The report by Sir Andrew Witty, Chief Executive of GlaxoSmithKline, published in autumn confirmed the central role of universities in the UK’s economic recovery. Encouraging a British Invention Revolution recognises that the UK is a world leader in technology and inventions and has some of the best universities in the world. It also says that in order to punch its weight internationally in turning inventions into successful businesses, universities should have a greater role in delivering economic growth.

We know that Scottish universities outperform their southern counterparts – but perhaps less well known is that here in Aberdeen we outperform many in Scotland.

International rankings drawn up by researchers at Leiden University in the Netherlands, published last spring, named the University of Aberdeen among the top 100 higher education institutions in the world for scientific performance.

And we certainly don’t keep our clever ideas locked away in the lab. Aberdeen researchers have also been recognised in recent months for their commitment to commercialising new ideas and innovations through forming spin-out companies which can then take them forward. The PraxisUnico Annual Report 2013 ranks Aberdeen sixth in the UK for success in spinning-out research into commercial enterprises over the last three years.

One of our great advantages is not just our research strength in particular areas but the increasing emphasis we place on an interdisciplinary approach. It is interdisciplinarity that will be vital to tackling the great puzzles which still remain, the new ways in which science and technology interact with society to create the world we know today, and the challenges which must be addressed to ensure our global communities can thrive in the 21st century.

The problems of the modern cut across disciplines – and so too must the response of research-led universities like Aberdeen.

Professor Sir Ian Diamond FBA FRSE AcSS
Principal and Vice-Chancellor
University of Aberdeen scientists are developing what’s known as Fast Field-Cycling MRI which breaks the rule of conventional MRI scans.

Traditional MRI keeps the magnetic field – used to produce the image of whatever is being scanned – at a constant. However Fast Field-Cycling rapidly switches the magnetic field - while the scan is being taken - in order to gain a more complete picture of what is happening inside the body.

The Aberdeen team liken Fast Field-Cycling to having 100-plus scanners – each operating at different magnetic fields – in the one scanner.

“We’ve been analysing data of patients with cancer and osteoarthritis and finding that the Fast Field-Cycling is picking up signals specific to diseased tissue that are invisible to conventional MRI,” says physicist Dr Lionel Broche.

“The signals Fast Field-Cycling are picking up are also linked to other medical conditions such as age-related muscle-wasting and thrombosis,” continues Professor David Lurie, Chair in Biomedical Physics, who is heading the research.

“While we will continue to scan patient tissue samples, which we are extremely fortunate to get via our collaboration with clinicians at Aberdeen Royal Infirmary, our aim is to further develop the technology, so that in the next few years we can actually start scanning patients.”

The second imaging technique the team is progressing is called Zero-Field MRI or ZF-MRI. This method takes the magnetic field within the scanner very close to zero. Again it is believed that the technology will enable disease to be ‘seen’ earlier than standard MRI.

ZF-MRI is a natural progression in the technology of Fast Field-Cycling,” explains Professor Lurie. “However, instead of just changing the magnetic field, we switch it to a very low value – almost zero – during the scanning process, and we believe that this will provide even more information about the disease status of tissues.”

“From the early days of conventional MRI it has been known that the contrast that can be seen between normal and diseased tissue is greater at lower magnetic fields. Applying zero field is therefore a logical step forward. Moreover, the physics of MRI are very different at zero field so we are exploring a new world. This should provide information on the most subtle changes in tissue, bringing the possibility of early diagnosis and possibly much more,” says Dr Broche.

“We also hope ZF-MRI will detect ‘biomarkers’ – indicators found in the body which give more information about disease,” says Professor Lurie. “Biomarkers are used by drug companies to measure how a disease is progressing and to see if a drug treatment is actually working.

“Our initial targets with this technology are neurodegenerative disease such as Alzheimer’s and Parkinson’s. With Parkinson’s, the disease is diagnosed purely from clinical symptoms because imaging methods are not currently available to detect the early changes that occur in the brain before symptoms actually develop. However we expect ZF-MRI to help with earlier diagnosis of a wide range of medical conditions.”

The team has begun scanning samples of diseased tissue removed during cancer and joint replacement surgery and they hope to start scanning patients within the next two years.

Professor Lurie adds: “We are leading the way with our research into Fast Field-Cycling and ZF-MRI, developing medical imaging techniques that are not yet available anywhere else in the world.”

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Exploring the unconscious mind

Envisage an existence trapped in your own body – unable to move, unable to talk, effectively shut out of the world.

But what if your brain is still functioning at some kind of level and those around you are unaware?

An unimaginable and tragic scenario for all involved – and one being explored by a University of Aberdeen research group which is yielding surprising results.

The Aberdeen Coma Science Group is applying two medical imaging methods to investigate the brain function of patients who have been unconscious for more than six months. It is the only centre in Scotland carrying out this research.

The scientists are using functional MRI – or fMRI – which provides information on the brain's ability to respond to external stimuli. PET – positron emission technology – is also being used to measure glucose uptake in the brain which reveals whether there are brain areas that have shut down. They hope to build a greater understanding of the brain of coma patients, as well as those in a persistent vegetative state and with ‘locked-in’ syndrome.

So far 11 patients from across Scotland have undergone fMRI brain scans while simultaneously being exposed to different stimuli. These include being played a recording of a voice saying short phrases that would ordinarily conjure up corresponding words.

“Examples of the phrases played to our patients include ‘barking house animal’ and ‘long yellow fruit’ and usually this brings to mind the words dog and banana,” explains Professor Christian Schwarzbauer, Chair in Neuroimaging, who is leading the work.

While half of the group had no brain response to stimuli, there was some brain response in the other half.

However one patient – who has been unconscious for two years – showed more response than most.

“When the short sentences were played to the patient in the scanner, the areas of the brain responsible for processing sound and language lit up. It was incredible to see,” says Professor Schwarzbauer.

“With our patients we do another test that involves asking the patient to imagine they are playing a game of tennis while they are being scanned. This task results in a characteristic brain activation pattern. If we see this type of brain activation, we know that the patient was able to understand the instructions, which proves that the patient is conscious.

Unlike standard neurological tests, this test is particularly useful to identify patients who are totally locked-in, which means that they are conscious but unable to move or speak. But in this case, unfortunately, this particular patient was not able to respond to the tennis task.

“Although this test showed that the patient was still unconscious, the patient’s family were really pleased about the parts of the brain that were activated by our stimuli. Our findings prompted us to call a case conference and as a result of those discussions the patient is now receiving rehabilitation therapy based on speech and language stimulation.

“Nine months later we carried out another fMRI scan on the patient and saw even more improvement in the parts of the brain responsible for sound and language. The patient is also more responsive.

“Of course it’s impossible to say if this is due to the patient getting speech and language therapy as there may have been improvement anyway. But if you leave a part of the brain that could be stimulated without any stimulation, perhaps that ability will be lost.”

Accurate diagnosis of disorders of consciousness is a major challenge for clinicians, according to Professor Schwarzbauer.

“Standard neurological tests that are used for diagnosis rely on behavioural assessment which is extremely difficult for this patient group and results in a rate of misdiagnosis of up to 40%. The tests are based on the patient’s ability to respond by moving their eyes or making noises and if they are unable to do so they are scored low on a typical coma rating scale. The patient that we have
Professor Schwarzbauer believes changes should be made to how these patients are diagnosed.

“Aberdeen is the only centre in Scotland carrying out these tests on unconscious patients although we are not the only centre that has the imaging equipment needed to do them,” he adds.

“Some might argue that the cost of imaging this group of patients would make it prohibitive but we need to think long term. “Compare the cost of scans that deliver better prognosis and rehabilitation strategies with the more than £300 a day it costs the NHS to care for a patient of this kind.

“The costs of the scans are almost negligible if it can lead to better patient outcomes. There could be patients sitting in care homes right now with those around them unaware that they have some level of awareness. Without brain imaging can we really be sure that all of these patients are completely unaware?”

Just over three decades ago Aberdeen scientists and clinicians were the first in the world to scan the body of a patient using a fledgling technology known as “Nuclear Magnetic Resonance”, now better known as Magnetic Resonance Imaging.

The “MRI” scan of a terminally ill man from Fraserburgh was groundbreaking – possible only following the tireless endeavours of a dedicated team of University of Aberdeen physicists and NHS clinicians, convinced of the power of medical imaging.

Nowadays MRI is an indispensable tool used routinely around the globe to diagnose and investigate all sorts of illnesses. Since those pioneering days the University has maintained its place at the frontiers of imaging research – evident also by the staff and students who choose to cross the world to work and study here.

“As well as leading the way with MRI, Aberdeen was the first centre north of Cambridge to have an imaging technology called Positron Emission Tomography or PET,” says Professor Alison Murray, who heads the University’s Aberdeen Biomedical Imaging Centre.

Aberdeen: still pushing the boundaries of imaging

“Because of our research expertise Aberdeen was selected as the base for Scotland’s first NHS PET scanner, which is used to diagnose, stage and plan treatment for cancer patients. Until PET CT scanners opened in other Scottish centres, we were investigating cancer patients from across Scotland.

“Aberdeen’s landmark imaging developments are underpinning our efforts to better understand a range of medical conditions such as dementia, cognitive ageing and autism. Our imaging expertise has led to use of MRI and PET in the TauRx international clinical trial of a new drug in Alzheimer’s disease.

“Retinal imaging developed in Aberdeen is now provided as a NHS screening tool for diabetic patients across Scotland. MRI techniques also helped Aberdeen scientists discover how electroconvulsive therapy acts on the brain of patients who are severely depressed. It’s extremely gratifying that we are continuing to push the boundaries and build on our internationally acclaimed imaging legacy.”

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One of the unknowns has been the extent to which marine mammals may be disturbed by oil and gas exploration, particularly the use of seismic surveys. These involve generating loud noises repeatedly in the water and then listening to the acoustic reflections which can identify potential oil and gas deposits.

Offshore windfarm construction can also result in loud noise when turbine bases are attached to the sea bed using hammered piles.

European Directives have greater awareness of these issues, and now demand more rigorous assessments when offshore energy developments are proposed in the vicinity of protected sites.

The Moray Firth is a hotspot for coastal harbour seals and bottlenose dolphins and Special Areas of Conservation have been designated to protect these populations.

