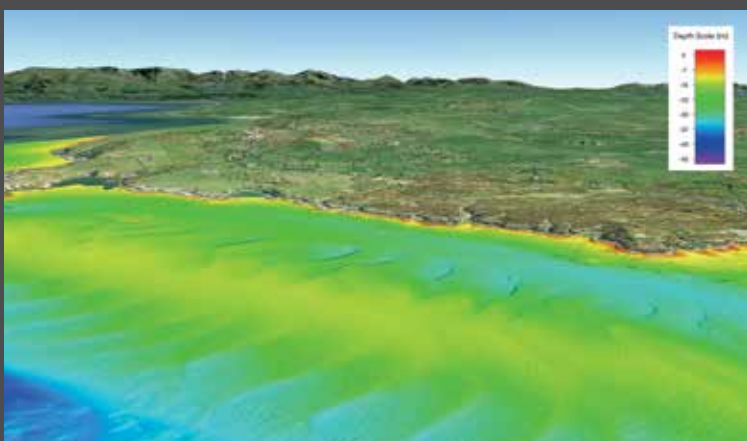
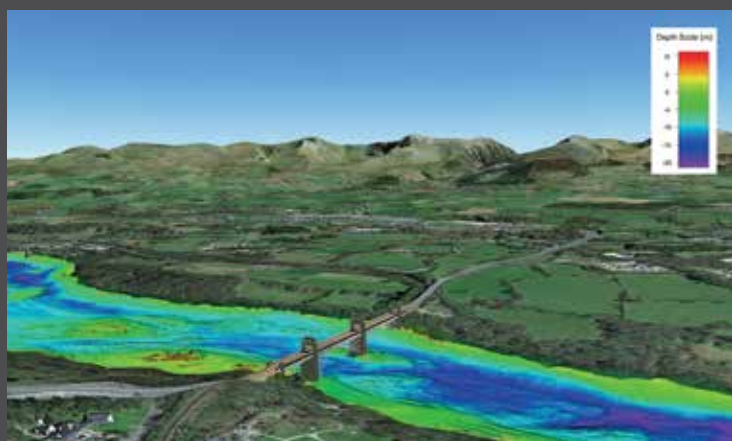
The research will help aid important decisions for integrating renewable technologies into the marine environment, such as proximity of devices and how many to use. Furthermore, when it comes to extracting the energy that has been generated through exporting it to the grid via cabling, the way this may impact on local beaches and other shoreline environments must be carefully considered. The whole process is highly complex.

To accompany the hypothetical investigation of how the marine environment will behave when an object is placed in the water, the team are studying shipwrecks to assess the actual impact structures have on seabed conditions.

Shipwrecks offer a vast and valuable set of data because there are a large number

of them in a range of shapes and sizes. They exist in a variety of locations, with different orientations and strengths of tidal flow, and have been there for varying lengths of time. Some of the wrecks captured by the project dated back to World War One.

Shipwrecks are also useful for measuring how animals colonise and develop eco-systems around foreign objects that are added to their environment. Using different technologies, the team of researchers study what has colonised devices, and in which ways, to help understand how this might be replicated on renewable energy devices in future. As marine devices would be installed over decades, it is essential to understand how the underwater environment could change over time.



Researchers need to develop a good understanding of how the marine environment behaves now, as well as hypothesize how it might change over various timescales. Impacts of climate change include rising sea levels and an increase in the magnitude and frequency of storms. These factors need to be considered when planning for energy projects that have projected lifespans over decades. The researchers are also exploring the potential impacts that renewable technologies may have on the environment itself.

”

“Shipwrecks are interesting because as well as being of obvious historical interest, marine scientists can learn a great deal about the response of the sea and seabed to the presence of these structures in terms of water and sediment movement, and the role they play in creating new habitats for marine organisms.”

**Dr Michael Roberts**  
SEACAMS R&D Project Manager  
Bangor University

### Profile

#### Product

Sonar mapping

#### Applications

Measuring climate change and impact of marine renewable technologies

#### Contact

Michael Roberts  
Centre for Applied Marine Sciences  
Marine Centre Wales  
Bangor University  
Menai Bridge  
Anglesey LL59 5AB, UK  
T: +44 (0)1248 383966  
E: michael.roberts@bangor.ac.uk





# Teaching robots to learn

Humanoid robots imitate child's technique of learning through play

**T**he Intelligent Robotics Group at Aberystwyth University is investigating how young children learn about the world around them and applying this to the development of humanoid robots.

The Modelling Developmental Learning (MoDeL) project is a three-year study, currently in the end of its first year. For humans, it is important to be adaptable to change. Adaptability comes from a process of learning from childhood. The project applies infant development

models to robotics, aiming to create a robot that is flexible, adaptable and able to learn.

In 2015, the group was awarded £560,000 by the EPSRC for a research project that sees the researchers working with developmental psychologists to investigate how robots can learn about the physics of objects and how to use them as tools.

Infants and children at play exhibit exactly the kind of autonomous learning that would be very desirable in robotics. Infant play has a major role in the acquisition of new skills and cognitive growth. MoDeL is a psychologically inspired investigation that uses the analogy of infant play as the central mechanism for autonomous, self-motivated robots that learn the physics of their local world.

