

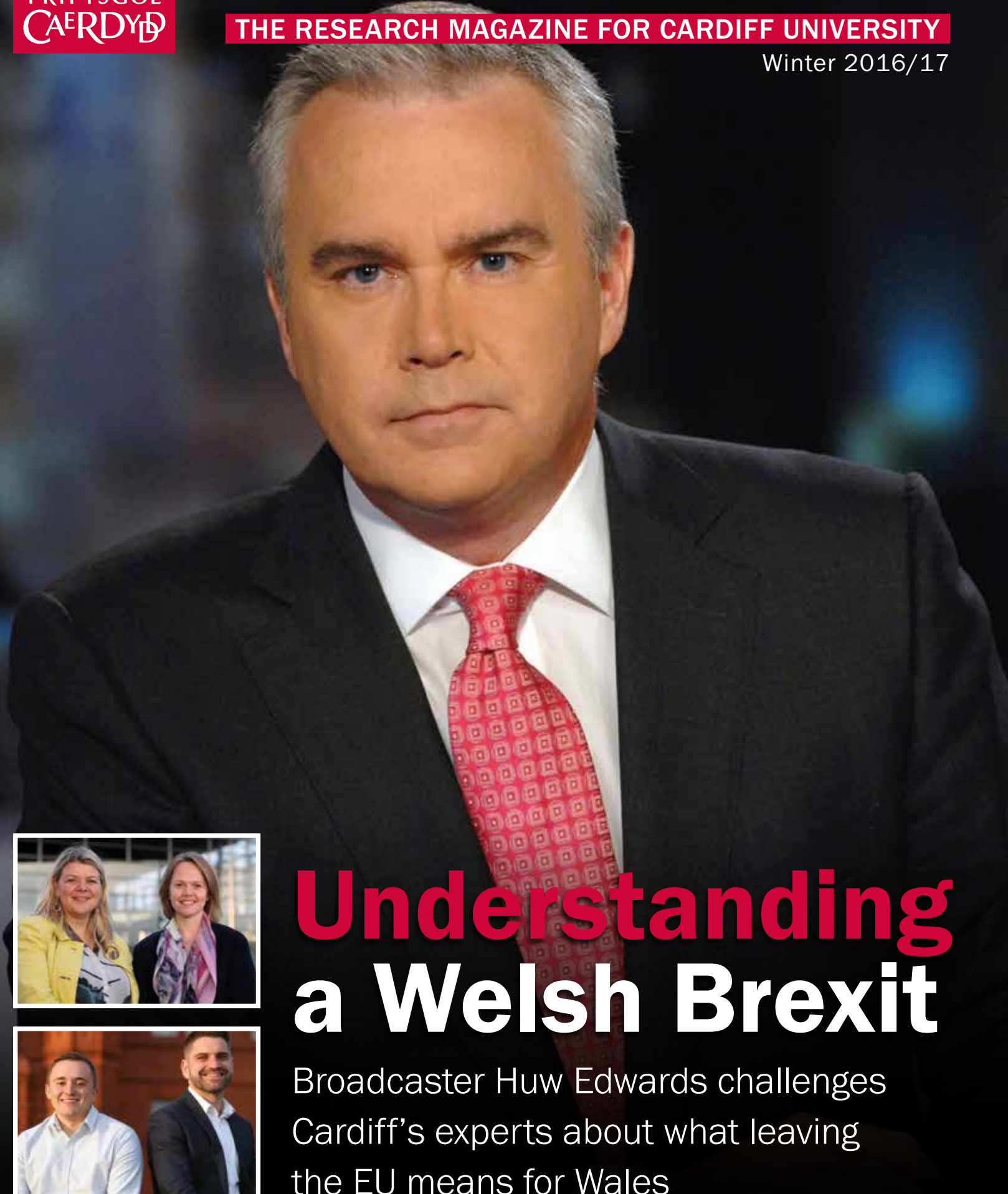
CARDIFF
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CHALLENGE CARDIFF

THE RESEARCH MAGAZINE FOR CARDIFF UNIVERSITY

Winter 2016/17



Understanding a Welsh Brexit

Broadcaster Huw Edwards challenges Cardiff's experts about what leaving the EU means for Wales

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Professor Colin Riordan
Vice-Chancellor

WELCOME TO CHALLENGE CARDIFF

2016 has been a year of unprecedented political upheaval that will lead to repercussions for UK universities for many years to come.

The decision by the electorate of the United Kingdom to leave the European Union means that there are challenging times ahead for all of us in the higher education sector. There is much uncertainty about what the decision will mean for the United Kingdom as a whole, as well as its devolved nations. However, there will be opportunities for the University, Wales and the UK, and we are keen to manage change in a way that is as beneficial as possible to all.

One opportunity is the wealth of knowledge that we have among our staff in relation to the complex matter of leaving the EU.

Distinguished broadcaster and Cardiff alumnus, Huw Edwards (BA 1983), challenges four of our leading EU experts about what leaving the European Union will mean for Wales and how it can ensure that it gets a fair deal.

Another opportunity is to strengthen our commitment to our local communities and to renew our sense of civic mission.

It's increasingly important that we involve our local communities with our work, so in this issue we have asked a group of local school children to quiz Professor Les Baillie at one of our community projects in Cardiff about how his quest to find new antimicrobial drugs is also helping to encourage the bee population.

Also close to home, this October saw the 50th anniversary of the Aberfan disaster, a landslide that claimed the lives of 116 children and 28 adults. Jeff Edwards was the last person to be rescued from the rubble. He met with Dr Rob Parker from the School of Earth and Ocean Sciences, to discover how his work is

improving our understanding and response to earthquake-induced landslides

It was a great honour that to commemorate Her Majesty the Queen's 90th birthday, our School of Chemistry was awarded the first ever Regius Professorship in Wales. The title is held by Professor Graham Hutchings, a world leading expert in catalysis, who spoke to Dr Peter Johnston of Johnson Matthey about his life of science for our What Made Me Curious feature.

To find out more about the work featured in this issue, please go to our website.

Please contact challengecardiff@cardiff.ac.uk if you would like to challenge our academics on an issue that matters to you.

Dementias Platform UK

The University's Professor Julie Williams, Chief Scientific Advisor for Wales, has been appointed Deputy Director for Dementias Platform UK (DPUK).

A member of the DPUK executive team since September 2015, Professor Williams' research focuses on identifying and understanding genes which increase the risk of developing complex psychological and neurodegenerative disorders. These include Alzheimer's disease, developmental dyslexia and schizophrenia.

DPUK has established an extended network of world leading scientists through the creation of networks and strategy groups. Professor Williams' has led the development of a genetics database as part of the Informatics Network which was launched in the autumn.

DPUK Director, Professor Gallacher said: "Professor Williams' globally recognised expertise in dementia genetics and her governmental experience will be valuable assets as we grow and develop platform activity."



The 'green' grass of home

A team of UK researchers, including experts from the University's Cardiff Catalysis Institute, have shown that significant amounts of hydrogen can be unlocked from fescue grass with the help of sunlight and a cheap catalyst.

It is the first time that this method has been demonstrated and could potentially lead to a sustainable way of producing hydrogen, which has enormous potential in the renewable energy industry due to its high energy content and the fact that it does not release toxic or greenhouse gases when it is burnt.

Hydrogen is contained in enormous quantities all over the world in water, hydrocarbons and other organic matter. Until now, the challenge for researchers has been devising ways of unlocking hydrogen from these sources in a cheap, efficient and sustainable way.

A promising source of hydrogen is the organic compound cellulose, which is a key component of plants and the most abundant biopolymer on Earth.

The team investigated the possibility of converting cellulose into hydrogen using sunlight and a simple catalyst – a substance which speeds up a chemical reaction without getting used up.

This process is called photoreforming or photocatalysis and involves the sunlight activating

the catalyst which then gets to work on converting cellulose and water into hydrogen.

The researchers studied the effectiveness of three metal-based catalysts – palladium, gold and nickel.

In the first round of experiments, the researchers combined the three catalysts with cellulose in a round bottom flask and subjected the mixture to light from a desk lamp. At 30-minute intervals the researchers collected gas samples from the mixture and analysed them to see how much hydrogen was being produced.

To test the practical applications of this reaction, the researchers repeated the experiment with fescue grass, which was obtained from a domestic garden.

Professor Michael Bowker continued: "Until recently, the production of hydrogen from cellulose by means of photocatalysis has not been extensively studied.

"Our results show that significant amounts of hydrogen can be produced using this method with the help of a bit of sunlight and a cheap catalyst.

"To the best of our knowledge, this is the first time that this kind of raw biomass has been used to produce hydrogen in this way. This is significant as it avoids the need to separate and purify cellulose from a sample, which can be both arduous and costly."

The team, which also includes researchers from Queen's University Belfast, published their findings in the journal *Proceedings of the Royal Society A*.

Cardiff scientist elected Royal Society Foreign Secretary

The Royal Society has appointed Professor Richard Catlow, from the School of Chemistry, as its next Foreign Secretary.

The post, which dates back to 1723, is considered one of the science world's highest honours, with notable past Foreign Secretaries including British physicist Thomas Young and chemical scientist Henry Tizard.

In his role, he will represent the British scientific community abroad and will be responsible for overseeing the Society's international business.

