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advances WALES

Humans and robots working together

Human-robot collaborations are increasing efficiency in manufacturing

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THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

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"Not all problems have a technological answer, but when they do, that is the more lasting solution."

Andy Grove, Semiconductor Pioneer

Advances Wales highlights the biggest developments in science, engineering and technology across Wales.

This edition features collaborative robots working alongside humans to increase efficiency in factories (pages 14-15), as well as laser wire stripping machines improving precision in manufacturing (page 20). Both technologies have been developed by Welsh companies and are having a global impact.

In the medical sphere, an innovative system is making life less difficult for people with type 1 diabetes (pages 6-7) and bioprocessing technology is making organoids more widely available for cancer research (page 9). Wales-based scientists have also made progress in understanding schizophrenia (page 8).

Meanwhile in agriculture, there has been a groundbreaking investigation into methods of fighting invasive Japanese knotweed (page 10) and a new insect trap enables farmers to tackle pests without a need for pesticides (page 11).

Penrhyn Castle is also becoming more energy efficient with the help of innovative technology (pages 18-19), while smart devices could gain the ability to harvest energy and power themselves without batteries (page 17). Other featured technologies include a self-healing system for masonry (page 13) and a digital platform for identity verification (page 16).

This edition of Advances Wales, and past editions, can be viewed online.

Sophie Davies
Editor

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Advances Wales is a quarterly technology journal produced by Welsh Government to showcase new developments in science, engineering and technology from 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.

For information on how to contribute features contact the editor, Sophie Davies tel 029 2047 3456
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Investigating concussion risk in rugby

Researchers at Cardiff Metropolitan University have discovered that rugby players are more likely to sustain a concussion after playing 25 matches.

Cases of concussion in rugby union have more than doubled in Wales and England since 2012. To investigate this, Cardiff Metropolitan University's School of Sport and Heath Sciences worked in collaboration with the School of Management. They conducted a study over four seasons of play using data from the Welsh Rugby Union's injury surveillance programme.

Although the increase in cases of concussion can be partly attributed to increased awareness of the symptoms, findings from the new study suggest that there are more contributory factors. One key factor was found to be the frequency of games. In Wales, approximately 10 per cent of professional rugby players are exposed to more than 25 matches a season, and incidences of concussion have increased year on year from the 2012/2013 season to the 2015/2016 season.

It was also found that once players have sustained a concussion, they are at a 38 per cent greater risk of sustaining another injury, compared to players who sustained a type of injury other than concussion. Moreover, injuries following a concussion were found to happen approximately two weeks sooner than injuries following a non-concussive injury.

There is currently a six-day return to play protocol following concussion, but the findings of the study bring into question whether this protocol is long enough to minimise the subsequent injury risk.

www.cardiffmet.ac.uk

Replacing microbeads with ground down seashells

Scientists at Swansea University are exploring the potential of using waste seashells in face washes as an alternative to microbeads.

Tiny pieces of plastic known as microbeads are commonly used in products such as face washes and toothpaste, but they have been found to have a detrimental effect on marine life. A team at Swansea University are therefore looking into the feasibility of a natural alternative – ground down shells.

Quay Fresh and Frozen Foods in New Quay, Ceredigion, are providing whelk shells for the research from the approximately 800,000 tonnes of by-product they have each year. The shells are crushed into a powder, before being analysed to check the composition and determine if there are any traces of heavy metals which could prevent the powder from being used on people's skin.

Ground down shells are abrasive, so would be suitable for use in cleaning products. The research team hopes that tests will show they can also be used in cosmetics.

"We're investigating how the shell powder can be used, the characteristics of it in different materials, such as in liquids or gels, and whether it behaves the same as a microbead. We haven't heard of people using waste shells as a replacement for microbeads, which is one of the reasons we want to investigate it."

Chiara Bertelli
Department of Biosciences
Swansea University

www.swansea.ac.uk

New technique reduces emissions in glass-making

A new way of reducing Nitrogen Oxide emissions produced by the glass-making industry has been developed by the University of South Wales with industry partners.

In conventional methods of firing glass-melting furnaces, large amounts of Nitrogen Oxide are produced and this is damaging to the environment. EU legislation now says that steps must be taken to reduce the emissions produced by such furnaces, which operate 24 hours a day, 365 days a year, for 15-20 years at a time.

Previously, reducing emissions would have meant companies spending millions of pounds on adding catalysts to their systems in order to clean the flue gases. However, a different approach to firing furnaces has now been developed, allowing emissions limits to be met while reducing or eliminating the use of flue gas clean-up. The quality and quantity of the melted glass produced remains unchanged.

The University of South Wales has worked with France's ENGIE and Scotland's Global Combustion Systems to develop the new firing technique.

"The high level of emissions produced by glass manufacture has long been a costly issue for the industry. The new combustion technique that we have developed with our industry partners marks a real opportunity for companies to meet EU regulations and save millions of pounds."

CK Tan
Faculty of Computing Engineering and Science
University of South Wales

www.southwales.ac.uk

IN BRIEF

Support for the steel industry

Swansea University's Steel and Metals Institute has been awarded £3 million of funding from the Higher Education Funding Council for Wales to support its vision of delivering a 21st century steel industry and future-proofing steel in Wales and the UK. This funding will enable the Institute to help the UK's iron and steel making industry transform into a low carbon, resource efficient sector utilising societal waste, such as plastics, which are currently non-recyclable. The focus of the additional funding will be on smart steel processing of high value products, including steels for electric powered vehicles, manufactured affordable CO2-positive buildings and sustainable packaging that can only be delivered through the use of steel. The funding supports five key areas of research – carbon neutral steelmaking, advanced alloy optimisation, performance in extreme environments, novel functional metallic coatings and imaging science.