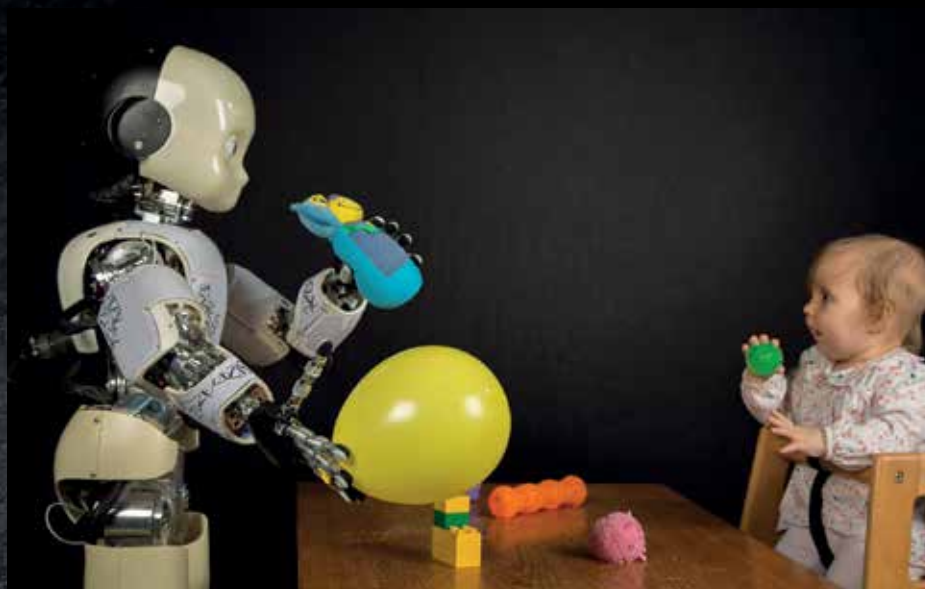
The team have previously looked at how robots can use motor skills and the coordination of looking and reaching. Developing on from that research, this new project investigates how a robot

”

“During infancy, children learn from their experiences of the world around them. Through playing with objects they build up an understanding of what objects are and how to use them, along with concepts about the basic physics of the world such as object permanence.”

Patricia Shaw  
Computer Science Lecturer  
Aberystwyth University





can learn to understand what objects are in their environment through play behaviour.

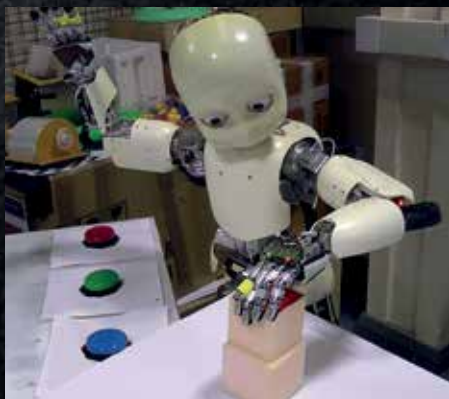
The first ten months of development involve changes in a child's perceptual ability and this influences their understanding. For example, the development of vision affects what captures their attention, and early on, a child is interested in things that are bright and moving. As a child's eyes develop and change, he or she can see more and is receptive to texture and colour influences.

These mechanisms are applied to the robot through a mapping system. This involves lots of maps that represent different sensory and motor spaces. Play represents how connections are made between these, like layers of neurons



in a brain that build connections. The connections developed include an understanding of colour, texture and edge perception, to identify features of objects.

Contributing to the study, a panel of psychologists provided their expertise throughout the project and assisted with the design of matching experiments that compared results from the robot model with those from infants. The data was analysed and interpreted to provide general principles for robots learning through play. Using a developmental approach, the results can be applied to new robotic and intelligent systems to further progress the robots and research studies.



The project implements a play generator algorithm on the iCub humanoid robot that allows experiments through a wide range of scenarios. These include playing solitarily with objects to learn their properties, as well as interactive play with a human participant. Experiments with tool use are also included, in order to investigate how objects may become extensions of self.

Moving forward, the researchers hope that the iCub will be able to build up context of how to use objects. For example, if it was to see an object too far away, it could learn to use another object to retrieve it, recognising how using a tool will help them reach their desired object.

Another outcome for the project is that models of play will help psychologists to understand what is going on in an infant's brain during this period of development. Where the infant cannot communicate and express what is going on, researchers can actually look inside the robot to see what it is thinking. This knowledge could help inform child psychologists in the future.

### Profile

#### Product

Humanoid robot with play generator algorithm

#### Applications

Investigating models of play for robot learning

#### Contact

Dr Patricia Shaw  
Department of  
Computer Science  
Aberystwyth University  
Aberystwyth  
Ceredigion SY23 3DB, UK  
T: +44 (0)1970 622432  
E: phs@aber.ac.uk  
W: www.aber.ac.uk



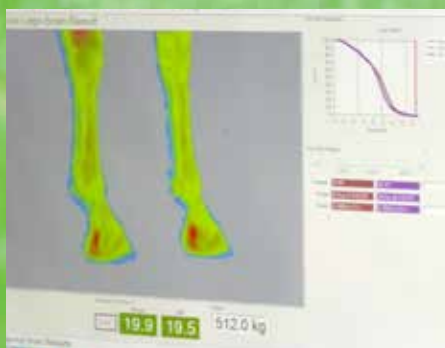
# Going is good for equine analysis

New technology for equine health detects and monitors lower leg injuries using thermal scanning

**A** revolutionary technology that detects and monitors potential lower leg injuries in equine athletes has been developed by Byerley Technologies.