Professor Catlow said: "I am very pleased and honoured to be taking on this new and challenging role. Science is an international endeavour and it is of key importance to maintain and extend the international collaborations and interactions of UK science and to ensure that UK science plays its full role on the world stage."

Said Venki Ramakrishnan, President of the Royal Society, commented: "This relationship between science in the UK and Europe is in a state of flux and so the role of the Foreign Secretary of the Society has never been more important. Science has always been a global undertaking and international collaboration has become the norm. Professor Richard Catlow is well placed to help the Society negotiate this difficult time and build on the strong relationships we have across the world."

Professor Catlow's research develops and applies computer models in conjunction with experiments to probe the properties of materials, including their synthesis, structure and properties. By combining

computational methods with experiments, he has made considerable contributions to major areas of contemporary materials chemistry and physics, including mineralogy and the study of electronic, energy and catalytic materials.

Professor Catlow currently has a joint appointment between the Department of Chemistry, UCL and the School of Chemistry, Cardiff University. He has collaborated in Europe, the US, India, China, Japan, Cuba, Africa and Australia and has a particular interest in capacity building programmes in Africa.



Cardiff joins Europe's top 50 innovative universities

The University is 45th in Europe and 8th in the UK in a new Thomson Reuters ranking of Europe's 100 most innovative universities.

The league table is based on a range of data including academic papers, patent filings, industry citations and industry collaborations.

It recognises institutions which specialise in practical research and applied science, turning research excellence into real world answers.

Vice-Chancellor, Professor Colin Riordan, said: "Cardiff has a long and proud tradition of invention and innovation, building partnerships with industry, growing spin-outs and start-ups, and nurturing academic and student expertise to create growth and prosperity. We are the only Welsh university in the table, and compete well against the UK's big technical institutions, such as Manchester and Edinburgh.

"Our numbers tell our innovation story. Cardiff's research contract awards have a total value of £500m, we have won six Queen's Anniversary Prizes, and we rank 5th in the UK for estimated

turnover (£72m) of all active graduate start-ups from 2008/09 to 2013/14."

Europe's number one innovative university is KU Leuven, a Dutch-speaking institution based in Belgium's Flanders region. It has enjoyed a long-standing academic relationship with Cardiff University.

Two years ago both institutions signed a cooperation agreement designed to boost research income, create new research collaborations and offer more opportunities for students and staff to study and teach abroad.



University engineer named among UK's Top 50 Women in Engineering



Professor Karen Holford, Cardiff University's Pro Vice-Chancellor, College of Physical Sciences and Engineering, has been named in the inaugural list of the Top 50 Women in Engineering.

The list was compiled by the *Daily Telegraph* in collaboration with the Women's Engineering Society (WES), to coincide with National Women in Engineering Day.

The top 50 were selected by a distinguished panel of judges from almost 900 nominations, and represent the UK's most influential female engineers. Professor Holford is among only eight on the list who are based in universities.

Professor Holford said: "It's an honour to be named on the same list as some of my engineering heroines, but this award is also recognition of people who have influenced my career - from those involved in my degree apprenticeship at Rolls-Royce and Cardiff, my engineering work at AB Electronics and the hugely supportive environment at the University.

"I have always felt very much part of a team here, and I'm very grateful to all the people who have helped and supported me in my various roles."

Professor Holford's career began at Rolls-Royce where she contributed to a range of

technical projects including work on the Adour and Pegasus engines. Then at AB Electronic Products, she was responsible for developing automotive electronic products for Jaguar Rover and was soon promoted to the role of senior engineer.

Since moving into academia 25 years ago, she has helped to build the substantial international reputation of acoustic engineering research at Cardiff, which now boasts the best equipped experimental acoustic engineering facility in Europe.

Her research into acoustic emission has resulted in technology that has greatly improved the safety monitoring of bridges and other structures, and she is now applying the same techniques to detect faults in aircraft structures - with the potential to revolutionise aircraft design and result in lighter aircraft.

This year she co-authored the Welsh Government report, *Talented Women for a Successful Wales*, which analysed the importance of getting more women into science and engineering careers, and how this might be achieved.

Lung cancer screening trial

The introduction of lung cancer screening in the UK could significantly reduce deaths in high risk groups, without causing participants the undue stress sometimes associated with medical tests.

Published in *Thorax*, a trial led by Cardiff University looked at long-term psychosocial outcomes of computed tomography (CT) screening for lung cancer and found that it did not cause unnecessary anxiety, even though fear and stigma can sometimes be barriers to participation in screening.

Lung cancer is the leading cause of cancer-related mortality in the UK, killing almost 40,000 people per year. Additionally, around three quarters of patients are diagnosed at a late stage when fewer treatment options are available. With early detection of lung cancer about seven out of ten patients survive for a year or more.

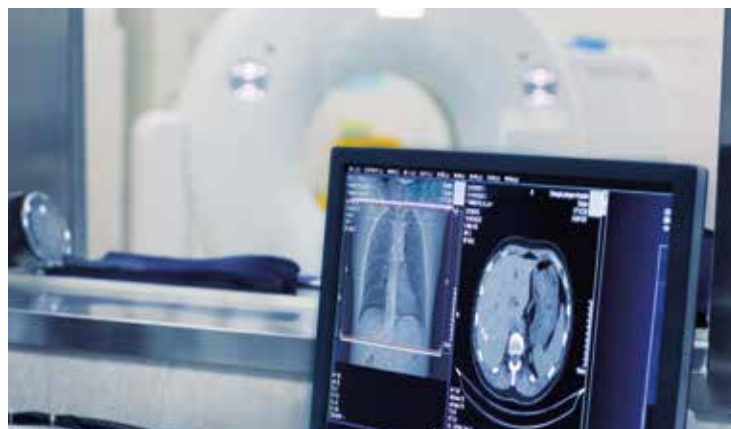
Dr Kate Brain from the School of Medicine said: "With the UK's five-year survival rate for lung cancer being lower than many other countries with comparable healthcare systems, it is important that we do more to introduce early detection strategies that help to ensure treatment is delivered before patients present at an advanced stage of the disease.

"Sometimes, fear of medical procedures and the results they might bring can prevent people from seeking life-saving tests. However, what our trial shows is that CT lung cancer screening actually has no long-term

negative psychosocial impact on patients, making it an excellent tool for catching lung cancer earlier when there is a better chance of survival."

The evidence produced will contribute to clinical and policy decisions regarding the successful and equitable implementation of potential future low-dose CT lung screening for high-risk individuals.

Institutions involved in the study include Cardiff University, Liverpool University, Royal Brompton & Harefield NHS Foundation Trust, Nottingham University Hospitals and Queen Mary University of London.



Preparing the next generation of leading social science researchers

Cardiff has been named as lead partner for one of 14 new Doctoral Training Partnerships (DTPs) announced by the Economic and Social Research Council (ESRC).

The 14 DTPs, along with two Centres for Doctoral Training (CDTs), form the ESRC's new Doctoral Training Network which significantly widens access for postgraduates to ESRC funding in the UK.

The ESRC Wales DTP is a collaboration between Cardiff, Swansea, Bangor, and Aberystwyth, with two pathways that incorporate specific provision in Cardiff Metropolitan University and Gloucestershire, respectively. From October 2017 onwards, it will support six new annual cohorts of doctoral students across the social sciences, with the majority of

accredited pathways hosted at Cardiff. It succeeds the University's current Doctoral Training Centre.

Students at Cardiff, and the other DTP locations, will benefit from access to

the highest quality training in the social sciences, supplying the next generation of social science researchers with the skills, curiosity and creativity to be truly innovative.



Landmark study on global container port health and safety



An independent study undertaken by University researchers could pave the way for significant improvements in the health, safety and welfare of workers in the global container port industry.

Carried out by Professor David Walters and Dr Emma Wadsworth, of the University's School of Social Sciences, the landmark report, *Experiences of arrangements for health, safety and welfare in the global container terminal industry*, is the only one of its kind ever undertaken to such an exhaustive level. It was commissioned by the Institution of Occupational Safety and Health and the International Transport Workers' Federation.

Researchers were granted unique workplace access by six major port/global network terminal operators, which are anonymised in the data.

While recognising the ongoing health and safety progress made by port operators, the report recommends attention be paid to the following areas of concern:

- Inaccurate reporting of health and safety outcomes: even within the context of modern health and safety management models, levels of injury and risk are being under-reported.
- Lack of provision for gender: the study found that there is very little attention to the specific needs of women workers.
- Limitations of behavioural management systems: the report finds the widely used behavioural OHS (occupational health and safety) model inferior to participative systems, which emphasise worker involvement as partners in health and safety management.
- A focus on immediate safety risks at the expense of longer term effects on health.
- Subcontracting undermining reporting and a safety culture: the report shows that health and safety outcomes are worse for subcontracted workers.
- Productivity targets undermining the will to prioritise health, safety and welfare.
- The lack of a consistent approach to OHS management, at least in terms of applying the highest standards regardless of country.

Bees on the frontline of superbug fight

Bees are essential to the survival of our planet, yet their numbers have declined significantly over the past 20 years.

People are being encouraged to plant a variety of wildflowers, whether it is in their back gardens or in more unusual places such as the roofs of urban concrete buildings, ensuring that bee numbers don't dwindle further and we create a pleasant urban environment in which to live.