Funding for digital health tech

Bond Digital Health, which develops software and other technology to support health providers, practitioners and patients, has received a private equity investment of £200,000 as well as a £68,583 grant. The £200,000 is part of a planned £1 million funding round for 2018 and will be used to support the growth of the business, including creating new jobs. The grant, awarded as part of Innovate UK's Precision Medicine competition, will allow the company to develop a new wearable technology product for patients with chronic obstructive pulmonary disease (COPD). This device, described as a 'digital stethoscope', will help patients to monitor their condition and will provide more accurate and comprehensive health data for their doctor.

Science park opens its doors

Menai Science Park (M-SParc) has officially opened in Anglesey. As part of Bangor University, it has been set up to bridge the gap between cutting-edge academic research and companies. The park's 30-year vision is based on creating highly skilled jobs for local people, developing a knowledge-sharing environment and creating an economic hub in sectors such as low carbon, energy and environment and ICT. Professor John G Hughes, Bangor University Vice Chancellor said: "We are working together with companies to ensure spin-outs and commercial research from the University can find a home at M-SParc. It is encouraging to see the uptake this early on, and the aim now will be to continue to support companies based there, and encourage graduates to see that there are prospects in North Wales and high-level jobs are being created in the region."

New warehouse to support armed forces

Optical and photonics business Qioptiq has opened a new £3.7 million warehouse in St Asaph, North Wales that will support an £83 million contract with the Ministry of Defence. The six-year contract saves the MoD £47 million and means Qioptiq will ensure vital night vision equipment is available to UK armed forces around the globe. The company's success came after it realised it needed to take a more collaborative approach to its work and gain outside expertise on reducing costs through a leaner supply chain. It entered into a Knowledge Transfer Partnership (KTP) with Cardiff Business School and KTP associate Thanos Goltos. Thanos worked for the company under the supervision of business school academics. His expertise in inventory forecasting showed how the business could reduce its inventory by 25 per cent.

Off-road wheelchair secures seed funding

Denbigh-based company Off-Road Engineering has been awarded £25,000 seed funding to design and develop innovative six-wheeled off-road wheelchairs. The HexHog has a flexible chassis, which keeps all six wheels in contact with the ground, even on the most rugged terrain. Engineer Sion Pierce came up with the idea when studying engineering at Harper Adams University and hearing about a disabled farmer who couldn't access all of his land safely. Sion commented: "Other wheelchairs dubbed 'all-terrain' are suitable for flat or muddy surfaces but struggle with the rugged countryside terrain. From private individuals who enjoy an outdoor life to farm workers who have lost their ability to continue working due to an accident, the Hexhog is ideal for anybody with a physical disability who needs the capability of a quad bike but is dependent on a wheelchair."

Awards for technology innovators

Winners across nine categories have been crowned at the Wales Technology Awards 2018.

The Sir Michael Moritz Tech Start-up Award went to We Build Bots, who have developed an AI-driven customer service automation platform. The ESTnetNG Tech Prize was awarded to David Barton, who has designed an insole to aid the healing of diabetic foot ulcerations by reducing the harmful pressures acting beneath them that prevent their healing.

AMPLYFI, who featured in Advances 80, won the Innovative Product of the Year Award for their AI-powered platform that mines the surface and deep web to make predictions and projection models for businesses. Signum Health received the Best Application of Tech Award for their cloud-based medical technology platform that directly connects patients with healthcare professionals.

The International Impact Award for Hardware was given to Silvertel, who specialise in the design and supply of electronic modules, and the International Impact Award for Software went to Wales Interactive, an independent video games developer and publisher. DevOpsGuys won the Best Tech Workplace Award, while Hywel Ifans from BCC IT won the Technology Leader of the Year Award and Callen Gibbs from Capital Network Solutions received the Best New Talent Award.

www.estnetawards.co.uk

Chatbot platform raises investment

Artificial intelligence technology start-up We Build Bots has raised more than £575,000 of investment in a bid to accelerate the growth of its chatbot platform. The company had aimed to raise £500,000 through crowdfunding but surpassed this goal within 50 days. During the crowdfunding campaign, the company created a chatbot that could answer questions from potential investors via Facebook Messenger, providing information while showcasing the company's technology. We Build Bots is currently valued at £2 million and founder Paul Shepherd plans to grow the company into a £100 million-valued business within the next five years. Its flagship customer service automation platform, IntelAgent, automates messaging apps, SMS, email, social media and voice assistants to provide customers with answers, perform tasks and identify sales opportunities.

Funding for fingerprint sensing technology

Touch Biometrix has secured £150,000 funding to develop new fingerprint sensors for consumer electronics such as laptops and smartphones. The company, based in St Asaph, has plans to eradicate the need for computer and mobile phone passwords and to become one of the top five fingerprint sensor suppliers in the world by 2023. Dr Mike Cowin, Chief Executive of Touch Biometrix, said: "The demand for user authentication and mobile payment services is driving tremendous growth. The industry predicts that biometrics will be standard in 90 per cent of mobile devices in the next four years, generating 1.37 trillion mobile device transactions. We will be using the money from our initial seed funding round to establish a minimum viable product in collaboration with our supply chain partners."

Programme to cut carbon emissions

A new £9.2m scheme has been announced to test and drive forward next-generation technologies in order to help reduce carbon emissions from Welsh industry. The Reduced Industrial Carbon Emissions (RICE) initiative will be led by the Energy Safety Research Institute (ESRI) at Swansea University, in partnership with the Sustainable Energy Research Centre (SERC) team at the University of South Wales. Experts will work with local supply chain companies to test how carbon dioxide produced from heavy industrial processes can be innovatively used to make high value products and industrially important chemicals. They will also explore the production of green hydrogen, which can be used to fuel cars, other modes of transport and energy production processes. As part of the project, large-scale demonstration systems will be set up with global steel manufacturer Tata Steel, as well as Welsh Water, to support the testing of technologies that can capture carbon dioxide and convert it into high-end products.