Byerley Technologies creates and sells monitoring products for the horse racing industry, which provide trainers with the required information to prevent lower leg injuries and to help horses recover from injury.

The company's Tendon Manager technology uses thermo graphic analysis to identify preclinical inflammation in equine orthopaedics. Preclinical inflammation is recognised as a temperature difference of more than 1.25°C over 25% of the body area in horses. The technology uses this definition to trigger an automatic warning to the trainer when the temperature reaches



1.5°C, although this setting can be altered to suit individual requirements.

The high-quality thermal imaging cameras can display 19,000 pixels at 100 frames per second. When the system takes a scan, it first isolates the horse's legs. The leg scans are processed and the results are recorded and added to a collection of historical data. The horse's weight is automatically taken and transmitted to a database.

Typically, each leg has 1,400 individual temperature readings. The system creates instant, remote online data of scans and records, which is translated into a simple temperature stress graph. A change in thermal characteristics from the scans highlights a significant reading and the system sends out a warning to the trainer's mobile device.

Initially, any trigger needs to be treated with caution. For example, the horse may have had a small knock in the stable, which will show up as a hotspot on the scan and in some cases may trigger an alarm. In the case of a small knock, the temperature will eventually return to

normal; the time for the temperature to return to normal is proportional to the severity of the injury.

If further investigation is needed, the system will automatically monitor the recovery of any preclinical inflammation. This monitoring and vigilance can ensure the horse does not move from preclinical inflammation into post clinical inflammation.

This information can also confirm whether or not a previously injured horse has fully recovered.

The vastly increased level of precision provided by Tendon Manager has led to a large degree of interest by the horse racing community. The company is currently engaging in further research and developing a new product that will help trainers avoid overworking horses and monitor the impact of training sessions on them.

## Profile

### Product

Thermo graphic analysis

### Applications

Identifying preclinical inflammation in equine orthopaedics

### Contact

Steve Hudd  
Byerley Technologies  
Springboard Innovation Centre  
Cwmbran NP44 3AW, UK  
T: +44 (0)7989 566694  
E: tom@byerleytech.com





# Space-time tracking

Unique tracking solution providing high-accuracy geolocation results in 4-dimensional space-time

**C**hepstow-based ZoneArt Networks has developed **Follow Spot**, a system to locate users and objects in space-time. Measured in milliseconds and centimetres, the technology combines high-speed and accurate geolocation, together with high-capacity Wi-Fi coverage, from a single access point.



There is a growing demand for indoor geolocation services for retail, transportation, healthcare and education. Tracking can provide useful analytics, creating invaluable data.

Location accuracy is often seen as the only metric of importance when considering a geolocation solution, but speed with which a user is located is equally important. Often, the time taken to obtain a position location is 10 seconds or more, because most Wi-Fi based systems rely upon multiple access points to provide a single reading.

For a solution with a claimed accuracy of 1 metre, which actually delivers its location 10 seconds late, the person walking could be 15 metres away from their reported location, in any direction, by the time their position is reported. This represents an area of over 700 square metres within which the person could be located; the equivalent area of three tennis courts. Therefore, a location system must locate in 4-dimensional space-time to be truly effective, accurate and fast.

Traditional Wi-Fi location solutions that use multiple access points typically use omnidirectional radiation patterns that overlap to cover the same physical space. In contrast, ZoneArt's technology uses a single access point to locate users. Measuring in centimetres and in real-time allows the technology to deliver readings with significantly improved accuracy.

Using one access point, the system moves Wi-Fi energy around to follow each user and does not waste signal energy. This has the additional benefit of minimising interference and providing added security. For example, energy is targeted within a building, rather than leaking out in all directions.

This incredibly accurate, targeted and personal experience is unique in the market and could transform a number of industries, including

analytics, retail, hospitality, healthcare, museums and leisure.

The antenna array employed by ZoneArt has an industry-leading level of antenna gain, creating a transformational range and coverage area. It is also capable of eliminating interference from many directions simultaneously. Together, the joint benefits of exceptional gain, leading to better signal strengths and reception sensitivity at all distances from the access point, and interference rejection, ensure much higher data rates for each user and consequently a higher overall capacity for the access point.

The company's solution is compatible with both wall and ceiling mounting, unlike existing solutions that are only capable of providing any meaningful level of coverage when mounted on a ceiling.

Incorporating a fundamentally new architecture, this disruptive technology has been completely re-imagined and re-engineered, utilising simple and low cost parts in a way that has not been done before. Individual targeting of all available signal energy results in an unparalleled user data-rate, quality of service and level of interference immunity.

Moving forward, the company plans to develop a hardware solution to provide both a best-in-class geolocation capability and an affordable, long-range and high-capacity Wi-Fi access point.



## Profile

### Product

4-dimensional space-time tracking

### Applications

High-accuracy geolocation solutions

### Contact

Nick Shaw

ZoneArt Networks

Trap Farm

Devauden

Chepstow NP16 6PE, UK

T: +44 (0)7773 778319

E: [nick.shaw@zoneartnetworks.com](mailto:nick.shaw@zoneartnetworks.com)

W: [www.zoneartnetworks.com](http://www.zoneartnetworks.com)



# Sign of things to come for digital

Electronic advancements for more environmentally friendly digital display technology

**D**ST Innovations Ltd (DST) has developed a series of technologies in plastic electronics. The company's new product, Videobrix®, is a modular digital display technology designed by a specialist team of PhD material scientists and electronics engineers based in Bridgend, South Wales.