Thanks to long-term University of Aberdeen research, these are now some of the most intensively studied marine mammal populations in the world, underpinning efforts to understand the impacts of underwater noise on marine mammal populations.

The UK and Scottish Government commissioned the University to assess the potential impact of oil and gas operations on cetaceans in the Moray Firth.
The work established that protected bottlenose dolphins were unlikely to occur in the vicinity of proposed seismic surveys. However it did show that another small cetacean, the harbour porpoise, was abundant in these offshore waters.

Researchers were then tasked with investigating the responses of the harbour porpoises to the seismic survey noise. “It’s often feared that underwater noise from seismic surveys or windfarm construction could lead to marine mammals being displaced from large areas around these developments,” explains Professor Paul Thompson, who heads the University’s cetacean research at the Lighthouse Field Station in Cromarty.

“It’s important to understand the scale of this impact where protected wildlife populations occur in areas being considered for new offshore energy developments. We studied changes in the distribution of porpoises before and during a 10-day commercial seismic survey in September 2011.

“Because porpoises make regular echolocation clicking sounds, we used an array of moored echolocation detectors to monitor their activity across the Moray Firth.

“The acoustic data was supplemented by digital aerial surveys that detected surfacing porpoises. Calibrated noise measurements were also taken at different distances from the seismic survey vessel.”

The scientists discovered that short-term disturbance from the seismic vessel did not lead to long-term displacement of harbour porpoises as had been suspected. While the porpoises initially responded to the noise at distances of 5-10km, they were detected again at these sites within a few hours, and the level of response declined during the 10-day survey.

Professor Thompson adds: “We were pleased to discover that the seismic surveys did not lead to broader scale displacement of the porpoises into less favourable habitats. These findings will help us assess impacts from both oil and gas exploration and windfarm construction.

“Future research now needs to explore the consequences of any more subtle changes in foraging behaviour that could result from exposure to underwater noise.”

Fast Facts

Cetaceans spotted during survey

In 2010, during 13 days of aerial survey covering 5,500 km of the Moray Firth, researchers identified:

- 26 bottlenose dolphins
- 230 harbour porpoises
- 6 common dolphins
- 14 minke whales
- 1 Risso’s dolphin
- 2 white beaked dolphins

Making waves

The University of Aberdeen has been conducting studies of cetaceans and seals in the Moray Firth for over 25 years.

The research programme – based at the Lighthouse Field Station in Cromarty – has informed a wide range of conservation and management issues.

Annual photo-ID surveys are providing information on changes in the number of bottlenose dolphins using the Moray Firth Special Areas of Conservation.

Studies of seal population ecology and foraging have led to changes in the management of interactions between seals and salmon fisheries.

The acoustic methods used to study changes in porpoise distribution were developed following an EU Project surrounding the installation of the world’s first offshore deep-water wind turbines in the Moray Firth.

Recent industry and government funded projects have also developed new approaches for assessing and monitoring the impacts of offshore windfarm developments on marine mammal populations.

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Race to save Alaska’s lost ‘melting villages’

Archaeologists are used to uncovering only bones and stones as they investigate ancient societies, but now climate change is starting to defrost amazingly well-preserved sites in the Arctic revealing a far richer archaeological record and, within these sites, could be clues to how global warming will affect us in the future.

Co-Investigator Charlotta Hillerdal holds a magnificently preserved wooden mask she found moments before. The mask depicts a human in the act of transforming into a wolf or dog-like animal and still had traces of silvery coloured paint.
Residents of the Yup’ik Eskimo village of Quinhagak in western Alaska first called in archaeologists from the University of Aberdeen in 2009 to carry out a rescue dig after observing their coastline being washed away as a consequence of global warming.

Within hours of beginning the dig, the team, working alongside local archaeologists, located a 700-year-old village site which was falling into the sea. Amongst the site were hundreds of immaculate artefacts which had been preserved by the permafrost, but were now exposed to the elements because of the thaw.

“The first thing we found was a complete wooden doll with the original paint still on it,” explains project leader Dr Rick Knecht of the University of Aberdeen. “It’s quite incredible – leather, fur, plants, even 400-year-old grass that has been completely preserved intact because they’ve been frozen all this time.

“Instead of looking at stones and bones, like archaeologists usually look at, we’ve got wooden artefacts - pieces of organic material. It’s the same as would have existed at the same time in Scotland but all that was lost long ago.

“The exposed archaeological site was rapidly eroding away because of global warming – you’ve got rising sea level, and the permafrost melting. The soil is held together by the ice, so when the ice melts the soil becomes very vulnerable to marine erosion.

“Since we started in 2009, the shoreline has retreated a full 10 metres. This is happening all around the Arctic and because these were coastal people, the archaeological record is lost with it. But it’s not just an archaeological record – it’s one of the clearest records of the past that we know of anywhere in the north."

Named ‘Nunalleq’ (meaning ‘the old village’) by village elders, discoveries at the site number tens of thousands and have included samples of human hair, ceremonial face masks and an ivory carving of a legendary river monster. In early 2013, the project was boosted by a £1.1m grant from the Arts & Humanities Research Council.

The dig has been carried out in full partnership with the local indigenous community. The pieces have been transported to the University of Aberdeen for preservation and archiving but remain the property of the people of Quinhagak and will be returned afterwards.

The site was inhabited between 1300 and 1650, during the Little Ice Age (shortly after 1400), which was a period of rapid global climate change which is well documented in Europe.

As well as providing a fascinating account of how the Yup’ik people lived hundreds of years ago, the project is also relevant to bigger issues concerning climate change in general.

“It’s ironic that climate change is bringing about this thaw, which, in itself, is helping us answer questions about how these people coped with climate change hundreds of years ago and may help us plan for similar conditions in the future.”

A boy from Quinhagak contemplates excavated masks, part of a workshop held for village residents at the end of every field season when all the finds are put on display.
More than 60 wooden dolls have been recovered from the site. Some were made as playthings, others were made for ritual and ceremonial purposes.

What we found in the earliest phases of the site is that, despite the very seasonal nature of the availability of wild foods in this region, there seems to be very little dietary change throughout the year – a mixed diet of fish like salmon, cutibou, and some marine mammals. The lack of variation in diet suggests they were preserving and storing the food and eating it all year around – this really attests to adaptations these early groups made to life in the arctic.

“Now we want to see how diet changed throughout the Little Ice Age. Our new grant will allow us to look more closely at the palaeoenvironment and food technologies at the site, such as pottery and hunting implements. We’ll combine this with the isotopes, and get a better look at how climate change influenced subsistence strategies and what made it onto the menu.”

Dr Knecht said: “Up until now the dig has been funded by the villagers themselves. The grant from the Arts & Humanities Research Council will keep the dig going for another four years, and also fund local archaeological education and training initiatives and, importantly, a regional survey to find more sites under threat.”

“The site is a little time capsule that we can tap into, to infer changes that may happen in the future – with regards to the availability of different animal species as climate shifts, changes in animal behaviour and how past humans responded to those changes.”

“She said: “Cut strands of human hair, the waste from haircuts, were found all across the site, sitting on the preserved house floors – rather like the sweepings you get at a barber’s shop. By taking a long strand of hair we can sequentially sample it and get a month-by-month or even bi-monthly record of dietary change, so you get a year in the life of this individual, in terms of what they ate.

What’s happening at Nunalleq will be repeated right across North America and into Greenland. Further north there are places in Arctic coastlines that have lost a mile of coastline. That’s their entire archaeological record gone.

“Looking at the past will help us see what parts of the environment are most sensitive to temperature change and hopefully provide a predictive model for what’s going to happen to the modern subsistence diet of animals and plants that people in this region are completely dependent on.”

Dr Kate Britton, of the University of Aberdeen, is carrying out stable isotope analysis of hair samples from the site in conjunction with labs across Europe and Canada, in order to reconstruct diet amongst the ancient inhabitants of the site.

Dr. Charlotta Hillerdal, also of the University of Aberdeen, is working with local community groups and schools in Quinhagak as part of the project, a process that has been beneficial to both the local people and the archaeologists: “Working with the people of Quinhagak is a true partnership and it is a great privilege to be involved in this project. As an archaeologist it’s great to see how archaeology can become a part of a living heritage, and witness the power these artefacts hold as cultural objects.

Throughout this project it has become evident that archaeological remains and artefacts in Nunalleq and their fascinating tale have the ability to bring people together. Local Yup’ik Elders and youngsters, experienced archaeologists, as well as students on their first dig, exchange knowledge and share experiences. The artefacts evoke the memories of some and arouse the curiosity of others. They inspire stories that could otherwise not have been told, and cultural meetings that without would not have taken place, as well as increase our own understanding of a fascinating Yup’ik past independent of colonial practices. The Nunalleq project has shown Yup’ik archaeological heritage to be dynamic and powerful and a great asset to the local community as well as to research.”

Dr Knecht added: “All the artefacts will be returned to the area and we’re looking to establish a local research centre and repository so the collections can be locally stored and expanded.

“What’s happening at Nunalleq will be repeated right across North America and into Greenland. Further north there are places in Arctic coastlines that have lost a mile of coastline. That’s their entire archaeological record gone.

“There are many more sites like Nunalleq that we just can’t get to, so part of the grant involves surveying the land to identify other sites and provide training to local people so they can take steps to preserve artefacts and record new sites.”

“The site is a little time capsule that we can tap into, to infer changes that may happen in the future – with regards to the availability of different animal species as climate shifts, changes in animal behaviour and how past humans responded to those changes.”

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He knew that he was setting himself a mammoth task. And spanning 15 centuries, there is no question that the Penguin Book of Irish Poetry is a comprehensive read.

In order to provide the best representation of Irish Gaelic literature, which was the first known art poetry to use rhyme, Professor Crotty would have to provide the first ever translations of many of the poems he wanted to include.

The Penguin Book of Irish Poetry presents poems in modern English and Ulster Scots, alongside verse translations from Middle English, Old French, Old, Middle, Classical and Modern Irish, Latin and Old Norse. With 80 pieces demanding new translations, Professor Crotty enlisted the help of internationally renowned poets including Seamus Heaney, Michael Longley, Maurice Riordan and Scotland’s own Kathleen Jamie.

The volume recounts a millennium and a half of Irish history through the art of the country’s greatest poets and songwriters.