Queen's award winners

Eleven Welsh businesses, across a wide range of industries, have been named as winners of the Queen's Awards for Enterprise 2018. The awards are given for the "highest levels of excellence" demonstrated in categories including innovation and international trade. Innovation awards went to vehicle trackers for insurance and fleet management Quartix, HD video hardware manufacturer Quicklink Video Distribution, crop protection company Russell IPM, and electronics component manufacturer SPTS Technologies. Underwater yacht lighting company Lumishore won two awards, for innovation and for international trade. Other winners of international trade awards were engineers to the oil industry Cokebusters, call blocking developers CPR Global, safety certification company ExVeritas, advanced wire strippers Laser Wire Solutions, Reid Lifting and bespoke yacht and home furniture builders Silverlining Furniture.

Australian firm invests in Wales

An Australian life science research and development company has invested more than £3 million in Wales. The move comes as part of a deal by Melbourne-based Medical Ethics to make Cardiff its new base in the northern hemisphere. The company develops products to alleviate pain and minimise suffering associated with wounds and surgical procedures in animals. Its UK hub will be responsible for progressing the development of its technology for humans. Allan Giffard, Managing Director of Medical Ethics, commented: "For us, Wales was the obvious choice in the UK, especially given our sector – life sciences. Wales offers the skills, expertise and infrastructure for our business to thrive."

Innovative management system for type 1 diabetes

Cellnovo's mobile, connected, all-in-one diabetes management system makes everyday life less difficult for patients.

Type 1 diabetes is an autoimmune disease in which the pancreas is unable to produce the insulin needed to regulate blood glucose levels. It occurs as a result of insulin-producing cells in the pancreas being mistakenly targeted and killed due to a fault in the immune system. Most people with type 1 diabetes are diagnosed as children or young adults, and the condition is lifelong and incurable.

People with type 1 diabetes must manage their condition by, among many other things, closely monitoring their blood glucose levels and administering insulin either through injections or an insulin pump. To keep their blood glucose levels under control, as the alternative can have both short-term and long-term health consequences, people with type 1 diabetes must think about their condition constantly. This often has a significant impact on their mental health and wellbeing.

The goal of Bridgend-based company Cellnovo is to alleviate the day-to-day burden of managing type 1 diabetes through the use of innovative technology. They have designed a diabetes management system to make life easier for patients, which consists of three parts – a wearable insulin pump, a mobile touchscreen handset controller, and an online platform that gathers data from the pump and handset in real time.

Insulin pumps vary in size, with traditional pumps being rather bulky and noticeable under clothing. They are also typically attached to an infusion set including a long plastic tube that takes insulin from the pump to the body.

The Cellnovo micro-pump is designed to be small and discreet. It attaches directly to the skin with an adhesive and has a short 1.5cm infusion set, but unlike other patch pumps that are worn in this way, it is detachable. This is because of a design consisting of two parts – a disposable insulin cartridge and a rechargeable battery to which the cartridge connects. Therefore, the wearer can easily remove the pump while, for example, taking a shower or bath. They can also move the pump to another area of the body, detaching and re-attaching it is as many times as they wish.

When designing the pumping technology, the company's founder, Dr Julian Shapley, took inspiration from his time working with astronauts at the US Space Agency. The wax actuator technology inside the insulin pump, which originates from NASA satellites, involves a tiny drop of paraffin wax being heated by a diode at the heart of the pumping chamber.

When the wax is heated it expands by 15 per cent, and when it cools it returns to its original state, creating a pumping mechanism that is uniform and precise. It enables the pump to deliver insulin in a highly accurate manner, and differs from other pumps which use a mechanical screw to push a plunger that in turn pushes the insulin. While this may seem like a minor difference, at a microscopic level even the slightest changes in movement can alter the drop-by-drop precision required by an insulin pump.

The user is able to operate and communicate with their insulin pump via the mobile touchscreen handset, which looks and feels similar to a smartphone. In addition to controlling the pump, it has an integrated blood glucose meter, which is usually a separate device.

Data is automatically transmitted from the mobile handset to an online platform, where patients can view their insulin pump activity, blood glucose levels and any other information they choose to record via the handset's apps. This enables them to identify trends and to gain a better understanding of their condition and how they are managing it. The online data can be shared with family members and healthcare professionals in real time for monitoring purposes. Consequently, healthcare professionals can get a clearer picture of how their patient is managing their condition and offer more informed advice.

The company is currently involved in the development of a next-generation technology known as the artificial pancreas, or the automated insulin delivery system. This new technology consists of three parts – an insulin pump, a continuous glucose monitor (CGM) and an algorithm. The algorithm can take many forms, but it often employs machine learning or artificial intelligence that enables the pump and the CGM to communicate with each other continuously, creating a 'closed-loop' system. The result is a fully automated pump that administers insulin without the wearer needing to make decisions. This has been long regarded as the holy grail of type 1 diabetes management.

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Bridgend

Closing in on schizophrenia

Researchers from Cardiff University have made a significant step forward in understanding schizophrenia.

A study undertaken at Cardiff University's MRC Centre for Neuropsychiatric Genetics and Genomics has discovered 50 new gene regions that increase a person's risk of developing schizophrenia. State-of-the-art information about brain development was also used to accurately pinpoint new genes and biological pathways implicated in the disorder.

The study examined genetic data in 100,000 individuals, including 40,000 people with a diagnosis of schizophrenia. Results showed that some of the genes identified as increasing the risk of schizophrenia have previously been associated with other neurodevelopmental disorders, such as intellectual disability and autism spectrum disorders.

> *"These findings are another important step on the long road to new treatments for schizophrenia and will be crucial for identifying potential new drugs, which will become an increasing focus of our work in the coming years."*
>
> **Professor Sir Mike Owen**
> Director of the MRC Centre
> Cardiff University

Another significant, and unexpected, finding of the study was that the genes linked to schizophrenia risk are mostly crucial to normal development and therefore do not typically contain harmful mutations. This discovery will help researchers to narrow down their search for the mechanisms of the disorder, as these genes (commonly called 'loss-of-function intolerant') only account for around 15 per cent of all the genes in the human genome.