The core technology is a technique for printing electronic circuitry on a range of materials from plastic polymers and paper to cloth. The technology uses low powered electronics, which are connected through the circuitry to digital displays made from semi-conductor components or luminescent materials. With higher efficiency, the technology uses up to 50% less power than traditional LED displays.

The panels are magnetically joined, with no wiring or complex display configurations, and easily mounted without the need for technicians. The screens can be networked, allowing remote access and an easier process for updating content.

The system works by using a single master panel, which powers multiple slave panels with automated screen adjustment. The system will also have return adjustment and return diagnostics for pixel management.

With durable and hard-wearing displays that are anti-scratch and weather resistant, this technology offers more than traditional LED displays. The screens are engineered so that they can stay cold to the touch, whilst being able to withstand moisture and extremes in temperature.

Using environment friendly, non-toxic, recyclable materials that are portable, easy to assemble and lightweight, the displays are a step forward for out-of-home advertising.

A forthcoming version that is being developed uses free hanging panels without casing, which can function around curved or moulded surfaces. These will complement traditional displays and speed the transition from print screens to digital.



## Profile

### Product

Digital display technology

### Applications

Out-of-home advertising and signage

### Contact

Mathew Gilliat-Smith  
DST Innovations Ltd  
6a Bridgend Business Centre  
Bennett Street  
Bridgend CF31 3SH, UK  
T: +44 (0)8458 625544  
E: mathew.gilliat-smith@dst-innovations.net  
W: www.dst-innovations.net





# In depth approach to wave energy

Unique technology developed to harness marine energy

**M**arine Power Systems, based in Swansea in South Wales, is Wales' leading wave energy technology developer. The company has developed the WaveSub energy converter, a device that redefines technical boundaries to capture the energy potential of ocean waves.

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“The results of our work to date have proven that the WaveSub solves the key challenges that face wave energy devices and we feel Marine Power Systems is one of the key companies leading the way in terms of technological advancements in harnessing this abundant form of energy.”

**Dr Gareth Stockman**  
Managing Director  
Marine Power Systems

The technology has the potential to reduce the costs associated with this method of energy generation, and the company is currently creating a prototype to be tested in Milford Haven and FaBTest in Falmouth Bay. The results of this project will inform the development of a full-scale version of the device.

The team at Marine Power Systems has made significant progress to date; having created an initial prototype device for sea trials and energy generation tests with successful results, the engineers proved the operating principles and ability of the technology to create energy.

Following on from this, further evaluation projects have been carried out to explore the cost of installation and maintenance of the technology, as well as the cost of delivering the energy. The results highlighted the substantially reduced costs associated with energy generation from waves in comparison to other technologies.

Currently, Marine Power Systems is in the process of designing, building and testing a quarter-scale prototype at sea. This allows the team to put all planning into practice and directly address the fundamental challenges facing devices that use wave energy.

The unique technology can exploit the energy of a wide range of waves, in

almost any offshore environment. With a subsurface orbiting energy capture system, the WaveSub harnesses the entire energy cycle of the wave. The device is depth-adjustable, allowing it to descend beneath storms when necessary and combat the harsh and dynamic weather environment. The floating surface configuration of the device makes it easy to transport, install and maintain, and its small size and simple shape ensures it can be manufactured at a low cost.



Using wave energy as a global resource could significantly reduce the dependency on fossil fuels and carbon emissions. The EU aims to get 20% of its energy from renewable sources by 2020, and the oceans surrounding the UK are a resource that could provide 50 terawatts per hour (TWh) of energy, offering the United Kingdom the unique opportunity to become a global leader in the development of wave energy technology.

## Profile

### Product

Wave energy capture system

### Applications

Marine renewable energy generation

### Contact

Dr Gareth Stockman  
Ethos Building  
Kings Road  
Swansea SA1 8AST, UK  
T: +44 (0)1792 277160  
E: [gareth@marinepowersystems.co.uk](mailto:gareth@marinepowersystems.co.uk)  
W: [www.marinepowersystems.co.uk](http://www.marinepowersystems.co.uk)



# Bacteria help for healthier hearts

Welsh scientists identify cholesterol-lowering friendly bacteria

**A collaborative study between Cardiff University and probiotic manufacturer Cultech has found that friendly bacteria can play a role in helping to prevent high blood cholesterol levels, and support current treatment programmes for heart disease.**

Heart disease kills approximately one person every 34 seconds and is responsible for more deaths worldwide than any other disease. It is a major economic burden costing the UK economy about £19 billion per year.

Having high cholesterol levels is one of the major risk factors for heart disease. A class of medications known as statins are currently widely used to manage this problem, but these sometimes have limited effectiveness and can be associated with numerous adverse side effects. This has encouraged the scientific community to search for alternative approaches, with probiotics emerging as a potential solution.

Probiotics are live microorganisms such as bacteria and yeasts that can provide various health benefits. These are also commonly known as friendly, good or healthy bacteria.

This study used cell-based experimental models to identify a strain of friendly bacteria that may be able to help lower blood cholesterol levels. Researchers found that the presence of *Lactobacillus plantarum* CUL66 can alter the behaviour of the major cholesterol absorbing cells of the intestines and reduce their ability to transport cholesterol.

It is now well understood that bacteria within the intestines, including probiotic organisms, can also control cholesterol absorption and numerous other processes by interacting with and altering the behaviour of intestinal cells.