The many ethnicities of Ireland are heard, whether by way of poetic reflections on the island’s culture and politics from the Old Norse of the Vikings, the Old French of the Normans aristocrats or the Middle English of their more lowborn followers.

The Ulster Presbyterian tradition is represented by poems in Scots drawn from across three centuries, and Old Irish lyric poetry is made available through a range of translations, many of them new.

At the heart of the book lie the courtly strict metre poems that dominated Gaelic culture from the 13th to the 17th centuries, while the achievement of the 18th and 19th centuries is more fully represented than ever before and the resurgence of verse making in Ireland since the 1960s given its due in a large but eclectic section near the end of the volume.

Two sections demonstrate the unparalleled wealth of Irish song from Columbanus to Christy Moore.

The book went straight into Penguin Classics and sold 12,500 copies in its first three months, featuring in the Irish Top Ten Non-Fiction best-selling lists in October 2010.

“It is of course an extremely satisfying moment when you have the finished product in front of you, but it took a lot of work to get there,” explains Professor Crotty.

Of the 80 new translations featured in the anthology, 50 of them were painstakingly created by Professor Crotty – he recalls one particular stanza requiring 64 drafts before he was happy with it. Many of the 80 translations were to some degree collaborative.

“I had great help along the way, and to have some of literature’s finest names be part of the project was both humbling and inspiring. It was a privilege to work alongside so many fine writers and scholars.”

It took nine years for Professor Crotty’s idea to finally become a reality and the book was officially launched by the late Nobel Laureate, Seamus Heaney, and Michael Longley, a former winner of the Queen’s Gold Medal for Poetry, at an event held at the Royal Irish Academy in Dublin. The event and the book received a great deal of media interest, with Patricia Craig of the Independent writing, “this magnificent anthology achieves what might seem nearly impossible, a balanced view of Irish poetry from the earliest times to the present.’”

Professor Crotty adds: “It is extremely flattering to receive the sort of reviews that the Penguin Book of Irish Poetry received. Creating it was a long process but a worthwhile one – I can always say that I went straight into Penguin Classics three years before Morrissey’s Autobiography!”

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Face fit

Passport to better security?

Professor Mike Burton
It’s projected a staggering 1.4 billion passengers will travel through airports across the globe in 2016.

But are the current security systems available best equipped to analyse the fleeting faces that pass through security checks, or is a new breed of technology required to ensure the face fits?

“Familiar faces trigger special processes in our brain,” says Professor Mike Burton, Sixth Century Chair in Psychology at the University of Aberdeen.

“We would recognise a member of our family, a friend or a famous face within a crowd, in a multitude of guises, venues, angles or lighting conditions. But when it comes to a stranger it’s another story.”

Unlocking the fundamental process that is happening in the brain when we spot someone known to us, is the focus of investigations being led by Professor Burton.

He is heading up a study, supported by a €1.5m European Research Council grant, aiming to pinpoint this crucial mechanism, and use this understanding to develop new technologies for the security sector.

“We’re working with identification professionals in several countries, for example passport and police officers. We hope this four-year project will lead to significant improvement in how security systems operate.

“Establishing what happens in the brain when you go from not knowing someone, to knowing someone is the key. It’s very clear that the brain is doing something rather special, and finding out what it is, is our goal.

“Our ultimate aim is to develop a computer that is just as good at recognising faces as a person looking at a familiar face. Whilst great progress has been made in understanding many of the signals conveyed by faces - for example their gender, attractiveness, expression and facial speech – little is known still about how we are able to identify the faces we see.

“Given the practical imperative to understand facial identification, I find it surprising that there has still been very little progress in this field,” says Professor Burton.

“Investigations to date have assumed that the level of recognition we have for a familiar and unfamiliar face is equivalent, and this is simply not the case. This limits not only our theoretical understanding of face perception, but is also reflected in the fact that no working automatic face recognition system yet exists – despite the claims of some vendors and well-publicised trials at some airports.

“The truth is that automatic face recognition currently being employed is flawed – it simply does not work as efficiently and effectively as we need it to. An average of 191,200 passengers arrive and depart through Heathrow’s doors on a daily basis and if the technology used were to even work at 99% accuracy, nearly 2000 mistakes would be made each day.”

Professor Burton believes that the technology currently available fails to take into account the extent and limitations of our ability to recognise faces.

“What seems to have been missing in the development of security technology so far is the fact that one photograph does not always give us a true representation. There is a great emphasis on a passport image to fit all purposes but if we think about it carefully, isn’t it common for people to comment on the fact that their passport photo looks nothing like them?”

“Our research suggests that this focus on a solitary image has slowed up progress in face recognition so far.

“Findings from previous studies show us that what really matters when you learn to recognise someone is capturing that person’s range – all the guises in which they can appear, from moment to moment and year to year.

“The man on the street could be presented with, for example, a range of pictures of Bill Clinton, from 20 years ago, at a distance, in bad lighting, and at differing angles, and still reconcile them as images of the former American President.

“It seems odd that we expect one single passport shot to encompass a person and allow us to consistently recognise them. Could there in fact be an argument for our passports to contain a multitude of images, taken at different angles, in different lighting and formats? This is certainly something our study will examine, and developing understanding of this variability in the way we recognise faces is something we hope to achieve.”

Looking to the future, Professor Burton believes this work could create an important shift in how security measures are undertaken.

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Taking to the skies to map the interior of the Earth
Unmanned flying drones and helicopter mapping using missile guidance systems, and carrying lasers, may sound like something from science fiction. But it’s actually a technology being used already, and academics at the University of Aberdeen are using it in a bid to recover more oil reserves from the North Sea.

In collaboration with a group at the University of Bergen in Norway, the project uses remotely operated flying machines to scan rock formations in remote areas in order to better understand what lies beneath the surface and improve understanding of subsurface reservoirs.

Professor John Howell, a geoscientist at the University of Aberdeen, explains: “When you drill a well in the North Sea, you can directly measure the rocks in the borehole, however you have much less certainty about what is going on away from the well. Given that two wells are often several miles apart, predicting what the rock layers in between the boreholes look like is a huge challenge.

“To solve this problem we look at similar rock units which occur in cliffs above sea level and we use the drone to make extremely detailed 3D models, which we can then adapt for the subsurface. This gives us a much better idea of what conditions are like between these two bore holes and then allows us to predict how the oil will flow and how much we can recover.

The advantage of the drone is that it allows us to collect large volumes of data from otherwise inaccessible cliff sections in remote and often dangerous places.”

Geological mapping has come a long way since the early days of the Victorian pioneers who spent years making painstakingly detailed geological maps by hand. However, in many areas, data is still being collected using conventional photographs and hand-written notes.

The recent development of laser scanning systems, initially from the ground and later from helicopters using gyroscopic guidance systems borrowed from cruise missiles, is revolutionising mapping because it allows very large quantities of very accurate data to be collected quickly and efficiently.

Most recently the group are using unmanned aerial vehicles (drones) to map cliff sections. The drones consist of a computer gyroscopically stabilised body, typically with up to eight tiny motors with helicopter-style blades on ‘spider legs’ emitting from its centre. The vehicle used in the project costs around £10,000 and is remotely operated using radio controls and carries two cameras which allow it to collect stereo, 3D imagery. The computer stabilisation and multiple motors means it is incredibly stable and provides an accurate map of the rock formations.

Professor Howell adds: “The work is part of a project called SAFARI which started in the late 1980s. The original workers on the project have seen data collection technology come on in leaps and bounds since then but the introduction of laser scanning was one of the biggest improvements and we’re now able to create virtual rock formations that are accurate to within less than a few millimetres.

“The overall project goal is to develop a fully searchable database of these relevant rock formations which will help oil companies build better models of the subsurface and improve recovery from oilfields.”

The research work in the SAFARI project is supported by 24 oil companies including many major firms. The next phase, which will be the first to fully utilise the drones, will start next year.

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Giving food poisoning the bird

It’s one of our favourite dishes but shop bought chicken is also to blame for the epidemic of Campylobacter food poisoning in the UK. University of Aberdeen scientists are part of Government-led efforts to curb incidences of the potentially deadly infection which are also extremely costly to the economy.

Campylobacter is the most common cause of food poisoning in the UK. In 2012, according to the Food Standards Agency, the bug was responsible for around 460,000 cases of food poisoning, resulting in more than 22,000 hospital admissions and claiming 110 lives. Research at the University of Aberdeen has demonstrated that most of these cases are associated with broiler chickens.

The bug also accounts for a third of the cost of the burden of foodborne illness in England and Wales, estimated at more than £583m in 2008, although infection has since risen by 30%.

However, according to research at the University of Aberdeen, half of the public have never heard of Campylobacter and are unaware of the risk to themselves and their families.

Since 2001 University scientists have been investigating where these food poisoning cases are originating. In what was the world’s largest study of its kind, the researchers identified retail chicken as the single largest source of Campylobacter food poisoning in Scotland.

“Other studies had suggested links with raw chicken but following nine years of lab work, public surveys and statistical data analysis, ours was the first study to definitively single out broiler chicken as being responsible for most cases of this kind of food poisoning,” explains Dr Ken Forbes, a microbiologist at the University.
who carried out the work with colleagues Professor Norval Strachan and Iain Ogden.

“Campylobacter bacteria live in the gut of a wide range of birds and animals and so affected faeces can contaminate meat as well as unpasteurised milk and untreated water. However our work established a major link to contaminated poultry. The bug can cause a problem for the consumer if poultry meat is not cooked properly or if there is cross-contamination in the kitchen.”

Using state-of-the-art technology, the researchers built up a detailed picture of the problem.

“We isolated Campylobacter strains from over 7,000 cases and compared these types with those from 1,400 food, bird and animal samples by using gene sequencing technologies,” says Professor Strachan. “Our findings showed that Campylobacter in other animals, such as cattle and sheep and wild birds, also play a part in infecting people by direct exposure and by passing on the bacteria to poultry.

“We also found that while virtually all campylobacteriosis cases are not recognisably linked, there was evidence of common sources in around one sixth of cases, even though people lived considerable distances from each other. This suggests that the UK’s extensive food distribution networks may play an important role in the dissemination of chicken which is contaminated.”