The findings also serve to explain a mystery that has long puzzled psychiatrists and evolutionary geneticists: if people with schizophrenia have, on average, fewer children than people without the disorder, why does schizophrenia still affect so many people?

Dr James Walters, who led the study, explains: "Many of the genetic variants that confer risk to schizophrenia are relatively common in the population. Therefore many scientists would have expected them to be selected against by natural selection, become rare and eventually disappear from the population….

Some theories have emerged to explain this. One is that genetic risk for schizophrenia must have, or must have had in the past, a positive effect to balance against the negative ones. We did not find any evidence for a so-called 'positive selection' but instead found that many gene variants linked to schizophrenia reside in regions of the genome in which natural selection is not very effective in the first place. Also, most of them do not have individually serious effects, and this makes them less likely to be selected, either for or against."

The study provides further evidence of the complex genetics underlying schizophrenia. By improving scientists' understanding of the biological pathways and mechanisms involved in the disorder, new targets for treatment will be uncovered, which could one day translate into better, more personalised care for people.

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Cardiff

Novel organoid expansion technology for cancer research

Bioprocessing technology from Cellesce is making organoids more widely available for cancer drug discovery.

There is an urgent medical need to discover and develop new disease-modifying cancer therapeutics that specifically target tumours and minimise adverse side effects. To discover new treatments, it is vital to have a test system that more accurately predicts whether a novel drug is likely to destroy the tumour.

Organoids are three-dimensional (3D) miniature versions of a patient's tumour from which they are derived. Donated tissue is processed in a lab to grow into multicellular organoids that recreate the anatomy and disease characteristics of the original tumour. They are grown in a 3D space within a bioreactor, rather than in an animal, and can be expanded to produce large quantities for research over a period of a few weeks.

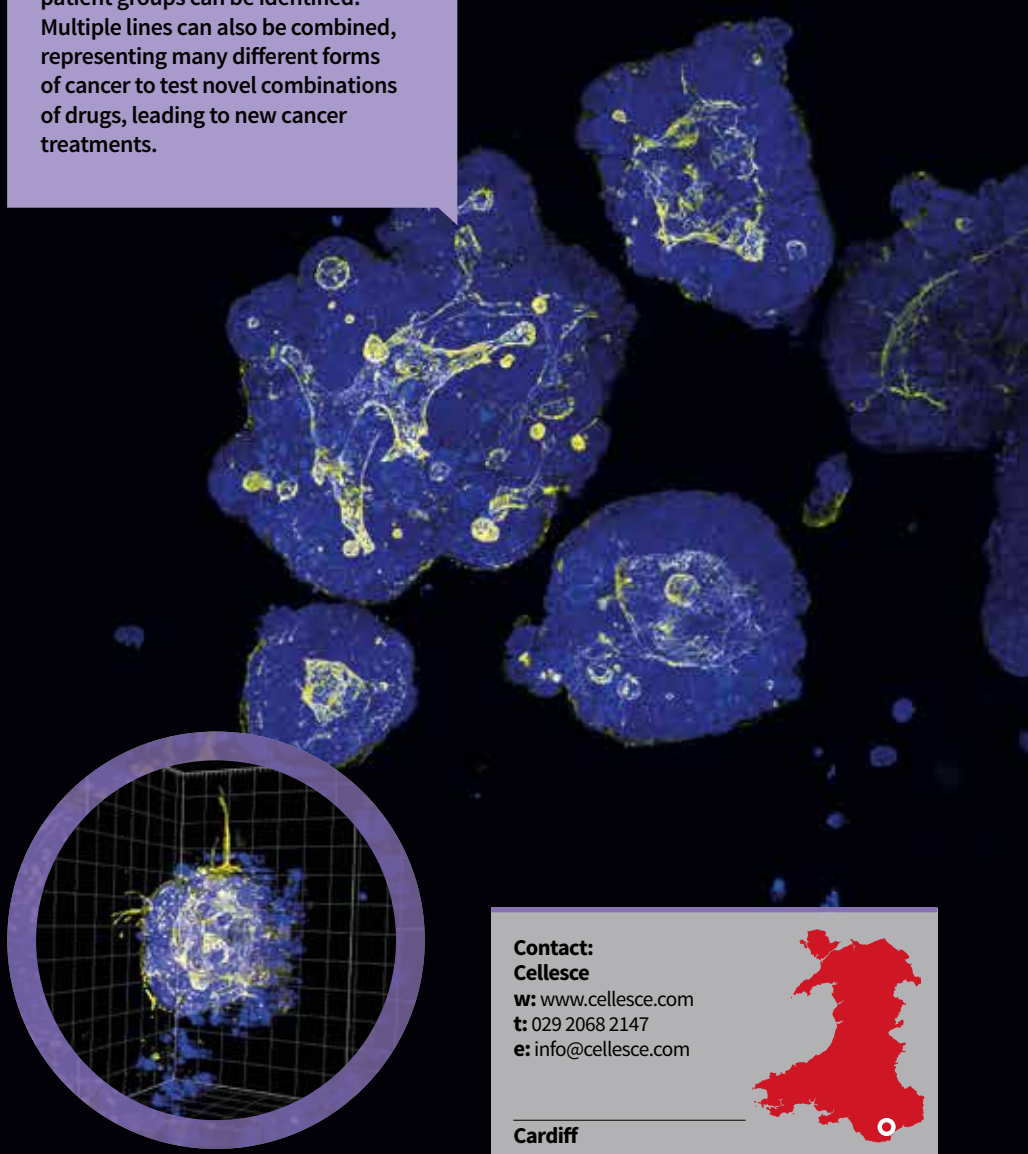
Previously, they could only be grown and expanded manually on a small scale, for specialist academic research. This restriction has limited the widespread commercial use of them, especially in drug discovery.