Cultech researchers found a pattern of gene expression emerge that was synonymous with a reduced ability of some cells to absorb cholesterol. The researchers collaborated with the School of Biosciences at Cardiff University to confirm these effects. They demonstrated that particular cells exposed to *Lactobacillus plantarum* CUL66 had an impaired ability to transport cholesterol and further highlighted the potential cholesterol-lowering ability of this strain.

Based on the promising results from the research so far, a new collaborative study between Cultech and Cardiff University

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“This piece of research has potential implications for the way we address the treatment of high blood cholesterol, and we look forward to carrying out further studies in this area.”

**Dr Daryn Michael**  
Senior Research Scientist  
Cultech

is currently underway. The study aims to confirm the anti-cholesterolemic effects of *Lactobacillus plantarum* CUL66, in combination with the company's flagship Lab4 probiotic consortium.

## Profile

### Product

Probiotics and friendly bacteria

### Applications

Preventing high blood cholesterol levels

### Contact

Daryn Michael  
Unit 3 Christchurch Road  
Baglan Industrial Park  
Port Talbot SA12 7BZ, UK  
T: +44 (0) 1639 825100  
E: DarynM@cultech.co.uk  
W: www.cultech.co.uk





# Recycling radioisotopes

World's first company to recycle the radiolabel carbon-14

**Q**uotient Bioresearch is a contract research organisation that provides radioactive tracers. Working with clients across the globe in the pharmaceutical, biotechnology, agrochemical, chemical and animal health industries, the company delivers early stage and specialist drug development services, testing how drug candidates and medicines are metabolised and react with the body.

Radiolabelling tends to produce a large amount of synthetic waste. Quotient Bioresearch recently benefitted from funding to develop a recycling plant for its raw material, meaning the bi-products of carbon-14 synthesis can be recycled and harnessed.

The company has now become the world's first to recycle carbon-14, which has been



A radioactive tracer, or radiolabel, is a chemical compound in which one or more atoms have been replaced by a radioisotope. Carbon-14 is a radioactive isotope of carbon. It is present in organic materials and can be used as a radioactive tracer for metabolism studies.

suffering a supply shortage in recent years. As a solution to both the supply and waste issues, the recycling plant allows this raw material to be re-used, alleviating demand and offering a more sustainable way of working.

The technology converts synthetic waste using a process of isotopic enrichment. The process involves oxidising the waste to form

carbon dioxide in an electrochemical cell with a nitric acid electrolyte, which is then converted to methane.

The isotopic forms of methane are easier to separate by thermal diffusion, because the mass difference in between isotopes is relatively large. The gas mixture is passed through a column with cold walls and a heated central rod. The lighter methane molecules move towards the heated rod and the heavier methane moves to the cold wall. This enriched methane product is re-oxidised to form highly enriched carbon dioxide. The reaction in the plant takes less than 2 hours and creates a substance with a purity of 99.6%.

To demonstrate the enriched carbon dioxide's efficacy for radiolabelling, researchers used it to label an anti-inflammatory generic drug with the gaseous carbon-14 precursor.

The company is also exploring how to re-use clients' unused excess material, so that excess units of carbon-14 can be retrieved and recycled. In time, the company plans to explore every opportunity to source materials to put through the plant, reducing global emissions to the environment, reducing waste disposal issues and costs, and creating a more sustainable future for industry.



## Profile

### Product

Recycling system for carbon-14

### Applications

Sustainable radiolabelling for drug discovery

### Contact

Mark Waring  
The Old Glassworks  
Nettlefold Road  
Cardiff CF24 5JQ, UK  
T: +44 (0) 2920 474 907  
E: Mark.Waring@quotientbioresearch.com  
W: www.quotientbioresearch.com



# Taking the pressure off

Hybrid mattress offers innovative solution for the prevention and treatment of pressure ulcers

**D**irect Healthcare Services, based in Caerphilly, South Wales, has been working to reduce the incidence of avoidable pressure ulcers. The prevention strategy is called Intelligent Pressure Care Management, featuring a unique hybrid mattress.



Pressure ulcers are the most costly chronic wounds treated by healthcare professionals in the UK. Each year, it is estimated that 400,000 patients in the UK develop a pressure ulcer, although the vast majority are considered avoidable.

Patients with serious comorbidities, including diabetes, are at high risk of developing pressure ulceration. The Department for Health, along with other organisations, has highlighted the need to develop new solutions to combat this largely avoidable problem. In response to this, Direct Healthcare Services has created a

hybrid of a high specification foam mattress and a dynamic mattress. It allows nurses to instantly convert any standard hospital bed into a dynamic mattress, enabling earlier intervention for at-risk patients. Currently, 45,000 patients in the UK are nursed on the hybrid mattress each day.

The technology was developed to address key factors within pressure ulcer prevention protocol, allowing earlier intervention with the appropriate support surface and offering a solution for the vast majority of clinical areas and requirements, including admission, discharge and community care.

The therapy delivered by the support surface can be quickly adjusted to meet a patient's specific needs. The mattress can be converted rapidly to provide effective pressure relief to support the treatment of pressure ulcers. Use of this mattress also minimises the need to transfer the patient from one surface onto another, which reduces risk of patient trauma and nurse injury.