The findings – published by the Food Standards Agency in Scotland on its website – have provided valuable evidence on the key sources of Campylobacter infection which the Food Standards Agency and other policymakers have used to develop strategies for tackling the problem. The novel approaches developed by this research will also help government to monitor the impact of interventions applied across the food chain on human cases of infection.

Since then the Aberdeen researchers have widened their investigations into the problem.

“We found that chicken liver pâté can be a source of food poisoning if it is not cooked properly,” says Professor Strachan. “This followed a study where we tested raw chicken livers from a typical range of supermarkets and butchers over a two-year period and discovered Campylobacter in 81% of them.”

“We’re also working on a number of other studies. One is funded by the Food Standards Agency, and is a continuation of our earlier work. But we are not just looking at Campylobacter in retail chicken, we are also looking at it in sheep, pigs and wild birds.

“Broiler chicks are born free of Campylobacter so we want to establish how they end up getting colonised by the bug,” adds Dr Forbes. “We’ve also received funding from the Biotechnology and Biological Sciences Research Council and from the Department for Environment, Food and Rural Affairs to work on two separate studies which investigate biosecurity measures to see if these can help prevent Campylobacter from getting into broiler sheds.

“We are also investigating the biology and seasonality of Campylobacter. The disease is less common until May when it increases dramatically over the summer before it then starts to decline again. We have found that a significant proportion of this seasonal peak of campylobacteriosis is due to illness acquired abroad and again this is linked to chicken. Also, that young children living in rural areas are contracting it from the environment.”

The researchers are well aware that furthering our understanding of the problem won’t lead to overnight eradication and that interventions throughout the food chain – from farm to fork – are required.

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Contamination targets

The Food Standards Agency, the Department for Environment, Food and Rural Affairs, the UK poultry industry, and major retailers have agreed a target against which to measure efforts to reduce the levels of the food bug Campylobacter in chickens.

There are three categories of contamination levels – currently 27% of birds are in the highest category.

The new target is for the industry to reduce the numbers of these most contaminated birds in UK poultry houses from 27% to 10% by 2015.

It is estimated that achievement of this target could mean a reduction in Campylobacter food poisoning of up to 30% – about 111,000 cases per year.

*Figures from the Food Standards Agency
Putting a spin on science

The University of Aberdeen has had an innovative approach to business since the 1970s when it set up a holding company to manage a group of wholly-owned and profitable subsidiaries as well as its spin-out companies.

Two of the spin-outs established then are still thriving today: AUPEC Ltd, which advises on oil and gas taxation, and NCIMB Ltd, which curates bacterial collections. Two decades on and these companies are among many flourishing enterprises sprung from the vision of Aberdeen academics.

“The success of a spin-out company is often driven by an academic researcher who is passionate about sharing the idea they have been working on, sometimes for years, and developing it into a product that can benefit the wider world,” says Dr Ann Lewendon, Commercialisation Coordinator within the University’s Department of Research & Innovation team.

Pioneering research findings that have translated into commercial applications span the academic disciplines. Such success earned the University 6th place in the PraxisUnico Spin-Out UK Survey Annual Report 2013.

“Aberdeen was one of the first academic institutions to adopt spinning out,” adds Dr Lewendon. “The biggest change from those early days is that there is now a much more direct path for University spin-outs with investors quick to recognise their viability. What has not changed, however, is that at the heart of a successful spin-out is an idea that has the ability to change thinking or practice and make an impact in the commercial world.”

For more information contact: res-innov@abdn.ac.uk
Developing new drugs for Alzheimer’s disease

TaRx Therapeutics was spun out of the University in 2002 – under the leadership of Professor Claude Wischik – to develop preventative treatments for Alzheimer’s and other neurodegenerative diseases.

The company has reached a milestone with over 400 patients enrolled in its global Phase 3 clinical trials of its lead compound, LMTX™, for mild to moderate Alzheimer’s disease.

More than 100 medical centres in 15 different countries are actively screening and enrolling patients for the studies, with extra centres in other countries expected to start soon.

“Reaching this milestone in our clinical research studies brings us one step closer in our quest to finding an effective disease-modifying treatment for Alzheimer’s disease,” says Professor Wischik.

Eye movement test to diagnose major adult psychiatric disorders

Saccade Diagnostics will be spun out of the University following a decade of research on schizophrenia and related conditions. The pre-spin-out won both the Converge Challenge Business Plan and Open Innovation competitions in 2013, and will be seeking investment in 2014.

Co-founder Dr Philip Benson says: “Delivering an accurate and timely diagnosis remains one of the most pressing responsibilities of modern psychiatry.”

Professor David St Clair adds: “Our test will help clinicians arrive at an informed diagnosis much sooner and reduce the time patients spend in clinics and may also have the potential to assist in assessing problems before they arise.”

Delivering world’s most advanced computational linguistics technologies

DATA2TEXT was spun out of the University in 2009 to commercialise Natural Language Generation – NLG – technology. Academic founders Professor Ehud Reiter and Dr Yaji Sripada, and industry collaborator and co-founder Ian Davy, initially developed a data-to-text system to generate high quality weather forecast texts from numerical weather prediction data.

Data2Text has since evolved this early NLG programme into a powerful platform technology capable of analysing various forms of Big Data to produce natural language reports for the monitoring and control of operations within large enterprises.

In 2012 Arria NLG acquired a minority interest in Data2Text and the partnership created the Arria NLG Engine™. Arria NLG and Data2Text’s mission is to become a global leader in the development and deployment of enterprise level NLG software technologies. An early adopter of NLG technology was an oil major which engaged Data2Text to apply NLG to real time production data.

Developing new drugs for challenging infections

Spun out of the Rowett Institute of Nutrition and Health, NovaBiotics is focused on the design and development of anti-infective therapies for difficult to treat, poorly served infectious conditions.

Its lead compound is Novexatin® – a topical treatment for fungal nail infections. It is also developing drug candidates for conditions such as blood stream fungal infections and cystic fibrosis.

NovaBiotics recently entered an exclusive agreement with Taro Pharmaceuticals North America, Inc. to licence and co-develop Novexatin®. Dr Deborah O’Neil, NovaBiotics CEO and Scientific Officer, says: “As a leader in dermatology, Taro is an excellent fit for NovaBiotics and our ambitions for Novexatin®.”

Signal Pharma is the University’s newest spin-out and first to emerge from its Kosterlitz Centre for Therapeutics. Backed by a local businessman and entrepreneur, the company will tackle the research required to develop a candidate drug for treating heart failure. It also has a pipeline of projects addressing unmet clinical needs.

Founder Dr Iain Greig says: “This is a very exciting opportunity for pharmacologists and medicinal chemists to work together to develop new breakthrough therapies for major diseases that affect huge numbers of people here in Scotland and the UK.”

Signal Pharma

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Within a university’s walls there sits a wealth of knowledge from a vast breadth of disciplines.

Unlocking the potential of this expertise to boost the local economy is the aim of funding streams established to bring together the worlds of business and academia.

“Government statistics tell us that 96% of UK businesses are small and medium enterprises (SMEs) and responsible for 32% of UK jobs. The potential benefit of helping these companies to grow by tapping into academic expertise is clear,” says Dr Rachael Wakefield, Technology Transfer Officer.

“Within a university setting there are experts from across the broadest possible range of subject areas, who have the potential to support the wider community, and specifically the business sector.”

Giving small and medium business owners the chance to utilise what was a relatively unexplored pool of expertise, is what new funding streams – referred to as innovation vouchers – from organisations such as the Scottish Funding Council and the Technology Strategy Board, have achieved.

These funding streams are supported by mechanisms to make it easier for company personnel to have those first, important conversations with individuals and teams that could lead to new products and services.

Dr Wakefield continued: “SMEs play a fundamental role within Scotland’s economic landscape and in order for these companies to continue to grow, they must innovate. This is where academic input can provide crucial and hugely beneficial assistance, whether it is helping to develop a brand new technology or service, or explore routes to market.”

Successful links between University of Aberdeen academics and local businesses to date have included:

**INGEN GTL LTD**

Collaboration between oil and gas engineering consultancy Ingen GTL and the University of Aberdeen’s Surface Chemistry and Catalysis Group led to the successful improvement of the performance of a catalyst developed by the company.

Experts at the institution worked on detailed characterisation, performance optimisation and the industrial scale-up of the iron catalyst created for the high temperature hydrogenation of carbon dioxide – an important reaction in the chemical industry to obtain different products from synthetic gas.

The success of the collaboration has opened the way for future collaborations between the company and University.

The project was funded by an Encompass Kick Start Award.
RURAL REGENERATION

A consortium of business and professional parties from the Howe of Mearns worked with academics from the University’s School of Education to boost economic rural regeneration in their area of Aberdeenshire.

The project included University research to establish the aspirations of the local community, investigations into the viability of Community Asset Transfer – where local authorities are empowered to transfer the ownership of land and buildings to communities for less than their market value – and help to establish a social enterprise where profit is invested back into the rural community.

The project was funded by an Encompass Kick Start Award.

EQUIBUDDY EXCHANGE

Equibuddy, a charity within the Riding for the Disabled Association worked with experts from the University’s Department of Computing to develop a data management and social network tool for horse owners and managers.

The technology allows horse owners to keep records and data about their horses in a standardised form within a cloud-based online service which can be accessed via a mobile application.

It also provides a profiling and training framework for horse owners to assess and evaluate their horse’s abilities and to support them in their training efforts with relevant information, tips and tutorials, and provides a social network for the equestrian community.

The project was funded by a Sporting Chance Initiative STAR grant.
Bringing medieval back to Dover

A failed camera flash and a revised PhD topic would three decades later see Professor Jane Geddes play her part in the major restoration of a British landmark.

Her early field-trip to study monumental medieval portal designs had resulted in a dismal haul of photos which illuminated only the tiny area of door handles – resulting in a swift change of plan. As a result, in 1999 Professor Geddes published Medieval Decorative Ironwork in England, the first specialised study of the medium. When creating the book, which was the culmination of many years work and travel, she hoped that apart from its historical value, it would go on to be a guide for restoration teams and film producers – such was her desire never to see the wrong doors used in the tales of Robin Hood again.
The impact she hoped her research – a study of virtually every medieval church door hinge in England – would have was realised when English Heritage was tasked with regenerating Dover and therefore restoring Dover Castle.