Cellesce is a Cardiff-based biotechnology company that was formed through a collaboration between scientists from Cardiff University and the University of Bath to enable the expansion of organoids for the first time on a commercial scale.

The company's novel bioprocessing technology involves seeding established lines into a bioreactor, under carefully controlled conditions, to encourage optimal growth and yield. The resulting organoids are subject to rigorous quality control to demonstrate their suitability for use in large-scale drug discovery campaigns by both commercial and academic organisations.

Tumour organoids have the potential to revolutionise the pre-clinical discovery of novel cancer therapeutics. They can be used in drug screening, so that targeted therapies for specific patient groups can be identified. Multiple lines can also be combined, representing many different forms of cancer to test novel combinations of drugs, leading to new cancer treatments.

Cellesce is currently focused on human-derived colorectal cancer organoids, based on a set of lines generated by Cardiff University. These reflect the genetic diversity found in the major colorectal cancer sub-types.



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Cardiff

Investigating treatments for an invasive plant species

Advanced Invasives have completed a groundbreaking study of Japanese knotweed and the methods currently used to treat it.

Since first being introduced to Europe in the mid 19th century, Japanese knotweed has become one of the world's most invasive plant species. Japanese knotweed control is estimated to cost the UK around £170 million per year and, until now, there has been no long-term, large-scale analysis of the various treatment methods available.

In 2018, Swansea-based company Advanced Invasives completed the world's largest field trial on Japanese knotweed, in partnership with Swansea University's Department of Biosciences. The seven-year research project involved three years of experiments testing the main physical and chemical methods of controlling Japanese knotweed used in the UK.

Three separate, but geographically and geologically similar, sites of large-scale knotweed infestation were selected for the field trials. The main twelve-acre site was Taffs Well in Cardiff. Herbicide protocols, with integrated cutting treatment, were applied at this site. Meanwhile, rhizome tillage with herbicide application was applied at the second site, Lower Swansea Valley Woods, and above ground covering treatment with hand-pulling was applied at the third site, Swansea Vale Nature Reserve. Nineteen commercially active treatments were tested over the course of three years. Of the treatments tested, three were found to be significantly more effective at controlling Japanese knotweed than the others.

The three most effective treatments were found to be (in order of effectiveness) twice yearly foliar spray of glyphosate-based herbicide, stem injection of glyphosate-based herbicide, and annual foliar spray of glyphosate-based herbicide. Although stem injection was found to be effective, it is time consuming and uses an extremely high dose of glyphosate compared to foliar spraying, so it could be an option in cases when weather or geographic conditions prevent spraying.

Researchers also discovered that non-glyphosate-based herbicide treatments for knotweed were definitely less effective than glyphosate-based treatments. Physiochemical treatments and physical treatments, such as above ground covering and hand-pulling of shoots, were found to be ineffective.

Other key findings of the study were that using herbicide treatments is about correct timing, not about excessively increasing the herbicide dose, and it is more a case of control rather than eradication as none of the treatments tested were able to completely kill Japanese knotweed.

As a result of the research project, Advanced Invasives have developed a four-stage model for Japanese knotweed control, linking herbicide selection and application with seasonal changes. This means that outdated industry guidance, based on short-term experiments and anecdotal information, can now be replaced with hard evidence.

> *"There is no 'one size fits all' solution for managing knotweed. Our experimental benchmarking of all practical knotweed control methods does, however, ensure that methods that don't work can be discontinued in the future. In addition to ongoing testing of the control methods that we started in 2011, we have now expanded our testing to include other invasive plants, further herbicides and habitat restoration approaches, so that land affected by knotweed can be used to its highest potential."*
>
> **Dr Dan Jones**
> Managing Director
> Advanced Invasives

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Swansea

Thrips come to a sticky end

Russell IPM has created an innovative insect trap to tackle a major agricultural pest.

Due to market demand for chemical-free groceries and an inability to protect crops with pesticides because of pesticide resistance, the challenges in producing fresh fruits and vegetables are becoming increasingly complex. Deeside-based company Russell IPM has developed an insect trap that makes use of nature's own tools to tackle pests, significantly reducing the need for pesticides.

Optiroll Super Plus is a sticky pheromone roller trap which has been specifically designed to help control western flower thrips (Frankliniella occidentalis), an insect pest that is devastating strawberry crops in the UK. It features insect pheromones microencapsulated into an adhesive layer to attract the target pest species.

To specifically attract western flower thrips, the roller traps are blue in colour and have an added white pattern that enhances the trap catch by 25 per cent. The flower thrips' aggression pheromone has also been encapsulated into beads and added to the roll. Male thrips produce a pheromone that encourages both male and female thrips to aggregate on attractively coloured surfaces. The encapsulated beads release this aggregation pheromone over several weeks, significantly increasing the trap catch.

Originally from the USA, western flower thrips have spread rapidly around the world since the 1970s, as a result of pesticide-resistant biotypes having been transported through the plant trade. It has become a major pest of protected crops, such as cucumber, pepper, chrysanthemum and strawberry, with global losses from the pest exceeding $1 billion.

In UK strawberry crops, western flower thrips larvae and adults feed on the fruit, turning it a bronze colour and making it unmarketable. Yield losses of 10-15 per cent due to thrips damage are typical and some growers have lost entire crops, because none of the insecticides registered for use on strawberry crops are effective.

The new roller traps were introduced to growers as part of an integrated pest management (IPM) programme, combining the use of trapping to catch adult thrips with predatory mites (Neoseiulus cucumeris) which feed on thrips larvae. Using the rolls reduced thrips numbers by between 53-87 per cent in field trials. Fruit damage reduced by a similar amount and grower returns increased by an estimated £2,000 per hectare.