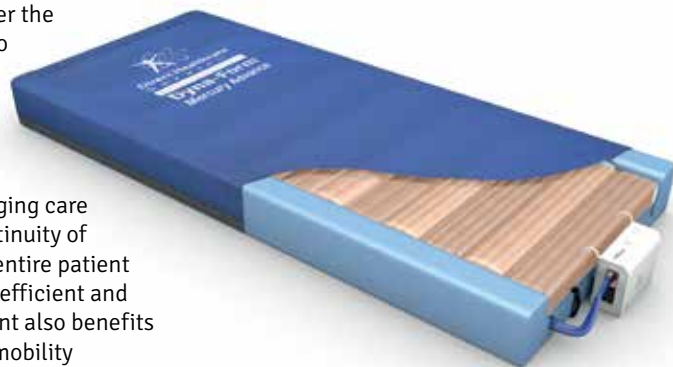
The simple features offer a responsive approach to changing care requirements. It ensures continuity of patient care throughout the entire patient pathway, whilst providing an efficient and economic solution. The patient also benefits from better sleep, improved mobility and uplift in general mental wellbeing. Increased comfort for the patient results in higher patient compliance and improved healing rates.

The technology recently earned royal recognition with a prestigious Queen's Award for Enterprise in Innovation.

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“Delivering genuine innovation that makes a real difference to both patients and the lives of our hardworking healthcare professionals is at the very heart of everything we do, so we are incredibly honoured to receive such a prestigious award. We are even more proud that our solution has been of huge benefit to the NHS, helping patients and saving valuable time and resources.”

**Graham Ewart**  
Managing Director  
Direct Healthcare Services



## Profile

### Product

Dynamic bed and management system

### Applications

Prevention and treatment of pressure ulcers

### Contact

Jane Devenney  
6-10 Withey Court  
Western Industrial Estate  
Caerphilly CF83 1BF, UK  
T: +44 (0) 845 459 9831  
E: jane.devenney@directhealthcareservices.co.uk  
W: www.directhealthcareservices.co.uk





# PET Project

Advanced scanner can detect tumours that are just millimetres in size to inform decisions about treatment

**T**he Cardiff University-led multi-million pound Positron Emission Tomography (PET) Imaging Centre is one of the most advanced facilities in the UK, giving researchers and doctors the ability to detect malignant tissue and track the effects of drugs in incredible detail.

Operated by Cardiff University in partnership with Cardiff and Vale University Health Board, the new centre is located in specially built premises at Cardiff's Heath Park complex. Before these facilities were available, it was difficult for patients and clinicians to access these services. Previously, Welsh patients had to travel to Cheltenham or London for their scans, and PET scanning for the management of cancer was underutilised in Wales.

The centre is improving the service for thousands of patients across the nation every year. The scanner can detect tumours using the radiopharmaceutical  $^{18}\text{F}$  FDG when they are just a few millimetres in size and can indicate how active a tumour is, helping to inform a doctor's decision about the most appropriate course of treatment for different patients. The technology can also allow a doctor to track a patient's progress during therapy, providing key insight into how a patient is responding to therapy much earlier than existing techniques.

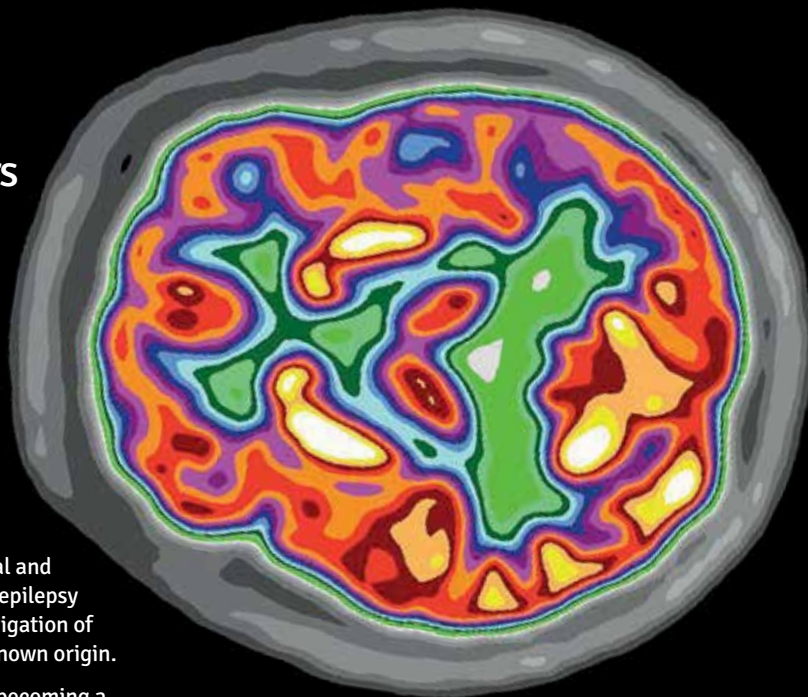
With an improved understanding of how effectively a particular treatment is going, healthcare professionals can quickly recognise if a different course of therapy needs to be taken, ensuring patients continue to receive the best possible care and giving them the best chance of recovery.

In its first year of operation during 2011-12, the centre provided 1,285 scans. Clinical indications have recently been expanded to include scanning of patients with

gynaecological and anal cancers, epilepsy and the investigation of cancer of unknown origin.

As a result of becoming a regional centre of excellence and providing paediatric PET scanning for the whole of the South West region, demand for  $^{18}\text{F}$  FDG PET has increased by around 18% year on year, with 2,119 scans performed for the Welsh NHS in 2015-16.