The town of Dover was decaying; the introduction of the Channel Tunnel and the declining numbers of ferries had had a detrimental effect on tourism in the area. The government’s Sea Change Programme, which aims to drive regeneration and economic growth in seaside towns, enlisted the help of English Heritage with a £2.45m project to boost the town’s visitor numbers; to encourage people to come back to the town and to spend longer there.

And so the idea to re-create Dover Castle to its original state was born and with it an expert in medieval ironwork needed.

With 600 photographs of various ironworks, dating as far back as 1060, Professor Geddes’ definitive study would play a huge role in ensuring that the Dover Castle which stood proud in its regal heyday back in 1180 was accurately revived.

The task at Dover was to provide appropriate fittings for 30 doorways connected to the royal apartments, paying attention to the social status of each entrance, and the existence of some original pintles still in the masonry. In each case correct timber and nails were required to represent the era accurately. In addition, many rooms within the castle needed to be furnished with chests, coffers and aumbries, with decorative grilles in the chapel.

Models for these could all be found within Medieval Decorative Ironwork and as such, the ‘new look old look’ Dover Castle is based on the precise descriptions and dates from the book.

Working with English Heritage historians, the designer Kit Surrey, architectural firm Purcell, Miller and Tritton and a team of 150 craftsmen, Professor Geddes acted as a consultant between 2008 and August 2009 when the castle reopened to the public.

She explains: “Every era in time has its own unique quirks that are demonstrated in various guises and when carrying out a project as vast as overhauling a castle and restoring it back to its former glory, attention to detail is vital. “When advising the blacksmiths, Julian Coode and David Gregory, we discussed the spontaneous appearance of medieval ironwork, compared with pedantic Victorian replicas. Rather than meticulously imitate the hinges as laid out in the book, part of the charm of recreating the castle was to allow that same degree of spontaneity to flow.

“I was delighted to have been asked to help with the project – it’s exactly the type of use I envisaged for the book when carrying out my research and compiling it. One of the highlights of my time spent at Dover Castle was walking into a room and seeing a well-used and well-worn dusty copy of the book lying on a work top. I’d much rather the book collect dust as the result of being on a building site than on a book case.”

Professor Geddes was also able to impart some historical context to the craftsmen involved in the project, with one even using the skills he acquired during the project to restore ferramenta of the 1180s for windows at Canterbury Cathedral.

“For a lot of the tradesmen working on the site, they had never experienced a project like this – they even had to make all the nails to be used by hand in order to keep true to the date.”

Television camera crews took a keen interest in the project and the reopening of the castle was followed by a Time Team TV special, which received more than two million viewers, and since the completion of the project, English Heritage have recorded a rewarding boost in visitor numbers to the attraction.

“It is wonderful to see excited family groups enjoying the atmospheric display at Dover Castle, and to have played my part in such an important project. It was beyond my imagination all those years ago to think the book would leap out of its obscure academic niche onto such a popular and colourful world stage.”

For more information contact: j.geddes@abdn.ac.uk
Offering peppermints is hardly the most promising way to start an after-dinner speech. Yet, Professor Wendy Graham – founder of ImpaCT, the University of Aberdeen’s maternal and newborn health research group – did precisely that when she addressed a prestigious dinner.
The University has a brain trust of natural and social sciences and strong partnerships with local industry and entrepreneurs which can help Soapbox make a difference for mothers, babies and their care-providers. We welcome contact from all interested parties.

My brief was to give a short talk on my specialist subject, a topic with which I have been engaged for over 25 years. Yet the palpable discomfort I have sensed over those years among diverse audiences – from local village chiefs in remote rural West Africa, to the general public in Aberdeen, and the United Nations General Assembly in New York - has made me avoid lunch or dinner presentations. Offering peppermints is a comfort I resort to when a talk is unavoidable...as it was on this night. My recollection was that the audience was genuinely moved and shocked by my account – and a few peppermints were indeed taken. But it is only recently that I have come to appreciate how this experience along with many others I have accumulated over the years reflect one of the greatest challenges and opportunities facing academics in the 21st century – effective communication.

As the stakeholders for research have become ever more diverse, so have the audiences we need to engage with, locally and globally. This is now the new frontier for achieving and demonstrating the societal benefit of research. But what do we do with those sensitive topics which may indeed need peppermints to ease the delivery of uncomfortable findings or harsh realities? We can of course try humour, but this is not appropriate for all topics and audience cultures – including my specialist area which lies in the category I call the “indigestion zone”.

By the time you have read these 800 words, around 40 women and babies will have died in pregnancy or childbirth, all in low-income countries and virtually all from preventable causes. This is a tough message for any audience, and certainly in parts of the world where childbirth today is – thankfully - mostly a joyous and positive event. The conundrum of communicating shocking realities without creating emotional fatigue in an audience – or transgressing ethical standards for preserving the integrity, dignity and privacy of vulnerable groups – is common to many spheres of global health and development.

This challenge has spawned examples of good (and bad) communication by activists, journalists, politicians – and scientists. We scientists need to craft engagement skills while also walking the tightrope of keeping true to the evidence, and not falling into what is called “the pit of over-advocacy”. This has been the path walked by the University’s Immpact research group, established in 2002 to strengthen the evidence base to reduce maternal and newborn deaths in low-income countries.

More than ten years on, Immpact continues to work in partnership with research institutions, ministries of health and international organisations such as the WHO to improve the quality of maternity services. With collaborations from Afghanistan to Zimbabwe, Immpact undertakes the essential mix of research, training and technical advisory work to help accelerate efforts to meet the Millennium Development Goals for mothers and children by 2015, and indeed the new Sustainable Development Goals for the period beyond. The challenges of communicating evidence on the tragedy of maternal and newborn deaths will continue, as will the opportunities for scientists to contribute.

Our role is also to innovate – and this brings opportunities to create the ‘good news’ stories. In the last 18 months, I have had the opportunity to help establish a new evidence-based charity which focuses on a very simple intervention – cleanliness at birth. The Soapbox Collaborative works in partnership to deliver action and new knowledge to enable mothers and babies to benefit from clean, safe care at birth in some of the poorest parts of the world. Hosted by the Immpact group, this is bringing new thinking on interventions, new partnerships, and new challenges. The need to maintain independence and objectivity in an area with strong commercial interests – ‘the cleanliness industry’ – is clearly key for us scientists, but the opportunity to contribute directly to improvements at the point of contact with mothers and babies is an amazing privilege. This is the sort of societal impact expected of academia in the 21st century.

But it is also the power of communicating a positive message – cleanliness – which is liberating on many fronts. We have been able to appeal to new collaborators who want to contribute to this good news story, and we need more! It is fitting that this has been born in Aberdeen, with its long history of ‘clean interventions’ – from the work of Alexander Ogston in the 1800s, to work today on food hygiene.

The University has a brain trust of natural and social sciences and strong partnerships with local industry and entrepreneurs which can help Soapbox make a difference for mothers, babies and their care-providers. We welcome contact from all interested parties. And we won’t need peppermints to present the case, but we do need other aids to achieve progress – water, mops, buckets, disinfectant, and SOAP! Yes – soap.
"The traditional habitable zone is also known as the Goldilocks zone," explains PhD student Sean McMahon. "A planet needs to be not too close to its sun but also not too far away for liquid water to persist, rather than boiling or freezing, on the surface. But that theory fails to take into account life that can exist beneath a planet’s surface. As you get deeper below a planet’s surface, the temperature increases, and once you get down to a temperature where liquid water can exist – life can exist there too."

The team, which includes Aberdeen professor John Parnell and University of St Andrews PhD student Jack O’Mailey James, challenge the traditional ‘habitable zone’ – i.e. the region of space around a star, or sun, which can support life – by taking into consideration life living deep below the ground.

They created a computer model that estimates the temperature below the surface of a planet of a given size, at a given distance from its star.

Digging deeper in the search for life on other planets

When a new planet is discovered the first question asked is usually, "could it support life?” But what does that actually mean? Traditionally a planet is deemed ‘habitable’ if liquid water could exist on its surface. However, academics at the University of Aberdeen are suggesting the search for life needs to go a little deeper.
Their findings published in Planetary and Space Science show that Earth-sized planets can support life at least ten times further away from stars than previously thought, which means cold rocky planets previously considered uninhabitable may actually be able to support life beneath the surface.

Effectively, it means habitable planets could be far more widespread in the universe than previously thought.

McMahon added: “The deepest known life on Earth is 5.3 km below the surface, but there may well be life even 10 km deep in places on Earth that haven’t yet been drilled. “Using our computer model we discovered that the habitable zone for an Earth-like planet orbiting a sun-like star is about three times bigger if we include the top five kilometres below the planet surface.

“The model shows that liquid water, and as such life, could survive 5km below the Earth’s surface even if the Earth was three times further away from the sun than it is just now.

“If we go deeper, and consider the top 10 km below the Earth’s surface, then the habitable zone for an Earth-like planet is 14 times wider.” The current habitable zone for our solar system extends out as far as Mars, but this re-drawn habitable zone would extend out beyond Jupiter and Saturn. The findings also suggest that many of the so-called “rogue” planets drifting around in complete darkness could actually be habitable.

“Rocky planets a few times larger than the Earth could support liquid water at about 5 km below the surface even in interstellar space (i.e. very far away from a star), even if they have no atmosphere because the larger the planet, the more heat they generate internally.

“It has been suggested that the planet Gliese 581 d, which is 20 light years away from Earth in the constellation Libra, may be too cold for liquid water at the surface. However, our model suggests that it is very likely to be able to support liquid water less than 2 km below the surface, assuming it is Earth-like.”

“The results suggest life may occur much more commonly deep within planets and moons than on their surfaces. This means it might be worth looking for signs of life outside conventional habitable zones. I hope people will study the ways in which life below the surface might reveal itself. Because it’s not unimaginable that there might be signs at the surface that life exists deep below.

“The surfaces of rocky planets and moons that we know of are nothing like Earth. They’re typically cold and barren with no atmosphere or a very thin or even corrosive atmosphere. Going below the surface protects you from a whole host of unpleasant conditions on the surface. So the subsurface habitable zone may turn out to be very important. Earth might even be unusual in having life on the surface.”

Cold rocky planets previously considered uninhabitable may actually be able to support life beneath the surface.