> *"Growers who have adopted an integrated approach to controlling western flower thrips using the new traps have gone from losing whole crops back in 2012 to seeing little or no thrips damage for the past three seasons, as well as reducing their pesticide use."*
>
> **Dr Clare Sampson**
> Entomologist

Growers using the traps have also reported lower pesticide use, changing from routine applications to just one or two applications in a six-month season. This inevitably reduces pesticide residues in fruit, to the benefit of supermarkets and their customers. The traps integrate well with the use of natural enemies and with bumblebee pollination, providing an effective, healthy and sustainable pest management programme.

Russell IPM has been awarded a Queen's Award for Enterprise in Innovation, and the company is now testing a new range of specialist traps targeted against other pest species that are causing crop loss, including the pepper weevil and spotted wing drosophila.

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Deeside

Solving the pollinator puzzle

Welsh scientists are a step closer to understanding plant pollination due to a study of hoverflies.

Swansea University PhD researcher Andrew Lucas has spent the past seven years studying an underappreciated and often misidentified player in the complex world of pollinators – the hoverfly. Hoverflies are often mistaken for bees, because they sometimes resemble them as a way of scaring off predators.

Andrew recently completed a study as part of the 'Saving Pollinators' programme, which is run by the National Botanic Garden of Wales in Carmarthenshire and involves Swansea and Aberystwyth Universities, as well as Emory University, USA.

The programme focuses on wild pollinators and honey bees. Dr Natasha de Vere, Head of Science at the National Botanic Garden of Wales, is keen to point out that it is not all about the bees: "There is a vast army of insect pollinators out there and 75 per cent of all our crops are relying on them to work their magic and give us apples, chocolate and coffee to name a few. This army includes hoverflies, beetles, butterflies, moths, wasps and bees. Our work is aimed at finding out which plants they visit in order to provide the right conditions so they can have the best chance of survival."

In order to understand the potential role of hoverflies in pollination, it is necessary to know which plants they visit. However, it is difficult to know exactly what a hoverfly is doing by just watching them in the field. A more effective way to learn about their activities is by analysing the pollen carried on their bodies. It is possible to identify which plants this pollen belongs to using DNA barcoding techniques, which is an area in which the National Botanic Garden's science team have become specialists.

> *"How plants get pollinated when pollinators seem to be visiting all different kinds of plants has puzzled scientists for some time. Our research shows that the Eristalis species are generalists overall and visit a range of plants, but are fussy as individuals. This ensures the pollen gets to the right place."*
>
> **Andrew Lucas**
> PhD Researcher
> Swansea University

The study focused on hoverflies in the group Eristalis, also known as drone flies. They were analysed during early summer and late summer in plant-species-rich Welsh Rhôs pastures. DNA barcoding was used to determine which plants the hoverflies were visiting. This involved removing pollen from the hoverflies and then extracting DNA from the pollen, analysing it and comparing it to the large barcode reference database for Wales.

It was discovered that, while the hoverflies mostly visited the same 65 different types of plant, individual hoverflies had their particular favourites, and brambles showed up as a key plant. This provides guidance for landowners and farmers on the importance of species-rich grasslands and brambly edges.

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Swansea

Self-healing masonry in development

Scientists at Cardiff University are developing a self-healing system for building stone and masonry.

Over time, masonry structures are slowly attacked by physical, chemical and biological changes which cause them to deteriorate. This damage builds up until eventually fractures occur. The fractures may not compromise the integrity of the structure immediately, but if allowed to develop, the damage can become critical.

Due to the growing costs associated with the maintenance and repair of masonry structures, there is significant interest from industry in self-healing technology. Researchers at Cardiff University have already been developing self-healing concrete, as featured in Advances 70, and a new project involving a different building material has now begun.

The team has set out to produce a system that could be applied to building stone and masonry in order to give it self-healing properties. Once applied, any damage to the stone will trigger the release of bacteria and a range of 'helper' chemicals, allowing the damage to start repairing itself autonomously.

Key to the technology is the fact that naturally occurring microorganisms such as bacteria can produce mineral deposits when mixed with certain precursor chemicals. One such mineral produced by bacteria is calcium carbonate, which is one of the main components in rocks and various other masonry materials.

As part of the study, the team is looking at the different ways that bacteria, along with the precursor chemicals, can be introduced into building stone and masonry, as well as the benefits that it could bring in a variety of situations. The researchers already have a firm idea of the intricate processes involved, specifically with regards to the behaviour of the bacteria once it is inside of masonry.

Throughout the two-year project, the team will be developing ways to engineer self-healing systems into masonry, whether this is during the material's production phase or once the masonry has been used as a building material.

One possible application would be to produce a liquid or suspension, which could be bought from a DIY store, containing all of the bacteria and chemicals that could be sprayed onto masonry to repair damage.

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Cardiff

Humans and robots working together with new technology

Reeco Automation is producing systems for human-robot collaboration in manufacturing.

In a human-robot collaboration, a robot works with a human to perform a task. The idea is not to replace the human with a robot, but for the robot to work alongside the human, complement their capabilities and relieve them of arduous tasks. For example, a robot could assist a factory worker by lifting heavy loads.

Reeco Automation, a company based in Powys, is creating 'cobot' (collaborative robot) solutions for manufacturing companies to integrate with their existing factory equipment and workers. Cobots enable manufacturing companies to bring their traditional methods into the digital age, helping them to become more efficient and therefore reduce their production costs. Workers also benefit as the machines can take on mundane and dangerous tasks, reducing the risk of repetitive strain or accidental injuries.

The technology allows humans and robots to work together in close proximity, with no need for safety fencing or guarding between them.

The company creates cobots primarily for the automotive industry and, working in partnership with KUKA Robotics, developed a system to be installed at the BMW/MINI Plant in Oxford. The automotive manufacturer wanted to reduce its crash can assembly cycle time with the help of robots. Previously, assembly was manual and consisted of three aluminium extrusions, four pop rivets and a number of rubber clips. An operator was required to complete all actions within a short cycle time.