Researchers at the PET Imaging Centre regularly work with clinicians to identify areas that need service improvement and continue to move technology forward. The introduction and increased utilisation of PET in Wales has significantly altered patient management, improved accuracy of diagnosis and staging in a range of cancers. Furthermore, when the cancer is treated earlier, it can lead to reduced numbers of futile surgical interventions and biopsies.



The activities at the facility continue to develop, and the centre's use of  $^{68}\text{Ga}$  Gallium DOTA imaging, which will revolutionise the management of neuroendocrine tumours in Wales, has recently been approved. Funding has been secured for the development of an  $^{18}\text{F}$  Tau imaging agent for human use and the centre has also developed a number of platforms for pre-clinical research, including  $^{89}\text{Zr}$  Zirconium labelling and imaging of monoclonal antibodies, and cell labelling and tracking. These recent approvals and funding for revolutionary imaging agents are expected to transform the management of tumours in Wales before the end of 2016.



PET Imaging Centre has developed a number of platforms that are available for companies and researchers in life sciences, including:

- $^{18}\text{F}$  DOPA to measure Dopaminergic function
- $^{18}\text{F}$  Fallypride to measure Dopaminergic receptor function
- $^{18}\text{F}$  Beta Amyloid Imaging to measure levels of Beta Amyloid in vivo
- $^{18}\text{F}$  Choline to image prostate cancer

## Profile

### Product

Positron Emission Tomography (PET) Imaging Centre

### Applications

Cancer tumour and neurological diagnosis and monitoring

### Contact

Dr Chris Marshall  
Room 694  
Ground Floor 'C' Block  
Cardiff University, School of Medicine  
Heath Park,  
Cardiff CF14 4XN, UK  
T: +44 (0) 2920 743 070  
E: MarshallC3@cardiff.ac.uk  
W: www.medicine.cf.ac.uk/petic



# 3D scanning for record breaking wingsuit

World's first 3D scanning of free-falling simulation to measure wingsuit aerodynamics

**O**R3D, based in Wrexham, North Wales, has developed an innovative 3D scanning solution to support Project Icarus, a student design project at the University of Southampton, which will culminate in a world record attempt for the highest, longest and fastest free-fall jump wearing a wingsuit in Autumn 2016.

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“OR3D provided a world first; vital 3D wingsuit data in a dynamic and challenging environment, enabling us to develop our world-class wingsuit design.”

Dr Angelo Niko Grubišić  
Lecturer of Astronautics  
University of Southampton and Project Icarus



The company was challenged to use 3D scanning technology that could measure and record a free-fall simulation in a wind tunnel, in order to understand how wingsuits operate aerodynamically.

Collaborating to create the world's first 3D laser scanned models of wingsuits in flight, the teams worked together to share

scientific insight for developing advanced wingsuit aerodynamics. Data of three variants were reviewed to give the product designers a baseline to start from, aiding them towards generating a potentially world-record-breaking wingsuit.

The company's scanning technology was used to capture the designs under

flight conditions in the RJ Mitchell Wind tunnel. The team laser scanned the wingsuits to record the geometry so that computer simulations could determine the flow-field around them in flight, allowing the designers to modify and improve them. The technology that was used incorporated the Mantis Vision F5 range of scanners, which can very quickly



gather data with an accuracy of down to  $\pm 0.25\text{mm}$ , collecting 500,000 data points every second.

Uniquely, the laser scanner is a dynamic video-based system, whereas most other scanning systems require a fixed point of reference to work from. This makes these scanners the most appropriate instrument while working in a tough environment, such as a wind tunnel.

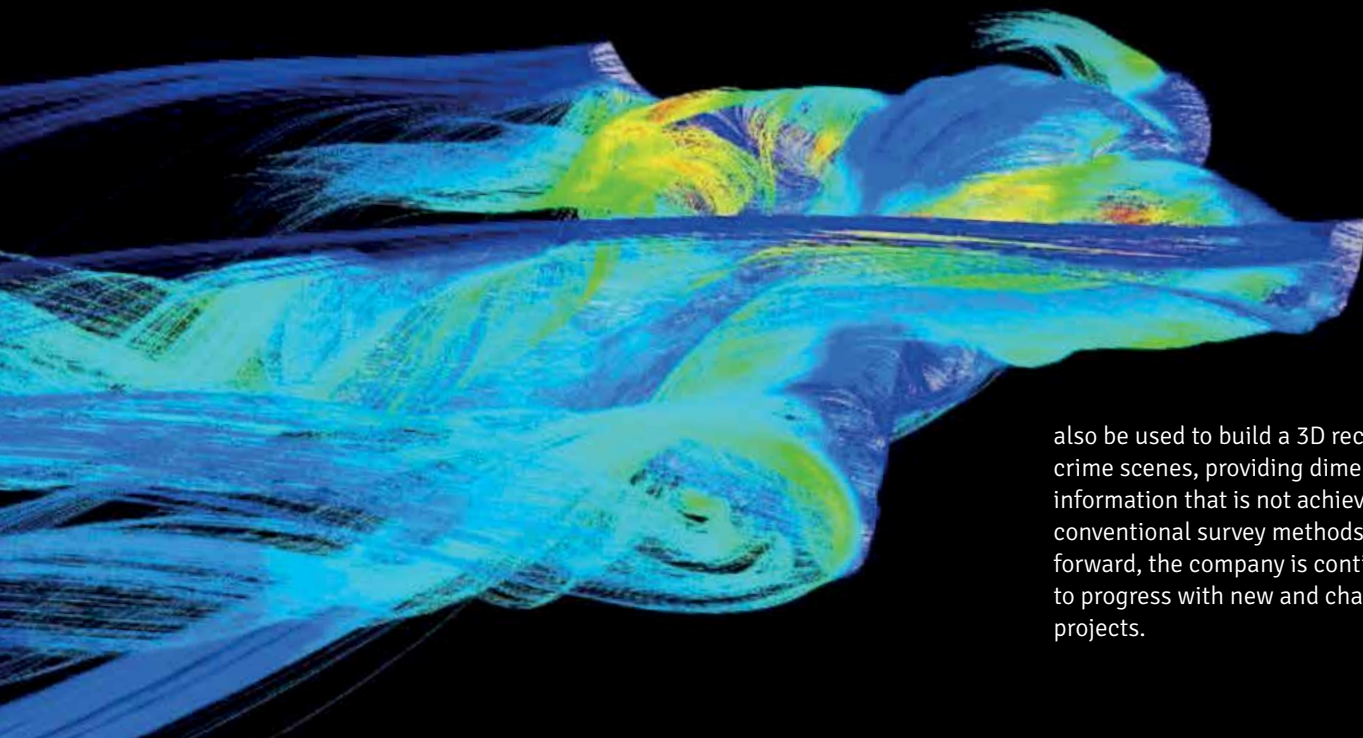
Geomagic Design X, a specialist reverse engineering application, was used to process the scans. Freeform Plus software