Scientists at Cardiff University are playing their part. They are not only doing this to encourage the growth of the bee population, but by planting certain wildflowers whose nectar is present in antibacterial honey, they are hoping to find solutions to one of the world's grand challenges, antimicrobial resistance.

Based in the University's School of Pharmacy and Pharmaceutical Sciences, microbiology Professor Les Baillie and his team are using honey in an attempt to find new drugs to treat hospital infections caused by antibiotic resistant superbugs such as MRSA and *Clostridium difficile*.

Professor Baillie's team is also working with a number of partners including the National Botanic Garden of Wales, St David's Shopping Centre, Pollen8 Cymru, Wyevale Garden Centres, Cardiff University Schools Partnership funded by RCUK, and schools across Cardiff to plant bee-friendly flowers in a variety of locations across south Wales.

Working with the University's Community Gateway project based in the Grangetown area of the city, Professor Baillie and his team have planted bee-friendly flowers in the grounds of Grange Pavilion, a former disused bowling pavilion and green.

On a cold crisp November morning, pupils from the local school, Grangetown Primary, met Professor Baillie at the Pavilion to find out more about why bees are so important and also quiz him about his research.

Professor Baillie had brought along an empty hive to show the children how it worked, a smoker, and some beekeeping suits for the children to put on.

He started by showing the children how the hive worked and what bees did to produce honey:

"Honey bees are the bees we work with and they all live together in a hive. The Queen Bee is the most important bee. Each hive has one queen who is in charge and she can produce about 30,000 babies. A queen bee is made by feeding it a special food called royal jelly.

"Bees have a nose that's called a proboscis, it's a bit like a straw. The plants produce nectar and they suck up the sugar and sick it up into the hive to make the honey.

"What's important is the food they live on. We've done lots of research in the University and we know which plants are visited by the bees. That's why we've planted the plants such as *Galium odoratum* (woodruff), *Taraxacum officinale* (dandelion) and *Trifolium spp* (clover) so we can encourage more bees in Grangetown and all over south Wales."

He continued: "When we want honey we put on our suits and use this device called a smoker. People found that smoke calms the

bees. The smoker makes smoke which goes inside the hive and causes the bees to chill out. We can then go inside the hive, take out the combs, knock off the honey and collect it. We then put the combs back inside the hive so that the bees can make more honey."

The children were concerned about the future survival of the bees and quizzed Professor Baillie about colony disorder, the effect of pesticides and whether there was a possibility that bees could become extinct.

"No one knows what causes colony disorder. Some people think it is caused by insecticides. We use these to get rid of the insects we don't want (but we need bees). The compounds that are used to treat the bad insects can also affect the good ones. They affect the bee's nervous system and their sense of direction. A bee has to find its way back to its hive.

It is thought that pesticides used by farmers to treat their crops are killing bees. There has been a 60% decrease in the number of bees in the past 20 years. We need to increase the number of people that become beekeepers or to encourage people to grow plants that will encourage the bees.

"Bees hopefully won't become extinct as the majority of the crops that produce our food need bees. The bees spread pollen from one plant to another and without that we have no food, so they are very important to us."

The children wanted to know why Professor Baillie had become interested in bees and how long he had been researching them.

Antimicrobial plants

Bluebell • Hyacinth • **Daisy or Sunflower family** • Sow Thistle • Daisy • Knapweed • Thistle • Hawksbeard • Cats ear • Milk Thistle • Dandelion • **Mustard flower family** • Cabbage • Rapeseed • Legume family • Broom • Wild Red Clover • White Clover • Gorse • **Oak family** • Sweet chestnut • Oak • **Rose family** • Cotoneaster • Hawthorn • Meadowsweet • Apple • Cherry • Rose • Blackberry • Mountain ash • **Soapberry family** • Maple • Horse chestnut • Mock Orange • Viburnum • Milkwort • Sweet Woodruff • Butterwort • Willow • Rosebay willow herb • Skimmia - Japanese shrub • Ladies Bedstraw

“Part of what we want to do in the University is find new antibiotics... We look at the honey and try and work out why it does what it does and understand it better.”

Professor Les Baillie



Professor Les Baillie

“That’s a very good question. I’ve been working with bees for five years. I don’t like honey or gardening but I do like nature, and bees play a key role in making the world work”.

The children were keen to find out how honey helps in the fight against antibacterial infections. One of the children had first-hand experience of this and recounted to Professor Baillie how when she had a sty on her eye, her mum had put honey on it to successfully treat the infection.

“Honey’s been used for thousands of years in many different parts of the world to treat things such as sore throats, wounds and infections, due to compounds present in the honey that kill bacteria. It was used by the Egyptians 4,000 years ago.

“Part of what we want to do in the University is find new antibiotics. If you get sick with a disease caused by an organism, you take drugs to make you better. The problem is all of those drugs are being used too much, people

are treating themselves and the bacteria are getting clever and can no longer be killed by the drug. This means we need to find new drugs.

“For example, there are people in Cardiff who are interested in treating wounds; you have an infection on the back of your hand, you put honey on it and it gets better. We’re interested in the science behind that. We look at the honey and try and work out why it does what it does and understand it better,” Professor Baillie explained.

Finally the children asked which plants were responsible for the production of the antibacterial honey that Professor Baillie and his team are working on.

“Working with the National Botanic Garden of Wales we have identified the types of flowers whose nectar contains the antibacterial compounds which we have found in honey. As part of research undertaken by Dr Jenny Hawkins, we analysed 250 samples of honey

provided by bee keepers from across Wales. From this collection we focused on 20 samples and were able to identify the plants visited by the bees by DNA sequencing plant-specific pollen which had been incorporated into the honey.

“For example, antibacterial compounds were present in honey produced in the back garden of a beekeeper from Tywyn in Gwynedd which killed a range of microorganisms including MRSA.

“Using this knowledge we are attempting to recreate this antibacterial honey by growing the Tywyn plants on the Cathays campus of the University and at sites across Cardiff. In addition to this targeted planting we have also installed bee hives on the roofs of a number of University buildings and are working towards creating the first bee-friendly University in Wales.”

You can follow the project on twitter **@pharmabees**



L: Dr Rob Parker
R: Jeff Edwards



“Climate change predictions suggest that we could see a 10% increase in the number of big rainfall events.”

Dr Rob Parker

On leaving his house, Jeff called on his friend Robert who lived a couple of doors down, before heading into school. He exchanged his library books and sat down at his desk for the morning's maths lesson.

It started as a normal day in the small mining village of Aberfan, but the catastrophic events that were about to unfold would change everyone's lives forever.

At 9:15am, more than 150,000 cubic metres of rain-soaked colliery waste came hurtling down the side of the spoil heap that towered above the school, engulfing everything in its path.

The landslide claimed the lives of 116 children and 28 adults.

Jeff was one of four survivors in his class of 34 and was the last person in the school to be rescued from the rubble. Even to this day, Jeff can vividly recall the sights, sounds and emotions as his classroom was submerged by the debris (see Jeff's story).

Fifty years on and many of the survivors, as well as the friends and families of the victims, struggle to come to grips with what happened.

Jeff is still deeply affected by the events that morning, and is overcome with emotion when he sees similar landslides occurring in other parts of the world, such as in Pakistan, Nepal and China.

This is why Jeff has taken a keen interest in the efforts that are being developed to predict the occurrence of landslides.

Just 20 miles from where the Aberfan disaster occurred, experts at Cardiff University are world-leaders in the prediction of earthquake-induced landslides.

Dr Rob Parker, from the School of Earth and Ocean Sciences, is one of these experts and

has been developing a statistical computer tool – known as ShakeSlide – that can provide a rapid assessment of landscapes after an earthquake and indicate where landslides are likely to occur.

A week before the 50th anniversary of the Aberfan disaster, Jeff (JE) and Rob (RP) met up at Ynysowen Primary School in Aberfan to talk about the significance of the disaster and how scientific research is transforming the way in which we understand landslides.

JE: What made you interested in landslides in the first instance?

RP: I've always found mountains fascinating. I'm a keen mountaineer and spend a lot of time climbing, so I've always been out there in the mountains. Landslides are probably one of the most dramatic processes that happen over a short period of time. From early on at school I knew about the events at Aberfan and what happened there so both the physical process of why these things happen, and their impacts on society, interested me.

JE: I'm interested in the predictive model that you've developed. How long has it taken you to develop?

RP: This is a model that tries to predict where landslides are likely to occur during big earthquakes, and I've been working on it for around seven or eight years. The model we've produced is called ShakeSlide, and it takes information from lots of past earthquakes and tries to predict where landslides are likely to occur during earthquakes in the future.

JE: How does the model that you're developing differ from other models?

RP: We take the earthquake event as a whole and, over a very large area, we try and predict where landslides are likely to have happened,

so it's a broad area prediction. I work in a team of geomorphologists who study earth surface processes. Their natural interest is how a landscape behaves at a large scale. So the difference is rather than make predictions for specific locations – such as if a certain hillslope will fail or not – we want to know what the likelihood is over a large area.

JE: How accurate is the model that you've developed?