The newly installed system at the plant is relieving workers of repetitive tasks and increasing product throughput. The cycle time savings achieved are allowing workers to attend to other processes within the manufacturing production line, increasing productivity.

Designers and engineers at Reeco have also created cobots that allow manufacturers to automate screw and bolt fixing, riveting, picking and placing, and pouch application.

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Caersws

Identity verification with facial recognition technology

Credas has created a platform and app for identity verification that uses facial recognition technology.

Identity verification is an essential measure in many industries, but it is typically done manually and can therefore be very time-consuming. It often involves chasing customers for forms and ID scans, and getting hold of a third party to confirm that someone is who they say they are. This needs to be done, but can end up delaying important and time-sensitive processes.

Penarth-based company Credas has designed a platform to help speed up and simplify identity verification in sectors including legal, accountancy, property, recruitment and crypto-currency. It offers a quick way to confirm that any ID document is genuine and that the person is real. The company's verification process makes use of facial recognition technology, takes place in real time and consists of three steps – a selfie, a picture of the photo ID and a liveness test. After downloading the app, the person takes a selfie and then a picture of their ID followed by a quick liveness test, which ensures that the person is present when the verification photo is taken. The software does the rest of the work, with many facial recognition and ID authentication algorithms working in the background.

The system provides an accuracy rate for verification of 97.7 per cent. It can check over 4,000 different ID documents, and its NFC chip reading technology has the ability to read biometric data which ensures further accuracy. All data is stored in a secure cloud environment.

Credas is currently helping the property, legal and accountancy industries to comply with new regulatory requirements surrounding anti-money laundering, which were introduced in 2017. After conducting market research, the company found that it takes estate agents, on average, four business days a month to complete anti-money laundering checks, with one of the main barriers to completion being cited as getting hold of customers. The new platform allows people to verify their identity in their own time, so businesses no longer have to meet every customer in person to check documents, saving a potential four business days each month.

By modernising the identity verification process, the platform will help businesses across a range of sectors to save time and money, improve the accuracy of their identity checks and ultimately prevent fraud. Credas won the award for 'Best Emerging Technology' at the WalesOnline Digital Awards 2018.

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Penarth

Internet-connected devices become self-sustaining

Trameto is developing technology that enables internet-connected devices to sustain themselves with no need for batteries.

The Internet of Things (IoT) refers to devices being connected to the internet and being able to communicate information with people and with each other. IoT devices are becoming increasingly commonplace, with the number of smart homes, smart offices and even smart cities on the rise.

An estimated 50 per cent of these devices need independent power, and batteries offer a quick solution. Nevertheless, there are operational, financial and environmental issues involved in using batteries, as they need to be regularly replaced and end up as hazardous waste. An alternative to this is micro energy harvesting, which requires no interventions once deployed and therefore allows devices to be self-sustaining. However, current systems only work with single energy sources, often leading to unreliable or unstable system operations.

Trameto's EMIC, known as HarvestAll, enables systems to scavenge all and any low-grade, ambient energy from sources such as environmental vibrations, human power, thermal difference and indoor light energy. It then manages and combines the outputs of these sources to capture the maximum energy and converts this into useable electrical energy.

Swansea-based company Trameto is developing an innovative energy management integrated circuit (EMIC) for micro energy harvesting systems that enables energy to be harvested from multiple sources within a single device. This will eliminate the need for batteries to power IoT devices, allowing them to be 'fit-and-forget'.

By removing the need for batteries in internet-connected devices, the new technology has the potential to save time, as no human interventions are needed, and reduce environmental damage, as no waste is produced. Applications for the technology have been identified in smart buildings, consumer electronics, asset monitoring, agriculture, wearables, healthcare and home automation.

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Swansea

Castle stops energy going down the drain

New technology is being introduced at the largest National Trust property in Wales to harvest heat from waste water for reuse.

Over the past 18 months, the National Trust has invested in technology to generate a sustainable source of energy and hot water at Penrhyn Castle in Bangor. However, after using a lot of energy to heat the water, much of this energy is simply flushed down the drain.

To combat this, Penrhyn Castle is collaborating with Bangor University and Trinity College Dublin on a new heat recovery project to make use of the castle's large amount of hot water that is currently going to waste.

Penrhyn Castle generates all of its heat from a biomass district heating system and 25 per cent of its electrical needs are met by an on-site solar PV system. The biomass and generated electric are used to make hot water for flats, offices, catering and toilets. All of the waste water from these systems goes out of the building to a septic tank.

After monitoring the process, scientists found that the best place to harvest heat from the water would be under the castle's kitchens in the cellar.

In the new project, heat recovery technology will be used to extract heat from the waste water that flows out of the castle's kitchens at between 40 and 50°C. It will then recirculate the heat extracted from the liquid in order to heat the incoming cold water into the kitchen. Thanks to this preheating, less energy will be required to heat the water, saving energy and reducing greenhouse gas emissions.

Keith Jones, Senior Environmental Advisor at the National Trust, explained: "Energy efficiency is about more than just reduction in use. It's also about the reuse of waste, or what we currently consider to be waste. Energy users from households to hospitals spend a lot of money on making water hot for many reasons, from hot showers to dish washing. But what do we then do with this warmed resource? We flush it down the drain and then start the process all over again, warming water from very cold to hot again. This is very wasteful in terms of energy and this project at Penrhyn Castle is seeking to close this circle of wasted energy."

A flow measurement campaign at the site is underway, involving several water and wastewater monitoring companies. If successful, the heat recovery technology could be rolled out at other National Trust properties across the UK and lead to significant energy and cost savings for the organisation. The economic and environmental gains will be calculated by the team at Bangor University, whilst Trinity College Dublin are leading on the optimisation of the technology.