“The significance of the subsurface is further illustrated by another paper published by the same team which suggests there could be more life below the surface of the continents on Earth than there is below the seafloor. McMahon hopes the studies will encourage other researchers to consider how life on other planets might be detected.

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Diabetes tackled by bright sparks

Once it would have seemed likely only within the realms of novelist Mary Shelley – applying electrical currents to parts of the human body.

But this is anything but Frankenstein science – electrical stimulation has been used clinically for decades to help fix difficult-to-heal bone fractures and this is now being extended to the repair of major skin wounds.

And the University of Aberdeen has played a critical role in helping clinicians get to this stage with skin repair. For the last 17 years, scientists have been unpicking the mystery of how the centuries-old therapy actually works.

“It has been known since Roman times that electricity from electric fish can be used as a therapy for a variety of medical conditions, but clinical acceptance of it has been slow because of a lack of understanding of how electrical stimulation operates at a cell and molecular level,” says Professor Colin McCaig.

“However Aberdeen has led the way with our studies which have shown that the electrical signals activate many of the chemical signalling pathways that stimulate cell division and direct cell migration, both of which are essential for wound repair.”

These findings have led to Professor McCaig being invited to speak at many clinical conferences. He has also acted as a consultant for a leading healthcare manufacturer which has produced a hospital device which passes an electrical current through skin to help wound healing. Since it became available...
• The team’s initial study – supported by the NHS Grampian Endowment Fund – is expected to run for one year and is a collaboration of University scientists and NHS clinical staff including Professors Mary Cotter, Norman Cameron, Donald Pearson, Dr Sam Philip and Ms Leigh Porter.

in 2005, clinicians have used this device in about 160 hospitals, and around 6,000 patients have been treated successfully.

Now the research team is about to embark on the first study of its kind to see if electrical stimulation of wounds can also help diabetic patients whose wounds can be notoriously hard to heal.

“Diabetics can have a real problem with wound healing,” explains Dr Ann Rajnicek. “Foot ulcers caused by ill-fitting shoes or other irritation can develop into chronic wounds. Unfortunately this often results in the need for amputation.

“Ours will be the first study to measure the electric field in human diabetic skin.

“We hypothesise that one reason diabetic skin heals less effectively is because the natural electric field within the wound is not strong enough to stimulate cells to divide or move into the lesion.

“We will test the ability of electrical stimulation to control movements of diabetic skin cells in a culture dish. This will show whether, in principle, an electric plaster could be used to supplement the natural electric field and improve healing and also give clues to how the electric field stimulates the cells at a cellular level.”

Researchers will recruit patients attending the diabetic clinic at Aberdeen Royal Infirmary. A control group of people who are not diabetic will also be sought.

“Diabetic people routinely monitor their sugar levels using a drop of blood from a small pin prick wound,” says Dr Rajnicek. “We will measure the electric field near such a wound using a handheld device that scans very near the skin surface without actually touching it.”

“Although our study targets skin wounds in diabetic patients, non-healing ulcers such as bed sores are a £4 billion healthcare burden in the UK,” adds Professor McCaig.

“Also the principle of using electricity to boost wound healing applies to many different tissues and diseases. Obvious future targets would be stomach and gut ulcers, damaged lungs where the lining breaks down, and brain repair following conditions such as stroke. The physiology of electrical signals coursing between our cells has been appreciated for a century, but learning how to adapt it for optimal clinical use is a major future challenge.”

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Watt Else?

• Skin is like a battery. Skin forms a tightly sealed layer with its individual cells pumping charged ions – sodium, potassium and chloride – in such a way that the region just under the skin is more positive than the outside and this can be measured as a voltage.

• When skin is wounded the charged ions leak out, collapsing the voltage at the wound, but it remains unchanged further away. This difference in local voltages creates an electric field near the wound edges.

• Voltage across skin is enough to power a small light bulb if several pieces were connected together. This was demonstrated using frog skin over 50 years ago.

• The electric field at a skin wound can be detected with your tongue. You might have noticed this as a slight tingling when the tip of your tongue contacts an ulcer or abrasion on the inside of your cheek.

• There is at least one company in the UK now using electricity to stimulate wound closure clinically.
“Building bridges between science and the food industry is a key factor to achieving nutritional goals in terms of how and what people eat,” says Dr Alexandra Johnstone, a nutritional scientist from the University of Aberdeen Rowett Institute of Nutrition and Health.

“Globally, obesity is a challenge that needs to be faced head on. Bringing expertise together to develop products that are satisfying in terms of both taste and appetite plays a crucial role in enabling people to make smart choices when it comes to their diets.

“The Rowett Institute’s work with Marks & Spencer on their Fuller Longer range, demonstrates the impact successful collaboration can have and the fact that good food and nutritious meals can go hand in hand.”

The story of this prosperous partnership between academia and commerce began in 2008. An initial approach by the Rowett Institute resulted in a meeting with key representatives from the retail chain in the November of that year.

The establishment of a 12 month consultancy contract quickly followed with Dr Johnstone and her team taking an advisory role in the development of the range that launched in the retailer’s stores in January 2010.

Dr Johnstone explains: “The research underpinning the Fuller Longer brand was the result of human intervention studies to understand how a diet high in protein and with moderate carbohydrates can control appetite and support weight loss.

“Our work looked at the satiating qualities of protein, which at the time, was already high in the public consciousness due to the profile of diet plans like the Atkins Diet. We are all fundamentally different, physiologically and psychologically, so what works for one person aiming to achieve weight loss, will not always work for another.”
With the Fuller Longer range the focus is on meals that are high in protein, but we are also looking at, for example, the impact of fibre on appetite, and the relationship between eating a dairy-based breakfast and satiety.

“Our investigations had focused on the relationship between dietary protein and carbohydrate influencing satiety and our findings indicated that when we eat proteins, different mechanisms are activated in our bodies that produce feelings of fullness and reduce hunger.

“Where our research differed from other high profile thinking at the time was that we suggested that it was not advisable to follow an extreme diet where only protein is eaten and other food groups are cut out.

“For gut health maintenance a moderate level of carbohydrates is essential and it was the balance of food groups and ingredients that we advocated that was the key to not just weight loss but overall nutritional health.”

These research strands led to the development of a range of calorie-counted meals and snacks to promote satiety. The subsequent interaction with Marks & Spencer took the research findings from laboratory to industry and the creation of what has fast become a market-leading brand.

“Integral to all of our work is the fact that when it comes to diets it’s not a case of one size fits all. There is not one magic bullet for weight loss,” adds Dr Johnstone.

“We are all fundamentally different, physiologically and psychologically, so what works for one person aiming to achieve weight loss, will not always work for another.

“Our research goal is the development of different strategies that take into account the variations in a person’s behavioural, physiological or psychological make-up.

“With the Fuller Longer range the focus is on meals that are high in protein, but we are also looking at, for example, the impact of fibre on appetite, and the relationship between eating a dairy-based breakfast and satiety.

“Fast forward 10 years and I hope we are at the stage of being able to tailor dietary plans to the individual and I believe our research is playing a crucial role in making that hope a reality.”

But could vegetables also boost the shelf life and health impact of convenience meals?

Scientists at the University of Aberdeen Rowett Institute of Nutrition and Health are examining if introducing the natural antioxidants found in locally-grown vegetables could improve the nutritional values and extend the sell by date of processed foods.

“Whilst we are all aware of the value of eating more fruit and vegetables, factors such as busy lifestyles mean convenience foods are forming a major and increasing part of our diet,” says Professor Garry Duthie who is leading the Scottish Government funded research.

“Our study is looking at the impact of introducing powders from Scottish-grown vegetables including beetroot, onion, celery and yellow and green peas, to processed foods such as burgers, pizzas and ready meals.

“We believe the benefits of adding the antioxidants found in these vegetables, are two-fold.

“Firstly they have the power to boost the health benefits of these products for the consumer.

“When we eat a fatty food, a process called oxidation occurs in our stomachs, where fats are transformed into potentially toxic compounds and absorbed into the body. These compounds are linked to cancer and heart disease.

“We believe that adding a vegetable extract, which contains antioxidant compounds, will stop this oxidation of fat in the gut, and thereby preventing the body from absorbing this more toxic form of fat.

“The second benefit of adding these antioxidants impacts the food manufacturer.

“When fats oxidise in the stomach they become toxic. This is essentially the same process that causes foods to go rancid or ‘go off’ in a shop or supermarket over time.

“So introducing an antioxidant such as beetroot or celery would slow down this oxidation process, and have the added benefit for the food industry of lengthening the shelf life of products.

“Our work with vegetable powders may also create additional or new uses for vegetable produce not selected for direct sale due to poor shape, colour or size and hence contribute to reducing the one third of food produced annually which is lost and wasted globally.”

For more information contact: alex.johnstone@abdn.ac.uk

www.abdn.ac.uk
Random benefits: the myths and methods of trials

Clinical trials have come a long way since Scottish physician and naval hygiene pioneer James Lind compared lemons and horseradish as treatments for scurvy while aboard the HMS Salisbury in 1747.

In James Lind’s time, if an eminent doctor said his – and it was almost always a ‘he’ back then – secret brew was the way forward, that was often enough. Today the media offers us a daily diet of promising treatments and wonder drugs. But is this all marvellous news to get excited about – or simply a good headline? Professor Phil Hannaford, Vice-Principal for Research and Knowledge Exchange, explains why we need randomised clinical trials...

In everyday life people who use a medicine are often different to those who do not use it. Sometimes the differences are obvious and easily identified. At other times the differences are subtle and hard to identify. Differences between users and non-users, however, can seriously affect perceptions about how effective a medicine is.

For example, many observational studies have followed users and non-users of hormonal replacement therapy (HRT) and found less heart disease among users. This led many clinicians to believe that HRT should be used by menopausal women to prevent heart disease. The lower risk of heart disease, however, may have been due to the characteristics of women using HRT – for example they may have a healthier lifestyle or be more likely to take part in preventative programmes – rather than because of HRT itself.

Although researchers can use a variety of statistical techniques to allow for differences that are measured, there is always a concern in observational studies that unknown – or poorly measured – factors explain the apparent effectiveness of a medicine. To overcome this problem, researchers wanting to know how well a drug, medical procedure or other clinical intervention works try to undertake a randomised controlled trial or RCT.