RP: In terms of predicting the precise locations of landslides, there is still a lot of uncertainty. There is uncertainty in the strength of the seismic shaking and the strength of the hillslope materials. What this means is that predicting the precise slopes that will fail is difficult, but predicting numbers of landslides across an area or along a valley can be done more accurately.

JE: Are there any practical examples you can give me where this model has been adopted?

RP: Last year when the Nepal earthquakes happened, we ran this model for the first time and we produced a prediction of the spatial pattern of landslides from that earthquake. We provided that model to the World Bank who were doing a lot of work in the post-disaster response to the earthquake. Together with satellite imagery it helped them guide the search for where landslides were likely to have occurred.

JE: How do you overcome the cultural differences between societies where landslides occur?

RP: This is really quite a challenge and it's relevant because we're talking about the 50th anniversary of the Aberfan landslide coming up, and that's an example where we were aware of the dangers of landslides. In fact the scientific community had known for about

40 years and understood the process of how landslides were triggered by rainfall, but the information wasn't acted on. So certainly one of the challenges is not just producing this information about the physical hazards and understanding landslides, but getting people to use the information.

We're currently working very closely with the Chinese government on some engagement projects to help them understand how they can best use that information. We're trying to understand how long landslides go on for, where they occur, and why they occur, and if we know that it can help us understand how to deal with that hazard in the aftermath of future earthquakes.

JE: What effect has climate change had on the number of landslides that have occurred?

RP: Climate change predictions suggest that we could see a 10% increase in the number of big rainfall events, which could lead to more landslides. We've done some work recently in the Appalachian Mountains in North Carolina, where we've essentially tested this theory and found that more rainfall events will not necessarily create more landslides. We know that the landslide at Aberfan was triggered by rainfall, but the cause of the landslide was the tipping of mine waste up on the hillslope. If that mine waste hadn't been tipped on the hillslope then the rainfall event would have happened, but we wouldn't have had the landslide. Now in natural landscapes it is soil that accumulates on hillslopes, and accumulates slowly over time. In the Appalachian Mountains where we were working we found that the rainfall events were so frequent that the landscape isn't actually producing soil quick enough to produce more landslides. So if we have more rainfall events,

it doesn't necessarily mean that there will be more landslides.

JE: What impact has technology had on your research?

RP: In the last 10 years we have gained access to two 3D models of the entire surface of the Earth. These models are really powerful tools that we actually use within Shakeslide. They tell us how steep hillsides are everywhere from the UK to China, and so we can carry out stability analysis over very large scales. We also have very detailed data sets which are really very valuable. Satellite imagery is also incredibly useful. We can use this to capture data on landslides, so we have a satellite image before an earthquake and a satellite image after an earthquake, and we can monitor where landslides happen and how those landslide change through time. Finally, we now have the computer processing power and the machine-learning algorithms to process and help us understand this data.

JE: Where do we see ourselves in ten years' time?

RP: The availability of data sets is increasing. We're getting 3D models of the Earth's surface and records of where landslides have happened in the past. There's a project called 'Planet Labs' that put hundreds of satellites into space over the last couple of years and they are in the process of imaging the entire Earth every single day. With systems like that we're going to have daily monitoring of physical processes on the Earth's surface and that's a really powerful tool for understanding when landslides happen and how they change with time. We'll also have more and more powerful artificial intelligence machine learning algorithms that work with and process that data. So having that data and then being able

to use it is only going to help our efforts to predict landslides.

JE: Obviously this year we're commemorating the 50th anniversary of the Aberfan disaster, in which I was involved, so do you think the modelling that has been developed would have prevented the accident from happening?

RP: Looking back to Aberfan, perhaps one of the most interesting things to think about was that we knew at the time the dangers of landslides. Landslides from mine waste were actually quite common in the Valleys and I don't think the problem there was so much the science, but the politics and getting people to act on that information. As a physical scientist I seek to understand the physical process of how landslides happen and perhaps one of the biggest challenges we have is putting that information into the hands of policy makers who can then make informed decisions on that basis. There was a big mine waste landslide that killed 128 people in China in 2008, so these things still happen around the world.

A really important thing I like to remember about Aberfan is that it triggered more research into landslides and is part of the reason why the UK is a world-leader in landslide research.

JE: It is important that we remember this as an iconic event in terms of Wales and probably the world; that such a large loss of children, and the loss of adults as well, together with suffering of the community, is not forgotten.

Jeff's story

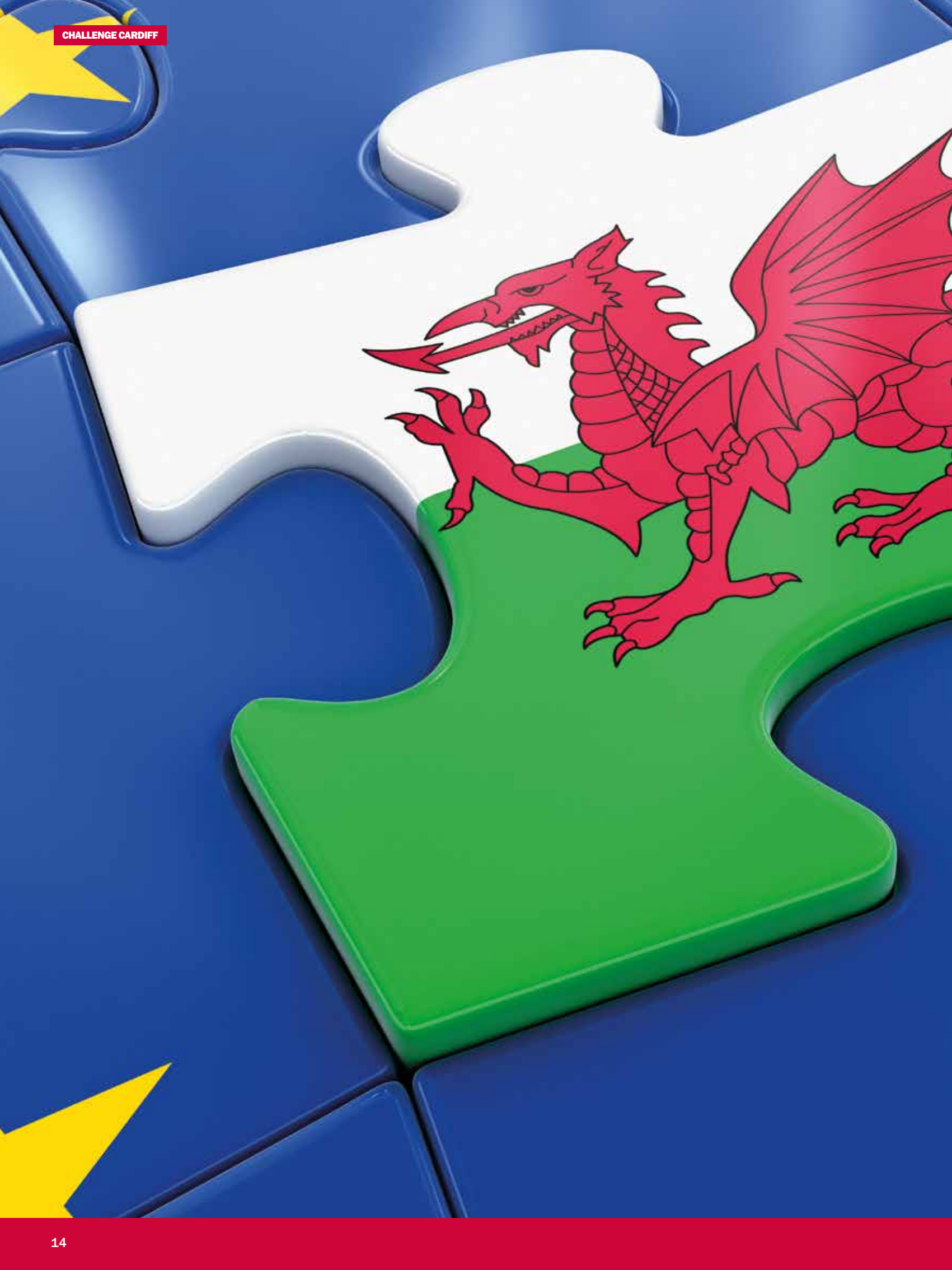
“On the morning of the 21st October, I left my house on Aberfan road and walked a couple of houses down to pick up my friend Robert, which is what we always used to do going to school.