"The application of our energy recovery technology can hopefully support the National Trust's goal as a low-carbon and green organisation. It could potentially make a considerable reduction in energy consumption at Penrhyn Castle, thereby lowering costs and reducing the carbon footprint of this extremely busy tourism attraction."

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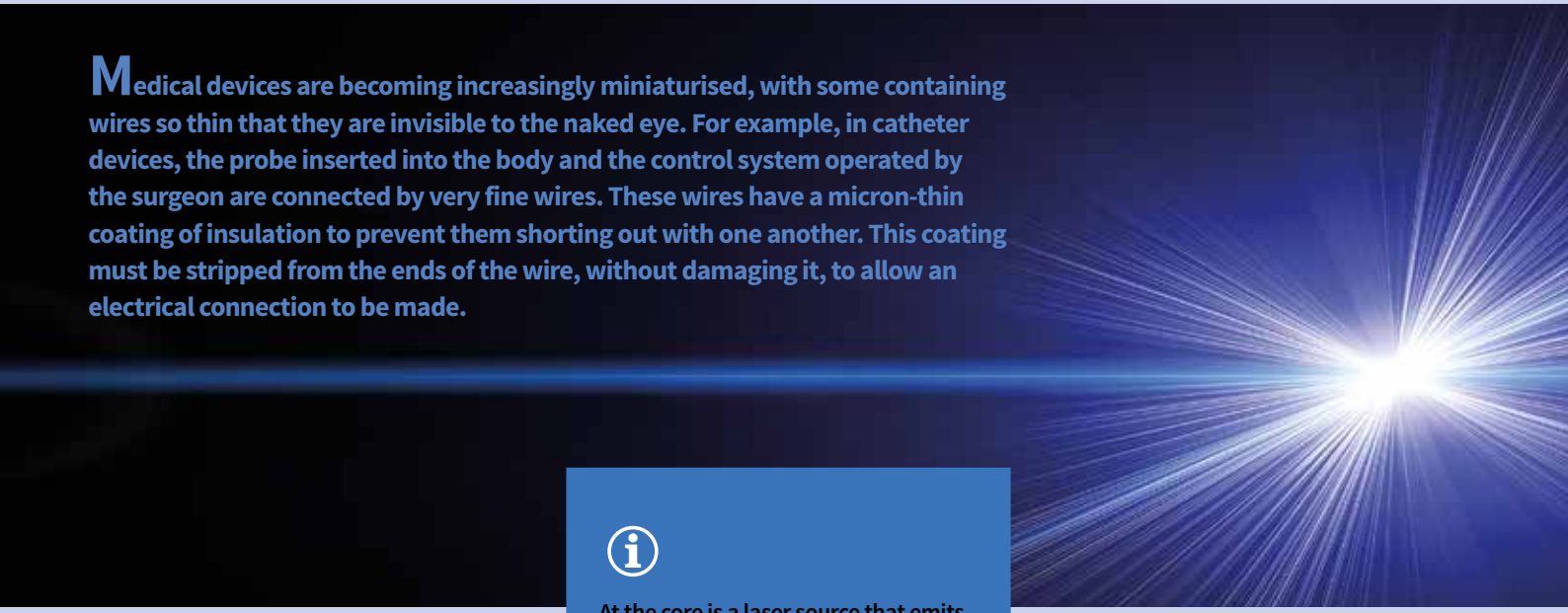
Bangor

Improving precision in medical device manufacturing

Laser Wire Solutions has developed ultraprecise laser wire stripping machines for use in medical device manufacturing.



Medical devices are becoming increasingly miniaturised, with some containing wires so thin that they are invisible to the naked eye. For example, in catheter devices, the probe inserted into the body and the control system operated by the surgeon are connected by very fine wires. These wires have a micron-thin coating of insulation to prevent them shorting out with one another. This coating must be stripped from the ends of the wire, without damaging it, to allow an electrical connection to be made.

Laser wire stripping was created by NASA in the 1970s and 80s as part of their Space Shuttle programme. The wire insulations used on the Space Shuttle were thinner and lighter than ever before, so new technology was developed because the risk of damage was too great when using traditional mechanical wire stripping tools.

The basic technology was later commercialised, initially for aerospace applications, and grew with the increasing prevalence of consumer electronics such as laptops and mobile phones. However, standard laser wire strippers are unsuitable for stripping ultra-fine wires that are now used in many medical devices. As a result, many medical device manufacturers are still using conventional techniques, such as manually scraping or grinding the insulation from wires, which can be unreliable and inaccurate. Devices with poorly stripped wires end up failing when tested and have to be disposed of.

Pontypridd-based company Laser Wire Solutions has developed a laser wire stripping machine that is able to provide the precision needed by medical device manufacturers. It safely removes the micron-thin insulation from wires, while built-in cameras with artificial intelligence enable it to 'self-check' and verify the quality of every strip.

At the core is a laser source that emits short pulses of light, vapourising all insulation material while harmlessly reflecting from the underlying metallic conductor, thus leaving it intact.

Building on earlier versions, the company's current Odyssey-4 machine squeezes the optical system into a desk-mounted unit which can fit onto the operator's bench. It has a high-resolution camera and a specially designed lighting system which allow it to check the quality of its output. After the operator loads the wires, the system verifies that the wires are correctly loaded and that the correct number of wires are present. If both of these conditions are met, the machine automatically processes the wires. If not, it advises the operator of the problem. Once it has finished stripping, the machine verifies that each wire has been fully stripped.

By making wire stripping more precise and reliable for manufacturers, the technology enables the development of more innovative medical devices. These devices provide direct patient benefits in terms of improved diagnosis and treatment of critical diseases and illnesses. For instance, miniaturised catheter devices can be used to treat heart arrhythmia by 3D mapping a person's hearbeat with a mapping catheter and then killing irregular beating cells with an ablation catheter.

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Pontypridd