In RCTs, the participants usually have an equal chance of being allocated to the intervention under investigation, or a comparison intervention, eg placebo or best current treatment, with the researchers using chance to randomly allocate people to either group. Such randomisation helps ensure that known and unknown differences are equally distributed among the groups. In turn this provides much greater confidence that if an intervention being tested is found to work; the effect is real rather than an artefact produced by differences between the groups. To further increase this confidence, carefully designed RCTs also try to make sure that trial participants, the clinicians looking after them, and the research team, do not know until after the trial is fully completed what intervention each participant received. This so-called ‘blinding’ prevents people from selectively reporting or ascertaining effects because of knowledge, or conscious or unconscious beliefs, about the intervention that a participant has received.

There are some situations in which RCTs are either unethical or highly impractical – for example persuading women to be randomly allocated to different types of contraceptives. Recruitment to a RCT can be difficult especially if there are complex criteria for inclusion, or a lot of criteria for exclusion. This can lead to questions about whether the results of the trial accurately reflect the effectiveness of the intervention when used in everyday practice. In addition, it can sometimes be difficult or impossible to ‘blind’ participants or their clinicians to the intervention they receive.

Returning to our example - when tested in carefully designed RCTs, HRT does not appear to reduce heart disease; indeed in some women it may even increase the risk. This new information has led to a global reassessment of the value of HRT in preventing heart disease, and is a powerful illustration of why, whenever possible, RCTs should be undertaken when trying to assess how well an intervention works.

Randomised Controlled Trials are a key part of the University of Aberdeen’s research portfolio, especially those associated with our Chief Scientist Office funded Health Services Research Unit, and related Centre for Randomised Healthcare Trials. We have a particular focus on surgical procedures and non-drug complex interventions, including those addressing gynaecological, urological, musculoskeletal, eye, respiratory and cardiovascular problems.

Fast Facts

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What’s the connection between randomised controlled trials and Sir Chris Hoy? Perhaps a few clues would be helpful and one would be the Trial Forge initiative of the University’s Health Services Research Unit, as Shaun Treweek, Professor of Health Services Research, outlines…

Despite trials being a cornerstone of evidence-based healthcare, much of the trial process is an evidence-free zone. For example, all trials have to recruit participants but, so far, methodological research has produced high quality evidence for only a handful of recruitment interventions.

More generally, research questions may not reflect what patients are most interested in; outcomes may burden trials with collecting data that is never published; and trial design decisions may guarantee irrelevance to those expected to use the trial results. Trials are in desperate need of efficiency improvements.

This is where Sir Chris Hoy fits in, or rather British Cycling. Performance director Dave Brailsford put Team GB’s dominance at the 2012 Olympics down to marginal gains – the idea that if you break down everything you could think of that goes into riding a bike, and then improved each element by 1%, you will get a big gain when you put them all together. Trial Forge aims to do the same for trials.

Trial Forge aims to look for marginal gains across all trial processes, from research question to implementation into routine care. It will encourage everyone connected with trials to be more sceptical of what we do by asking for the evidence behind all of our trial decisions.

Where no evidence exists – as will often be the case – Trial Forge will provide a platform to highlight this gap and bring researchers and others – including funders – together so that they can fill the gap.

Insights from disciplines not normally associated with trials – such as business and organisational change management – will be part of this efficiency drive. Indeed, increased collaboration is at the heart of Trial Forge.

Things are now getting off the ground, with discussions underway with the MRC Methodology Hubs and others about workshops and funding.

For more information contact Shaun Treweek at streweek@mac.com

An invitation to SHARE

Scotland-wide bid to improve the success of health research projects was launched in northeast Scotland this autumn.

SHARE – the Scottish Health Research Register – is a new NHS Research Scotland initiative to grow a register of people interested in participating in health research.

“Clinical trials are vital to the development of new medicines and other new life saving treatments,” points out the clinical lead for SHARE in NHS Grampian, Dr Sam Philip. “Finding suitable participants is one of the main reasons for delay in a clinical trial. The SHARE register aims to remove that delay.”

SHARE is an initiative from NHS Research Scotland, aimed at creating a database of people willing to participate in research work. By signing up to the register, each participant allows SHARE to use information in their health records to see if they might be suitable for an upcoming project. People are then approached and asked if they would like to take part. There is no obligation to participate and people can leave the register at any time.

Professor David Reid, Research & Development Director for NHS Grampian and the Head of the University’s School of Medicine and Dentistry adds: “The University – in association with NHS Grampian – has a great reputation, internationally, for many pioneering medical research projects. These have improved patient care and extended our understanding of a variety of health conditions. This would not have been possible without the support of local volunteers.”

It is hoped that nationally up to one million Scots will sign up to the register. Established and approved record linkage methods developed within the Scottish Health Informatics Programme (SHIP) will allow linkage to a wide variety of health databases, governed by current NHS and academic regulations.

For more information visit www.goshare.org.uk
Developing top flight healthcare skills

Links between the aviation and medical worlds are perhaps not instantly apparent. But aviation psychology is helping health professionals fine-tune some of their key skills.

It’s estimated that up to 10% of hospital patients suffer what’s known as an adverse event – a mistake during treatment that can, in worst cases, cause disability and even death. Errors made during surgery, wrong prescribing and avoidable infection are examples of adverse events. The World Health Organization says patient safety is a serious global concern.

Industries viewed as high risk, such as aviation and nuclear, have a much better safety record than healthcare, according to WHO. It therefore makes sense that medical professionals such as anaesthetists, surgeons and scrub nurses, in Britain and across the world, are turning to the methods used by airline pilots to help improve their non-technical skills – skills such as decision making, leadership, situation awareness, communication, task management and team working abilities. Research to identify these non-technical skills for pilots and clinicians has been carried out at the University of Aberdeen.

“I was part of a major European project in the 90s that brought psychologists and the aviation industry together to develop a tool that would allow experienced airline pilots to ‘rate’ the behaviour of other experienced pilots,” explains Professor Rhona Flin, who heads the University’s Industrial Psychology Research Centre.

“The behaviour rating system that we developed assessed the cognitive and social skills required by pilots for efficient and safe operations. The civil aviation industry has long realised that the majority of accidents could be prevented if better non-technical skills were applied by staff operating and maintaining the aircraft.”

Healthcare is one of the sectors that have since caught on to the importance of the human dimension in improving safety as well as productivity.

“When healthcare started using simulators to help train medical professionals it became apparent that there was no formal way of testing the non-technical skills of those learning on these simulators,” says Professor Flin.

“University of Aberdeen research bridged that gap by developing ‘tools’ for health professionals using task analysis methodology that we developed for airline pilots.”

Professor Flin’s team developed three behaviour-rating tools – the Anaesthetists’ Non-Technical Skills System (ANTS), Non-Technical Skills for Surgeons (NOTSS) and the Scrub Practitioners’ List of Intra-operative Non-Technical Skills (SPLINTS).

Patient Safety

- About 50% of adverse events experienced by patients are deemed to be preventable.
- Surgical ‘Never Events’ – e.g. wrong site, retained instruments – are rare but 326 were reported in 2011-12 for NHS England and Wales.
- In industry, it is recognised that about 70% of accident causation can be attributed to human factors.

“The tools are designed to raise awareness of human factors in patient safety and to enhance the non-technical skills of clinical practitioners working in the operating theatre where serious adverse events can take place,” states Professor Flin.

And they have been welcomed by those at the sharp end.

“NOTSS is a wonderful contribution to surgical training, both for education and assessment, and its influence is truly global,” says Professor Douglas Smink, Assistant Professor of Surgery, Harvard Medical School.

The tools have received international recognition and are being adopted in a number of countries including Japan, Australia, USA and Denmark.

Adds Professor Flin: “It has been very encouraging to see how psychological research can be applied in these safety-critical workplaces when the practitioners recognise the importance of understanding non-technical, as well as technical skills. We are now collaborating with general and military surgeons to examine the cognitive skills they use to make decisions while they are operating.”

For more information contact: r.flin@abdn.ac.uk
Four years ago when an interdisciplinary research team launched a bold bid to bring over £11 million to the University from the UK’s Research Councils for a new breed of research hub, not many outwith the field of computing science would have been familiar with these terms.

One word we were increasingly familiar with though was sustainability and its vital importance to the health of our communities, in every respect. And it was clear that technology was advancing at a rate that could provide some of the answers.

Today we have birds that blog, people posting photos online of the bees in their garden, island dwellers getting in touch with their families and heritage, rural dwellers turning to a phone app to make sure they get the bus, and much more.

dot.rural - based at the University of Aberdeen - is one of three Digital Economy research hubs funded by the RCUK to explore how digital technology can transform lives, society and economy across rural UK and beyond.

Four years on, more than 100 interdisciplinary researchers work together, there are partnerships with more than 100 companies, government and not-for-profit organisations from small rural businesses to international corporates including IBM and First Group, and a portfolio of 22 projects applying innovative digital technology solutions to four rural challenges: accessibility and mobility, conservation of natural resources, enterprise and culture, and healthcare.

www.dotrural.ac.uk
Sharing the adventures of blogging birds

Last year Scientia introduced Ruby, a busy bird of prey who has been blogging her daily life. This remarkable achievement is possible thanks to Natural Language Generation (NLG), a tool that allows data to be used to generate text.

The blogs constructed from the lives of tagged red kites are narratives designed to engage an interested public in the lives of these vulnerable birds, reintroduced in the 1990s, having become extinct in Scotland and England in the 1940s. Working with the RSPB, ecologists and computer scientists transform GPS tag information into blogs that appear as if they are written by a human, but are in fact the product of a computer programme.

Project leader Dr René van der Wal explains: “At the University, the information is automatically processed and the points plotted on the maps you can see when visiting the live blogs. Because we know where our kites were at specific times, we can access other information about those places, such as the type of habitat, for example woodland or bog, nearby landmarks, and the local weather at that time. We can also calculate if this bird was in the patch it normally hangs out in, or has gone to explore a new area. Quickly we end up with a lot of information about where the kites have been and this might help us explain why they were there.”

To date the Blogging Birds website (redkite.abdn.ac.uk) has received over 5,000 visits from all over the world, and appeared in media worldwide, turning the spotlight on the re-introduction of species, and engaging and educating the public about conservation.