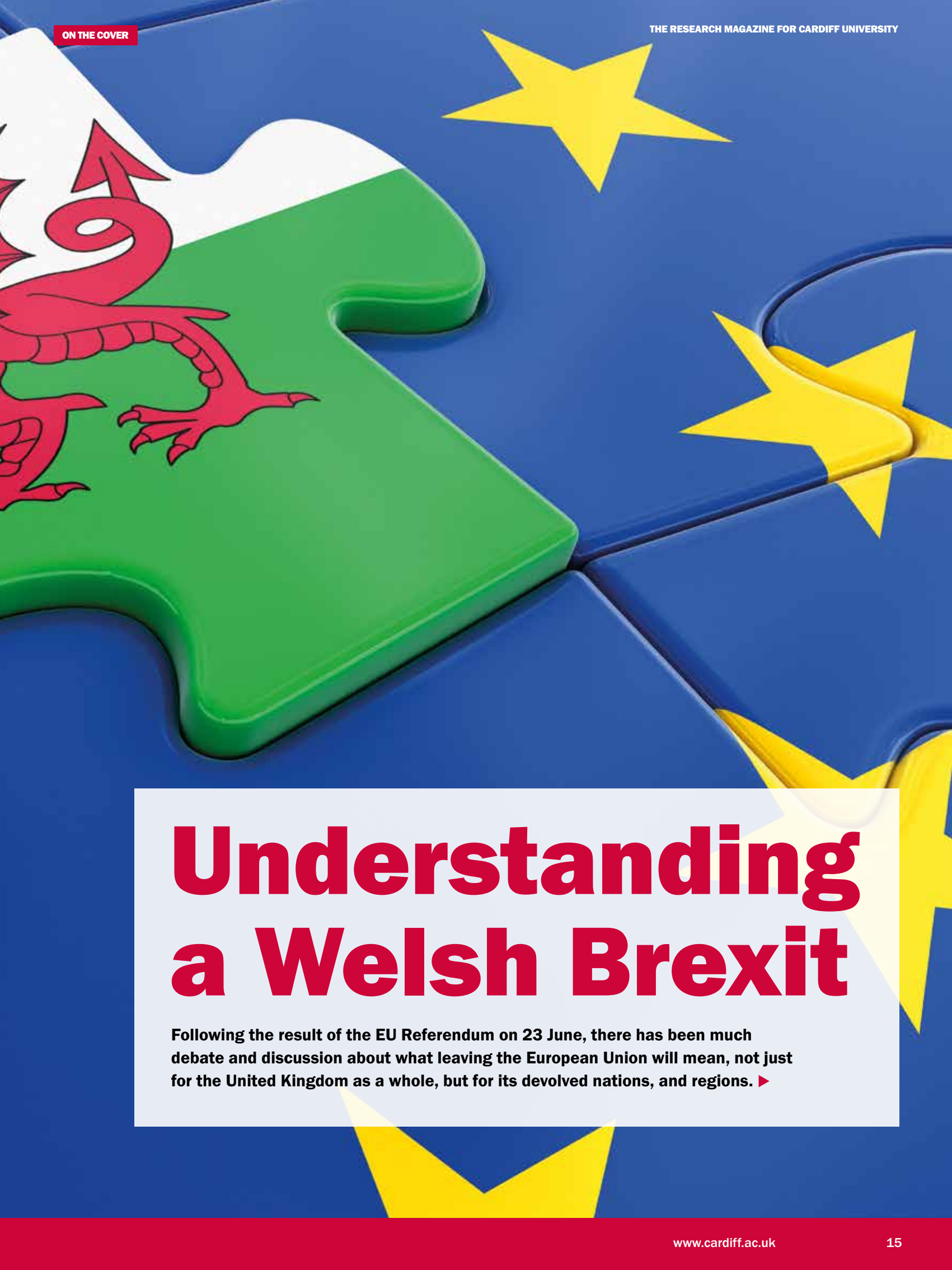
We walked to Pantglas School which was situated in Moy Road. When we got to the school we registered as normal. Friday was library book day so I went over to the windows nearest to the tips where the library books were actually kept and took Herge's *Adventures of Tin Tin* and returned to my desk. The teacher, Mr Michael Davies, started the maths lesson of the morning and then there was a rumbling sound of thunder which got louder and louder. Mr Davies reassured the class that there was nothing to worry about and that it was only thunder. The next thing I remember was waking up covered with all of this material. All I could hear were screams and shouts, and those screams and shouts got less and less as time went by. I was lucky because I was in a pocket of air which enabled me to breath. To the left of my body was the body of a young girl, and her head was on my shoulder. I couldn't move because the desk was against

my stomach. My right foot was caught in the radiator, and whilst I tried to push myself out I couldn't do anything. I was stuck there.

The next thing I remember was rescuers coming into the classroom and shouting. Because I had very white hair one of the rescuers saw it and shouted, 'look, there is somebody down here', and they started to remove the debris that was around me. They eventually got to the desk which was trapping my stomach, and used their hatchets to break it away. Then they lifted me out and threw me in a human chain from the classroom into the hall and out into the yard. I was the last child to come out alive. I had stomach injuries and head injuries but those injuries would heal over time. I think it was the psychological injuries that were the worst and they will last until the day I die.”







Understanding a Welsh Brexit

Following the result of the EU Referendum on 23 June, there has been much debate and discussion about what leaving the European Union will mean, not just for the United Kingdom as a whole, but for its devolved nations, and regions. ►



Huw Edwards

Cardiff University is the home of Welsh Brexit experts. Based in the Wales Governance Centre is the Wales and the EU hub, a project created to provide and disseminate non-partisan and independent research on Wales and the EU.

Here respected journalist Huw Edwards (BA 1983) quizzes four leading academics on what the future holds for Wales following the decision of the UK electorate to leave the European Union.

Senior ESRC Fellow Dr Jo Hunt (JH) is leading on a project entitled The UK in a Changing Europe: Legal Powers in Wales in the Context of UK Membership of the EU; Dr Rachel Minto (RM) is undertaking research into Brexit and UK devolved politics; and Ed Poole (EP) and Guto Ifan (GI) work on the Government and Expenditure Review Wales project, which

provides an analysis of Wales' public spending, public sector revenues and the nation's overall fiscal balance.

HE: How likely is it that the Welsh perspective will be represented in any meaningful way in negotiations which exclude the Welsh Government?

JH: The Prime Minister has been clear that she will be taking a "whole UK" approach to negotiations. The UK is the member state of the European Union and foreign policy remains a matter for the UK Government.

In terms of its influence in the negotiations, Wales is not in a particularly strong position compared to the other devolved nations. Scotland and Northern Ireland have additional leverage. Scotland has already raised the idea of a second independence referendum and possible secession from the UK; and there are a host of complex and sensitive issues attached to Northern Ireland's withdrawal from the EU, relating to a potential hard border with the Republic of Ireland, the Peace Process and economic inter-dependence.

In addition to these specific questions that require attention, both Scotland and Northern Ireland voted to remain within the EU. Wales doesn't have any such leverage. Furthermore, it voted to leave the EU. So, it is participating in these intra-UK negotiations from a position of relative weakness.

RM: There is now a structure in place for the inclusion of the devolved administrations in decision-making around Brexit: namely, the Joint Ministerial Committee (EU Negotiations). This is a forum in which the devolved administrations will have the opportunity to influence the UK's negotiating position. It is headed by the Secretary of State for Exiting the European Union, David Davis MP, and brings together the corresponding Ministers from Wales, Scotland and Northern Ireland. Unlike Scotland, Wales doesn't have a dedicated Minister for Brexit. The Minister for Finance and Local Government, Mark Drakeford AM, will be attending these meetings from Wales.

His portfolio includes the policy and administration of EU structural funds, as well as chairing the External Advisory Group of independent experts. The first Joint Ministerial Committee (EU Negotiations) took place on 9 November 2016. The outcome of this initial meeting was a commitment to meet monthly and to develop a work programme. It's too early to say how effective a forum the Joint Ministerial Committee (EU Negotiations) will be for the devolved nations. As the negotiations progress, it is likely that bilateral relations between Wales and the UK will become increasingly important. So, in one sense, Joint Ministerial Committee (EU Negotiations) has an important role to play in building relationships between key politicians and officials.

HE: How many extra civil servants will the Welsh Government and Wales Office need to deal with Brexit issues?

JH: When considering the question of capacity, we have to remember that the Brexit process will involve many stages. Article 50 of the Treaty on European Union (TEU) foresees that there will be two negotiations taking place: one dealing specifically with the UK's withdrawal from the EU, and another about the UK's future relationship with the EU. Article 50 TEU is supposed to concern the first of these, while having in mind the second. Before Article 50 TEU is triggered to start withdrawal negotiations, work needs to be done to determine Wales' priorities as part of the Brexit negotiations. Wales can try and feed these into the UK's negotiating position. This work is going on now and will continue throughout the UK's negotiations with the EU. Accompanying this, there will have to be ongoing work in Wales to understand the full implications of the UK's withdrawal from the EU, and what this will mean for Welsh public policy and public finances. Wales will need to prepare itself for post-Brexit.





Dr Jo Hunt

Dr Rachel Minto

“Before Article 50 TEU is triggered to start withdrawal negotiations, work needs to be done to determine Wales’ priorities as part of the Brexit negotiations.”

Dr Jo Hunt

RM: The Welsh Government and the National Assembly have already made some institutional changes to deal with these Brexit issues. The First Minister has established an External Advisory Group of independent experts, including Cardiff University’s Vice-Chancellor, Professor Colin Riordan. Within the Government, a new team of officials has been created to coordinate the work on Brexit – the EU Transition Team. Within the Assembly, Brexit-related matters are being addressed by the newly created External Affairs and Additional Legislation Committee.

Together, Wales’ political and administrative institutions are working to identify Welsh priorities. Although Welsh officials will not be participating directly in the UK-EU negotiations, extensive background work is required to ensure that the interests of Wales are identified and articulated, so that they may be fully considered.