was then used to turn the scan data into a virtual clay, which could be edited using a haptic device allowing the user to physically interact with the 3D model. The finalised model was imported into a computational fluid dynamics (CFD) application. The numerical analysis and algorithms were used to improve the accuracy and speed of complex simulation scenarios, such as transonic or turbulent flows.

The scanner operates at high speed to capture data, which complements the high-speed activities that it scans. Laser

scanning technology can be used for a wide range of applications, with previous OR3D projects involving the scanning of engines, vehicles, medical parts, statues, bridges, roads, and aircraft.

Several large car manufacturers are also using this scanning technology in order to record their crash tests. The advanced technology allows manufacturers to scan a vehicle very quickly and with no preparation. It generates a 3D record of each car crash test conducted, which can be used to quickly compare one crash against another. The scanners can



also be used to build a 3D recording of crime scenes, providing dimensional information that is not achievable with conventional survey methods. Moving forward, the company is continuing to progress with new and challenging projects.



### Profile

**Product**  
3D scanner

**Applications**  
Measuring aerodynamics of free-fall simulation

**Contact**  
James Earl  
2 The Sawmill  
Brynkinalt  
Chirk  
Wrexham LL14 5NS. UK  
T: +44 (0) 1691 777 774  
E: info@or3d.co.uk  
W: www.or3d.co.uk



**H**ydrogen, made of a proton and an electron, is the most abundant element in existence, and it is hard to imagine life without it. According to the Standard Model, the physics theory that explains how the basic building blocks of matter interact, an equal amount of matter and antimatter formed at the birth of the Universe.

# Big Bang balance

World-leading experiment takes measurements of the properties of antihydrogen

However, almost no antimatter can be found today. Unless we make it ourselves, there is no sign of antihydrogen, the antimatter counterpart of hydrogen, but nobody knows why.



Matter and antimatter annihilate upon contact; if there was ever a balance, we wonder why there is almost no antimatter left at all. This is a serious puzzle for physicists, because symmetry is so central to the way that nature is understood.

The Standard Model also says that during the Big Bang, equal amounts of antimatter and matter were created. Therefore, the current model predicts that we should not be here to ask this question at all. The theory that the Universe is composed of half matter and half antimatter would mean that everything was annihilated and we would never have existed.

Physicists from Swansea University's College of Science, together with

colleagues from the international ALPHA collaboration at CERN, are using state-of-the-art techniques to address as many aspects of antimatter as possible in order to determine if there is a difference between antimatter and matter that can explain this conundrum.

Their research has found a new limit on the charge of antihydrogen atoms, which was obtained by 'tickling' the anti-atoms while they were held in a magnetic bottle. This world-leading experiment is the first that has done any measurements of the properties of antihydrogen. In previous experiments, the researchers have obtained a first glimpse of its internal structure, by manipulating a property called the spin of the antielectron.

The aim of the studies is to move forward our understanding of why we are here, and how the Universe could evolve from the Big Bang to today in the way it has done. Matter-antimatter symmetry lies at the heart of this endeavour.

In this experiment, physicists studied the antihydrogen atoms by first combining an antiproton and a positron (the antimatter equivalent of an electron) to make antihydrogen, which they trapped in a magnetic field. They then kicked the trapped particles with an electric field to see if they would react. If an antihydrogen

reacts and escapes from the trap, this means it has a charge; if it doesn't then it's neutral.

As no atoms escaped, the researchers concluded that the limit on the possible charge of the antihydrogen atom was less than about one billionth of that of an electron.

To move forward, the researchers plan to measure the internal properties of antihydrogen, and measure the gravitational force on antihydrogen.

## Profile

### Product

Antimatter research experiment

### Applications

Exploring antihydrogen atom properties

### Contact

Niels Madsen  
Department of Physics  
College of Science  
Swansea University  
Singleton Park  
Swansea SA2 8PP, UK  
T: +44 (0) 1792 602 652  
E: n.madsen@swansea.ac.uk  
W: www.swansea.ac.uk