Managing our own health

ASICA – which stands for Agent-Supported Integrated Cancer Aftercare - is a digital platform for encouraging people to monitor their own skin following a diagnosis of melanoma.

Patients can engage with an interactive application to direct them through monitoring procedures and enabling them to get feedback directly. So far ASICA has successfully developed a prototype and the next move will be to trial the technology with patients in two GP practices.

The ASICA digital platform offers considerable benefits in involving patients in their own care, and in education and convenience, and to GPs and dermatologists in freeing up their time for other priorities.

dot.rural health projects are also operating further afield than the UK. One example is the Trusted Mobile Platform for the Self-Management of Chronic Illness in Rural Areas (TRUMP).

A ‘mobile-health’ project involving the universities of Aberdeen, Newcastle, City, Lancaster, Northumbria in the UK, the International Institute of Information Technology, Bangalore, and the Indian Institute of Public Health, Hyderabad, TRUMP (http://trump-india-uk.org/) is developing a generic, trusted mobile technology platform for facilitating patient self-management of chronic illnesses – specifically depression and diabetes – in rural areas of the UK and India. This will improve lives for rural dwellers in both the UK and India, whilst forming new and exciting academic partnerships.

Connecting communities with their heritage

2014 is designated a year of Homecoming for Scotland, and cultural traditions and history will be in the spotlight, as the Scottish diaspora is encouraged to make a trip home.

Linked data technology – used to share data already available online – can help scattered rural communities connect and maintain a record of their cultural heritage. Tools developed through the CURIOS project are being used in a collaboration with Hebridean Connections Ltd – a non-profit organisation based in the Western Isles – to help the community create and preserve a repository of its cultural heritage of the Outer Hebrides, and be a vital tool in genealogical research.

This in turn helped secure funding from Scotland’s People and Communities Fund and secure a Smart Tourism grant from the Scottish Informatics and Computer Science Alliance (SICSA).
Is there disruption to my planned bus route? Should I make alternative plans?

The Informed Rural Passenger Project can help with GetThere, an android app that provides real-time bus information to passengers in the Scottish Borders. Working with First Group, the GetThere bus application enables passengers to make more informed decisions about their journeys.

Underpinning GetThere is a collection of datasets – some originating from sources such as data.gov.uk, while others describe local bus services, routes and timetables. These are combined with data supplied by travellers about vehicle location, disruptions and so on. Researchers are investigating a range of issues associated with the use of such diverse data sources, including provenance and data quality.

User location is kept confidential, and other users see only that somebody is on the bus at a particular location, not the user’s name or any other information.

Users can access information via the smartphone app or using SMS.

Get there – and on time!

To help develop the app, and promote it, project researchers toured bus routes and stopped in the Scottish Borders, talking to over 550 bus users about their bus journey experiences, and holding focus groups with public transport users in the Borders, Aberdeenshire and on the island of Tiree – including finding out what passengers do during travel disruption.

Crowd-sourcing technologies have now been deployed to help ecologists keep track of bumblebee populations in the UK through the BeeWatch website, developed by dotrural researchers in collaboration with the Bumblebee Conservation Trust.

The public is encouraged to submit photos of bumblebees for bee experts to identify. The BeeWatch system then generates automated text feedback for the photographer using NLG. As the project has progressed BeeWatch users can use a friendly system to identify other users’ bee images themselves.

To date the BeeWatch technology has generated over 5,000 records of bumblebees across the country through this crowd-sourcing photo-submission system. What the BeeWatch does for citizen science goes beyond identifying the bees. The simple interface is also a learning tool for scientific information and communication technology that allows interested users to remain engaged and maximise the accuracy of their contributions.

The plight of bumblebees is rarely out of the media. There are 25 different species of bumblebee in the UK and many of these are threatened by habitat loss.

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Be an expert with BeeWatch
How would an independent Scotland fare as a small state in modern Europe and a globalised world? To answer this question, I look at the experience of other small countries.

In one sense, the answer is simple, as there are many states even smaller than Scotland whose viability is not questioned. A closer examination, however, shows that there are very different modes of adaptation.

One mode, the market-liberal one, involves bending to the needs of the international market-place through low taxes, deregulation and flexible labour markets in order to attract mobile capital. This is the way followed by many ex-Communist transition states.

Other small states, however, have large public sectors, high taxes and extensive welfare states. The secret here is that they are social investment states, in which public spending is used to enhance productive capacity through education, training, research and infrastructure. Active labour market policies ensure that people get back into work quickly, so reducing the burden of unemployment.

Social investment states rest upon a shared consensus about the value of public spending. Universal services avoid a polarisation of the population and keep the middle classes on side. There tends to be less income inequality and a tolerance for higher taxation, as long as people can see that it is well spent.

Such states also typically practise social partnership in which government, business, trades unions and others come together to negotiate priorities, think about the long term and agree on sharing out the benefits of growth. Old-style corporatism, in which deals were hammered out at the top and applied all the way down have given way to more flexible forms of partnership, in which issues are taken into whichever forum can best handle them. At their best, social investment states combine high levels of economic performance with social inclusion and good public services.

2014 is a critical year for Scotland with the independence referendum. Research activity by Aberdeen academics is helping inform the public debate.

So where does Scotland fit in?

It is difficult to see it as a market-liberal state, since that would require drastic cuts in social welfare and public services as well as further reduction in the role of trade unions and social partners. It is not a package that would sell easily to the electorate. Yet there are hints of such a strategy in SNP promises to cut corporation tax and restrain the growth of other taxes. Could Scotland be a social investment state, like the Nordic countries? That, too, would require substantial internal change, an acceptance of higher taxation levels and a measure of social partnership.

There are signs here, in the Scottish commitment to more universalism in public services and a predominant social democratic culture. Scottish government does tend to be less adversarial than its UK equivalent and policy is more consensual, except on the independence issue.

On the other hand, broad social partnership has been out of fashion since the 1970s and none of the parties is prepared to be open about the implications for taxation.

Perhaps we will end up like Ireland, which tried to mix the two models, a recipe that did not succeed.
Research on the subject of the interaction between taxation policies and activity levels in the petroleum industry has been conducted at the University of Aberdeen for many years.

The first studies on the relationship in the North Sea industry were conducted as far back as the mid-1970s before the first barrel was produced from the UK sector. The policy intention of host governments around the world is to design a tax system which collects a ‘reasonable’ share of the revenues from production without introducing disincentives to exploration, field development or production. There are several requirements for effective research in this area. Thus an understanding of the concept of economic rents and its practical measurement in the petroleum industry is necessary.

The proposition that economic rents are returns above those necessary to sustain investment in exploration and developments is easy to state in general terms, but how these are measured in practice depends on many factors including expected prospectivity, exploration, development, and operating costs, expected oil and gas prices, and the investment hurdles employed by oil companies. Investors are usually reticent about revealing information on these matters which is considered commercially sensitive.

It follows that sophisticated economic modelling whether based on financial simulation – including the Monte Carlo technique for assessing exploration risks – or econometric techniques need to be backed up by reliable or well-informed data before useful pronouncements can be made about the effects of royalty and taxation arrangements and any changes to these.

Over the years our research – which has involved past and present colleagues including Linda Stephen and Sola Kasim – has developed models which, when combined with the high quality field database made available by Oil and Gas UK, has provided many insights into the likely impact of taxation changes on activity levels.

Many studies have been produced and have informed the debates in the UK following the several taxation changes which have occurred over the years. While individual investors are able to estimate the effects of tax changes on their own portfolios they cannot readily do so for the whole industry. Oil and Gas UK have been undertaking such studies, but independent research adds extra value in the ongoing debates.

Recently our modelling capability has also been employed to shed light on the constitutional debate. Thus, research has been undertaken which has estimated the potential division of oil and gas production, investment, operating and decommissioning costs, and tax revenues between the hypothetical Scottish sector of the UK Continental Shelf and the rest of the UK.

Long term projections of production and expenditures attributable to the defined Scottish sector have also been made. Again, these inform the ongoing debate.

Recently, much concern has been expressed over the decline in the exploration effort in the UKCS.

Our new paper has employed financial simulation modelling and the high quality database to measure the full-cycle returns to the exploration effort undertaken in the periods 2003-2012 and 2008-2012.

Key results indicate that, for the longer period, expected returns exceed those from the effort over the more recent period. The substantial difference between expected returns by an investor currently in a full tax-paying position compared to one who has no current tax shelter and has to carry forward his losses/allowances was also highlighted in the research.

The decision in 2012 to enhance the allowances for non-tax paying investors will help to redress this situation. It should be noted that a substantial number of explorers are currently not in a tax-paying position and are nursing losses.

In recent years substantial research has also been undertaken on economic issues other than taxation. We have produced several papers on the economics of CO2 capture and storage. These have helped to inform the debate on the comparative merits of different capture technologies, highlight the economic issues involved in designing a CO2 transport network, and emphasise the need to ensure that investors in all three elements of the capture, transport and storage chain have prospective positive returns before the activity can proceed.

Our most recent paper has highlighted the prospective returns to a CO2 EOR cluster of fields in the Central North Sea. The study has highlighted the importance of the CO2 price employed, the prospective oil price, and the need for tax incentives to encourage investment in CO2 EOR schemes.

For more information contact: a.g.kemp@abdn.ac.uk
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THE UNIVERSITY OF ABERDEEN

The University of Aberdeen is internationally renowned for the quality of its teaching and research, attracting students from all over the world. Founded in 1495, the University can boast over 500 years of history and achievements. Students are taught by academics at the forefront of their fields of expertise and actively engaged in research. The latest UK Research Assessment Exercise (RAE) confirms that we are among the UK’s top research universities. Nearly 90% of our research activity was rated as being of international quality and eleven research areas were ranked among the top 25% in the UK.

The University offers excellent facilities for students, including a beautiful central campus where ancient buildings sit side by side with modern, first-class laboratories, up-to-date computing facilities, including a wireless campus, and the latest library technology. In recent years over £170 million has been spent on new facilities for students with a further £270 million of investment underway. This includes the newly opened Olympic standard Aberdeen Sports Village and the new Library, opened in September 2011.

The University has also been ranked within the top 150 in the QS World Rankings. We offer over 150 different one year masters programmes, along with a wide range of postgraduate research degrees. Opportunities for part-time and distance learning study are also available.

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