JH: Then there is post-Brexit. Capacity is already an issue in the Welsh Government and the Assembly. This will become more pronounced post-Brexit when powers are returned from the EU to Wales. There are a number of policy areas that are both devolved and Europeanised, where Wales’ powers have been effectively limited to implementing policy made in Europe. Post-Brexit, Wales could find that it has the power to make policy itself, in areas like the environment and agriculture. In these cases, additional capacity within the Government and the Assembly will be required.

HE: Is it likely that Wales will have to pay for continued access to the Single Market as part of a UK-wide deal?

JH: The UK’s future relationship with the Single Market is at the centre of debates about Brexit. We don’t yet know what relationship the UK will seek to have with the Single Market, let alone what relationship it will secure following the negotiations with the EU. It’s worth being really clear about what we mean when we talk about “access to” the Single Market. As an EU member state, the UK is a member of the Single Market. The benefits of this include tariff free trade, as part of the Customs Union. But Single Market membership offers much more than the Customs Union. Additionally, members of the Single Market share a body of commonly agreed regulatory standards, meaning that products made in Wales can be sold across the EU as easily as they could to other parts of the UK, without the need for further regulatory checks or bureaucracy.

The principle of mutual recognition also applies, which means that, where there are no common EU rules, national rules are presumed to be equivalent to one another, and so a product lawfully made in one EU country can be sold anywhere else, with some limited exceptions. There is a price to pay for full membership of the Single Market, through contributions to the EU budget. The Single Market is underpinned by four freedoms: the freedom of movement of goods, services, capital and people. The latter of these is highly politicised in the UK, and is likely to preclude the UK from securing a deal that includes continued membership of the Single Market.

It would also rule out the “Norway option”, as Norway is also bound by these four freedoms. More recently we have heard talk about securing “unfettered access to” the Single Market. It’s not entirely clear what politicians mean by this, but it has been associated with tariff-free access

to trade with EU states, so would probably require the UK to be part of the Customs Union. This Customs Union covers both internal borders and external borders, meaning that members of the Customs Union share common external tariffs with third countries. So, as part of the Customs Union the UK would not be able to negotiate its own trade deals.

RM: Wales has a particular relationship with the Single Market, given its size and the significance of the European market for particular industries and goods produced in Wales, for example the agri-food, aeronautical and automotive industries. Its future relationship with the Single Market will be determined

“Until 2020, most funding from EU programmes will continue to be above and beyond the annual block grants which the Welsh Government receives from the Treasury to pay for devolved services.”

Ed Poole



Guto Ifan



Ed Poole

by the final deal struck between the UK and the EU. At this stage, it is not possible to say what financial contributions the UK may have to make post-Brexit. Any budgetary contributions from the UK to the EU would need to be agreed as part of securing a preferential relationship with the Single Market.

HE: Is it likely that Wales will have to pay to sustain current and overhanging EU plans for Wales?

GI: The Treasury announced in August that it will guarantee the full funding of all structural and investment fund projects if they were signed before the time of the Autumn Statement, securing continued funding for such projects even after the UK's departure from the EU.

This guarantee was extended in October for projects signed after the Autumn Statement, if they meet the Treasury's conditions of being good value for money, and in line with domestic strategic priorities. The current level of agricultural funding (under the Common Agricultural Policy) will also be guaranteed until 2020, before the transition to new funding arrangements.

EP: Until 2020, most funding from EU programmes will continue to be above and beyond the annual block grants which the Welsh Government receives from the Treasury to pay for devolved services. There does remain a question of how these types of projects will be funded after 2020. Given that Wales currently receives around 20% of all EU regional funding available to the UK (well above its population share of around 5%), there remains a possibility that future funding for the devolved areas of agriculture and regional development may have to come from the same pot of money that funds other devolved services, such as education and health.

HE: How credible is the guarantee given by Andrew R T Davies AM, leader of the Welsh Conservatives, (in BBC Wales Report interview) that Wales would not lose any of its current funding level after Brexit?

JH: Unlike the UK as a whole, Wales is a net beneficiary of EU funding. In a Wales Governance Centre Report released earlier this year, this benefit was estimated to be to the tune of £245 million in 2014, predominantly through EU Structural Funds - for regional development - and the Common Agricultural Policy. Certainly, the UK Government has not given any commitment to maintaining current levels of funding to Wales post-Brexit. As Guto has said, the Treasury has now guaranteed that it will honour existing EU funding commitments to Wales that fall within the EU's current 2014-2020 spending

round. However, it has not gone further than this. In the context of a shrinking economy – which the UK is likely to experience post-Brexit – there are inevitably concerns that current funding levels to Wales won't be maintained.

RM: There are a few points to bear in mind when thinking about funding to Wales post-Brexit. First, domestic funding will be required for both regional policy and agricultural policy. As we've said, the UK Government has not guaranteed that current levels of funding for regional policy and agricultural policy will be maintained, and this is even less likely in the case of a diminished economy. Secondly, how will any additional funding allocation be calculated? EU funding into the UK is needs based, with Wales receiving significantly more than England from both the Structural Funds and the Common Agricultural Policy per head of the population. In contrast, the current arrangement for allocating funding to Wales from the UK Government (the Barnett formula) is based on per capita spend in England. Given the per capita differential in EU funding receipts between England and Wales, Wales would be left severely out of pocket if the block grant to Wales were adjusted using the existing approach. There has been a lot of noise around the future of funding for agriculture, in order to ensure the competitiveness – indeed the viability – of Welsh farming.

Finally, it is important to note that EU funding to Wales is ring-fenced: EU Structural Funds money is for economic development projects and the Common Agricultural Policy funding is for farming. It is not necessarily the case that any post-Brexit increase in funding to Wales from the UK Treasury will be earmarked

for a specific policy area. So, there would be nothing to stop the Welsh Government from spending any additional funding on, say, health or education. Given the negative economic impact of Brexit, there will likely be increased pressure on public services and therefore more competition when it comes to the spending of any additional money coming to Wales.

HE: Michel Barnier and Donald Tusk define hard Brexit as relinquishing access to the Single Market, gaining full control over borders and making new trade deals. What impact will this have on Wales?

EP: A "hard Brexit" is likely to have a significant impact on international trade and Foreign Direct Investment in Wales, at least in the short-to-medium term. Most estimates of the economic impact of a hard Brexit have focused on the UK-wide impact, and we are not aware of a recent Wales-specific calculation. However, because the economic impact will vary significantly by industrial sector, and because the relative importance of each sector to the Welsh economy is different from that of the UK economy, then the impact of a hard Brexit might be different in Wales. Manufacturing of goods constitutes a higher share of the Welsh economy, such that the £5 billion-worth of exported goods from Wales to the European Union is proportionately more important to the overall Welsh economy. Conversely, barriers to exports of services, such as any that might be faced by the financial sector, may have a proportionately larger impact elsewhere in the UK. Economic effects felt in the rest of the UK will also have important indirect effects on the Welsh economy.

GI: Policy responses and guarantees such as those reported to have been made to Nissan in October could offset some of the potential downside economic impact. Depending on the nature and scope of the commitment, such guarantees could come at a cost to the Welsh or UK Government.

For more information on the Wales Governance Centre's work and to find out about upcoming events related to the Wales and Europe Hub, please visit <http://sites.cardiff.ac.uk/wgc/>

“Given the negative economic impact of Brexit, there will likely be increased pressure on public services and therefore more competition when it comes to the spending of any additional money coming to Wales.”

Dr Rachel Minto

GW4's ambitious vision for region

The GW4 Alliance of four leading research-intensive universities, Bath, Bristol, Cardiff and Exeter, looks to the future

Research and industry strengths

GW4 Alliance joined UWE Bristol, Plymouth University, Local Enterprise Partnerships (LEPs) and major businesses in the region to map out an ambitious vision for South West England and South East Wales in the Science and Innovation Audit.

The South West England and South East Wales Science and Innovation Audit (SWW-SIA) concluded that the region could lead the UK and compete with the world in the areas of advanced engineering and digital innovation.

SWW-SIA identified that the region is home to the largest aerospace sector in the UK and pioneering automotive, nuclear and marine renewables industries. The region is also

synonymous with digital innovation: home to the largest silicon design cluster outside of the USA; more climate expertise than any other area worldwide; a global powerhouse for the microelectronics industry; and a national exemplar for smart cities.

The SWW-SIA consortium has called on the government to make a series of strategic investments to strengthen centres of excellence including the Compound Semiconductor Applications Catapult, the proposed Institute for Advanced Automotive Propulsion Systems (IAAPS), and Composites Excellence – with National Composites Materials Centre.

Professor Colin Riordan, Vice-Chancellor of Cardiff University said: "The audit acts as an important milestone in the economic growth of the South West England and South East Wales region. I am delighted to see pioneering projects from Wales such as the Institute for Compound

Semiconductor (ICS), a joint venture with IQE plc and Cardiff University, championed by the report. We are looking forward to working together with GW4 members and major businesses across the region to drive this vision forward."

The first wave of Science and Innovation Audits was launched at Innovate 2016 by Secretary of State for Business, Energy and Industrial Strategy, Greg Clark MP. Professor Elizabeth Treasure, Deputy Vice-Chancellor at Cardiff University and GW4 Board Member, and Dr Neil Bradshaw, Director of Enterprise at University of Bristol, attended the event on behalf of the SWW-SIA consortium. The minister said that the audits demonstrated that "the locally-directed, collaborative approach is the right way forward". He thanked the consortia for their work and committed to using these reports as the authoritative evidence base to direct future investment.



Dr Sarah Perkins

New Director

GW4 Alliance has appointed a new Director, Dr Sarah Perkins, to lead on its long-term research and innovation strategy. Dr Perkins joins GW4 following her previous role as Programme Director (Research) at the Faculty of Medicine at Imperial College London, where she managed a world class research portfolio at one of the largest medical faculties in Europe.

At Imperial, Dr Perkins was involved in developing and delivering research strategy, and leading initiatives such as the Research Excellence Framework submission, working closely with several NHS trusts through the Imperial Academic Health Sciences Centre (AHSC) to foster collaboration and implement

research strategy at a senior level, exemplified by delivering and renewing one of the largest NIHR (National Institute for Health Research) Biomedical Research Centres. Her achievements were recognised in 2013 when she was shortlisted in the Women of the Future Awards, and she is also a Fellow of Westminster Abbey Institute.

Dr Perkins said: "GW4 Alliance has a fantastic track record in creating the research leaders of the future through collaboration, funding and mentored training. I am looking forward to building on this success to address local and global challenges and catalyse wealth creation across the region."



Funding and training opportunities

GW4 has announced its latest Building Communities funding round, which brings the total investment in this programme to £1.9m. Over 61 research communities have been created through Building Communities, tackling challenges from Alzheimer's diagnosis to producing biofuels. The latest call for the Initiator fund requires applicants to focus their efforts on Official Development Assistance (ODA) compliant work, in line with the Global Challenges Research Fund.

Building on the success of the Welsh Crucible (which opens in January), GW4 has launched GW4 Crucible (Healthy Living) for talented researchers across the alliance. Up to 30 research leaders of the future will come together to explore and expand their creative capacity and problem-solving potential. GW4 Crucible will introduce them to new ideas, contacts, and ways of working which will have a positive impact on their career development. Successful applicants will participate in a series of workshops across the region, starting in February 2017, in which they will hear from expert GW4 speakers and co-create innovative breakthroughs to tackle global challenges in 'healthy living'.

Adding to GW4's impressive portfolio of externally-funded doctoral training partnerships and centres, The Wellcome Trust has awarded funding for a new clinical PhD programme which will run between the GW4 member



universities of Bristol, Exeter and Cardiff. It will offer trainees access to a broad range of training opportunities with world leading researchers in population health; epidemiology; cardiovascular health; neuroscience and mental health; molecular cell biology; cancer; infection; immunity and repair. Known as GW4-CAT, the programme will support trainees for almost a decade from pre-PhD through to research independence.



Tracing Panama's geological footprints

It sits at the junction between two continents, separates two vast oceans and has a significant effect on global ocean currents and the climate across Northern Hemisphere.

Yet little is known about the history of this tiny strip of land between North and South America, known as the Panama Isthmus, which has shaped the Earth as we know it today.

Dr David Buchs, from the School of Earth and Ocean Sciences, and his team are carrying out detailed explorations of the geology of remote areas of Panama and Colombia to determine how, when and why the Panama Isthmus became fully emerged several millions year ago.

"Our world would certainly be very different if the Panama Isthmus had not formed. The Pacific and Atlantic oceans would not have

been separated by a land bridge, allowing vast quantities of water to flow between the Americas, which would probably have impeded the establishment of the climate as we know it today," Dr Buchs said.

The team are piecing together the history of the Panama Isthmus by studying how plate tectonics and volcanism have affected the region, which has remained relatively unexplored due to the dense vegetation cover.



What made me curious?

Professor Graham Hutchings is one of the world's pre-eminent authorities on catalysis, and was recently appointed Regius Professor of Chemistry. He spoke to Dr Peter Johnston, Scientific Consultant at Johnson Matthey, about his life of science.

PJ: What sparked your passion for chemistry?

GH: I wanted to be a chemist from the age of 11. I saw my first experiment - the distillation of water, a purple solution that was being boiled over into a colourless liquid. I was mesmerised by it.

I told my parents I wanted a chemistry set and saved up my pocket money, and eventually got the apparatus. I put the apparatus together and it wobbled, but the teacher's apparatus didn't wobble, so I put a cork in it. I'd created a closed system which I heated up, and it blew up. It was one of those moments where you just say "this is what I want to do."

PJ: You did a PhD in biological chemistry at UCL but your career has been in catalysis. Why did you make the switch?

GH: In the late 1960s and early 70s there was a lot of new science coming out in the biological arena. I saw biological chemistry as the subject to be involved with. Although I was offered jobs in the Scientific Civil Service I finally accepted a job at ICI on Teesside.

They recruited me as a biological chemist but they decided to change projects just before I arrived. I turned up on Teesside and they didn't really know what they wanted me to do, so they told me to look at some papers. All the papers were on vanadium phosphate for butane oxidation so at that moment I became a heterogeneous catalysis person.

PJ: What prompted the move into academia?

GH: I decided I would rather be an academic and be in charge of my own destiny than have industrial problems given to me which I would solve partially, and they would be happy with the partial solution; but I was never happy with these partial solutions and wanted to work more on them to obtain a complete answer.

My whole raison d'être is doing experiments and finding out something new that no one has found

out before. That's what fascinates me and is the driving force.

PJ: Did you find your time in industry rewarding or valuable as a stepping stone?

GH: Very much so. When I became an academic I had so many ideas to work on. I think there's a way of working in industry which opens up areas most people don't look at. For one thing, as an industrialist, you look at patent literature far more closely than we do as academics.

Had I become an academic by the standard route I don't think I would have made the discoveries I have made. Having an industrial background makes you think about things in a slightly different way.

I'm always mindful of a simple question: Can this be applied, can this discovery be used in any way? Pasteur said "There's only applied science and science yet to be applied". Working in industry, you see that first hand. Pure academic research is fantastic, but eventually it will find application.

PJ: You've had a long distinguished career in catalysis research. What topics and themes have you covered?

GH: I started off with vanadium phosphates when I worked at ICI and made some discoveries that fascinated me. My first academic appointment was at the University of Witwatersrand. I wanted to work on two things born out of things that happened when I was seconded from ICI to African Explosives and Chemical Industries. The first was methane oxidation, which is a topic I still work on today. It's a problem that has faced chemists for over 100 years. How can you take methane and oxidise selectively to methanol? If you could do that in an energy efficient way, you could revolutionise that part of chemistry, and there's huge kudos for anyone who can do that. We've been trying for 30 years and hopefully one day we will succeed. I like researching really challenging reactions.

One of the other things that came out was catalysis by gold. That's where we met of course, you were my project student. I'd predicted from looking at some data that gold would be the best catalyst for acetylene hydrochlorination for making vinyl hydrochloride. The company was very interested in it. I left the company and knew I couldn't write up the work that we'd done but I thought the correlation was something they would allow me to publish. I wrote a very short paper and they allowed me to publish it and that was back in 1985.

I wanted to take that out of my industrial work and carry it forward.

PJ: You've received many awards. Which one stands out for you?

GH: The Royal Society's Davy medal (founded in 1877), for the recognition of gold and gold palladium catalysis work. Some very illustrious names preceded me. I don't think my science measures up to a large number of those people's work, but it's nice to be thought of in that way.

PJ: Technology is changing rapidly, and so are ways in which science and catalysis problems are tackled. Is it different from the beginning of your career?

Yes and no. The basic methodology is still there, but we can interrogate things much more quickly than we could 30-40 years ago.

You can image things on an atomic scale. The techniques you can use now to get at information would have saved us years when I first started my research into vanadium phosphates.

PJ: Do you think now that research is done in a much more collaborative way, or is it still down to individual ideas?

GH: There is a place for the individual to work on a difficult problem but if you really want to solve the problem you need to collaborate with people with different expertise. You need to combine theory, material science and characterisation,

in situ spectroscopy for example, and no one laboratory or scientist has all that expertise.

PJ: Looking to the future, you've recently become a Regius Professor. What does that mean in terms of your position at Cardiff and your research, and does that open up new opportunities?

GH: It's fantastic recognition for chemistry in Wales as well as for the School of Chemistry which I helped to set up. It will enable us to open up new avenues and international collaborations.

From a personal point of view it's also nice.

PJ: In catalysis, what do you see as the future challenges?

GH: That's a very good question Peter. I've already set out some of the key challenges

that have been here for 100 years are yet to be solved.

Precious metals are used as catalysts and they are a non-sustainable resource unless we can use them more efficiently. It would be really neat if we could use earth-abundant metals to do the reactions. We have to look to biology which tends to use copper, iron, magnesium, and manganese.


If I was younger I'd love to bring what we know about biological and enzymic catalysis into play with what I know now about heterogeneous catalysis. I think with the interplay between these two we'd be able to solve these problems.

If you came back in 50 years' time, I'd be very surprised if we were still using precious metals and would hope we'd transformed into using earth-abundant metals.

What are your plans for future research?

GH: Cardiff University has been very good for catalysis. It's recognised catalysis as an essential science of the future, enabling us to access into areas where traditionally it has not been applied, such as water purification and cleaning applications.

Moving Cardiff Catalysis Institute into the Translational Research Facility (one of four new buildings on the University's £300m Innovation Campus) is a great opportunity. While buildings don't do research, it's the people in them and the opportunities that will come from that move that will inspire our young researchers to take on these new challenges. I hope the legacy of my involvement will be vibrant with young researchers working across a wide area of catalysis.



“If I was younger I'd love to bring what we know about biological and enzymic catalysis into play with what I know now about heterogeneous catalysis.”

Professor Graham Hutchings

Dr Peter Johnston

Professor Graham Hutchings

Systems Immunity Research Institute

Cardiovascular disease, diabetes, cancer, dementia, arthritis, infection, respiratory problems in new born babies, macular degeneration, eczema, psoriasis – all seemingly different diseases and yet there is something that links them all, inflammation.

This is the body's normal response to infection or injury and is essential for healing. Often, the point when it becomes chronic (or long term) is when it changes from being helpful to harmful. When this happens, our bodies lose control of the inflammatory response, promoting the development of disease. Although scientists know that inflammation plays a key role in all these illnesses, what drives it to become damaging in the first place is still largely a mystery.

We know that the processes responsible for driving inflammation vary considerably, even in patients with the same disease, but the study of this on an individualised basis is only in its infancy and still poorly understood. To be able to make clinical decisions on the basis of detailed knowledge of each person's inflammatory or infection status is a major goal and highly relevant for precision medicine, where treatments are individually tailored and based on a far deeper understanding of the stage or form of the disease itself.

Researchers at Cardiff University are internationally outstanding across a broad

range of infection, immunity and inflammation research and the University set up the Systems Immunity Research Institute in August 2015 to address the global health challenge of these killer diseases. Researchers apply big data/ systems biology approaches to understanding inflammation in all its forms, by studying large datasets using computer sciences and mathematics. A major challenge lies in integrating separate and often disparate views of co-existing diseases in the same patient groups, as well as in cellular studies and animal models.

Director, Professor Paul Morgan explains the challenge that this can present: "Nowadays our experiments generate a massive amount of data, for example describing the genetics, genomics, metabolomics/lipidomics and proteomics of inflammation either in cells or human samples. Identifying and extracting the important pieces of data is extremely challenging. Ensuring we have the right tools is essential if we are to succeed in the search."

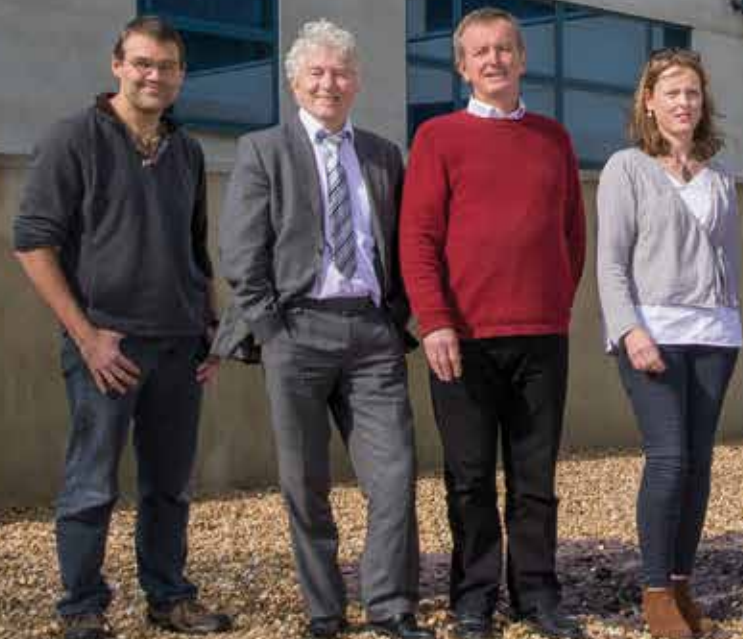
Co-Director, Professor Valerie O'Donnell said: "Combining biomedical expertise with informatics and mathematics takes our

research to the next level allowing us to handle and analyse our data in new and innovative ways. This approach is already leading to major findings that have the potential to change how we view inflammatory and infectious diseases."

Significant progress has been made at Cardiff in recent years in studying inflammatory variables in large population groups, offering data riches which can help to identify and focus on the triggers of chronic inflammation.

The following examples of work demonstrate that it is wide-ranging in terms of pathology, yet with a clear focus on providing a holistic view of chronic disease progression, the control of infection and the mechanisms affecting the body's capacity to regulate while mounting an effective response to chronic diseases.

An MRC Experimental Medicine Challenge grant awarded to Research Institute member Professor Sailesh Kotecha focuses on neonatal respiratory disease in premature babies. Ten per cent of all world-wide births annually are preterm (less than 37 weeks gestation), which translates into over 56,000 premature births in the UK alone. He found that these babies have more



Members of the Systems Immunity Research Institute. From L to R: Professor Philip Taylor, Professor Ian Weeks, Professor Paul Morgan, Professor Valerie O'Donnell, Professor Vincent Pigué, Professor Simon Jones, Dr Ian Humphreys and Ying Lin.

severe respiratory symptoms than their full-term counterparts, but their treatment is variable and not based on clinical evidence. Collaborating with Bristol, Sheffield, South Wales, and Bangor universities and University Hospital of Wales, 1,000 children from Wales are being screened to establish optimal monitoring and treatment of respiratory disease in premature babies, following them as they grow up during childhood.

Researchers recently discovered a new approach to prevention of the onset of an aggressive and hard-to-treat form of rheumatoid arthritis - a condition that affects 700,000 adults in the UK. Published in the *Journal of Experimental Medicine*, Professor Simon Jones and Dr Gareth Jones identified an important immune system protein - interleukin-27 - essential for development of a rapidly progressing and severe form of the disease which accounts for up to 40% of all cases. This marked a first in being able to explain how this form of the disease develops and highlighted new treatment opportunities targeting this protein. The findings are already being applied in the clinic, enabling doctors to divide patients into different sub-groups based on the often greatly varying patterns of arthritis. This will enhance early diagnosis, ensuring patients receive the most effective therapy for their particular condition.

Another area that the Research Institute specialises in is the analysis of lipid (fats) mediators, called "lipidomics", led by Professor Valerie O'Donnell. Highly specialised mass spectrometry enables researchers to map the lipids in human immune cells, and use this information to find new molecules that signal during inflammation, blood clotting and wound healing. The Wellcome Trust recently awarded £1.3m to a joint initiative led by Cardiff, in partnership with Babraham Institute, Cambridge and University of California, San Diego in order

to bring LIPID MAPS to the UK - an international online database that curates all lipid structures and provides informatics tools to the global lipidomic research community.

Professor Tim Walsh leads an exciting project supported by the European Union and the Bill and Melinda Gates Foundation, which is playing a major role in understanding how antibiotic-resistant infections are spreading across the world.

Infection scientists, Professor Gavin Wilkinson and Dr Rich Stanton's group have defined how viruses alter protein production by cells during infection. Their research will be used to design vaccination and therapeutic strategies to target these viruses, and will be also be exploited in the design of vaccines against other diseases such as cancer. Related to this, funded by Cancer Research UK and Cancer Research Wales, Professors Awen Gallimore and Andy Godkin are using genomic-based methods with the aim of generating new anti-cancer vaccines. They plan to test these in Phase I clinical studies within the next few years.

In its first year, the Research Institute secured 46 new grants worth over £9.4m, including prestigious Wellcome Trust Investigator Awards, a Bill and Melinda Gates Foundation grant and several Medical Research Council grants. It also established a PhD programme in Systems Immunity, appointed new faculty in key skills areas of systems biology and mathematical modelling and consolidated its informatics core with new staff and infrastructure.

Another highlight is the Research Institute's strategic international partnerships with the new Biomedical Discovery Institute, at Monash University, and with the Hudson Institute of Medical Research (HIMR) at the University of Melbourne, led by Professor Jamie Rossjohn,

joint faculty with Cardiff and Monash.

Collaborative studies between Research Institute and Monash are providing novel data on roles of cytokines in disease progression, as well as defining new paradigms in T cell biology (major cells involved in autoimmune disease), with Professors David Price and Andy Sewell. The collaborative work includes the development of new treatments, diagnostics and predictors of disease outcome in these areas.

The Research Institute invests significantly in public engagement activities, working with teachers and school children, health care professionals, national funders, local charities, policy makers and the general public. Patient-oriented events raise awareness of its research and its implications for improved patient management and public health via diagnostics, therapies, vaccines and life-style choices. It established a lay faculty to advise on research and engagement priorities and dissemination of its findings. It works closely with Techniquist Science Museum and Health and Care Research Wales to involve lay people in its activities. Its research is showcased at events such as the Cardiff Science Festival, Soapbox Science, Hay Festival and The National Eisteddfod. Working with the Nuffield Foundation, group members each summer play host to sixth-form students who undertake research projects in its laboratories.

The Research Institute is a major participant in the recently established Clinical Innovation Partnership between Cardiff University and Cardiff and Vale University Health Board; this enables it to work with healthcare professionals and industry to accelerate the real-world applications of its research leading to new diagnostic tests, drug treatments and changes to national and international policy in healthcare and patient treatment.



“Combining biomedical expertise with informatics and mathematics takes our research to the next level allowing us to handle and analyse our data in new and innovative ways.”

Professor Valerie O'Donnell



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