

Up and running

The first Annual Report of the Environment
and Sustainability Institute



European Regional
Development Fund
Investing in your Future



convergence
for economic
transformation



Director's overview

Welcome to the first Annual Report of the Environment and Sustainability Institute (ESI). For some people the Institute seems to have been part of their landscape for a good while; the idea for such a venture emerged some eight years ago. Some became aware of the Institute as it came into physical being and recruited staff, or from the media attention surrounding its launch. For others, it came to their attention as our research and business engagement activities gathered pace, and the first products were published and publicised. A key challenge for us now is to convey to all of these groups the breadth and depth of the projects, collaborations and partnerships that are taking place. The ESI has grown, and continues to grow, very rapidly. In any one sensibly-sized document we can therefore only give a taste of what is happening. We hope that you enjoy this sample, and will come back for more.



Professor Kevin J Gaston

Director of the Environment and Sustainability Institute, University of Exeter.

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The Environment and Sustainability Institute (ESI) is a new, interdisciplinary research facility that works in a new, different and – we think – better way, and our Annual Report reflects this.

We'd like it to be the kind of Annual Report that is easy to read; the kind you'd rather take with you than leave behind.

So it's smaller and shorter than you might be used to. We have plenty to say and much progress to report, but because we don't want to make this an over-long repository of every last detail of our existence to date, we intend to give you an overview of what we've been doing as well as directions to where you can learn more.

The University of Exeter's Environment and Sustainability Institute (ESI) is an interdisciplinary centre leading cutting-edge research into solutions to problems of environmental change. Based on the University's Penryn Campus, near Falmouth, our world-class work is enhancing people's lives by improving their relationships with the environment.

The ESI has been funded by the European Regional Development Fund Convergence Programme (£22.9m) and the South West Regional Development Agency (£6.6m), with significant support from the Higher Education Funding Council for England.

More than two years, less than one page

The ESI was officially opened by the schoolchildren of Cornwall on 23 April 2013, although our diverse team of academics, postgraduates, research fellows, professionals, knowledge exchange experts and support staff were already working well before we officially opened. A year later, we held our first Environment and Sustainability Day, which also heavily featured young people; this is an important and recurrent theme, and one we return to on page 21.

Although annual reports typically look back at the past 12 months, ours encompasses a much longer timespan; the flexible and often-changing worlds of research, funding, reporting, and business engagement don't always conform neatly to the passage of months and years. Our review stretches from when our research and engagement efforts were just getting under way, right into the final quarter of 2014.

During this time, our researchers were part of a collaborative project awarded by the Chartered Institution of Water and Environment Management Living Wetlands Award. Our director, Professor Kevin J Gaston, received the British Ecological Society's Marsh Award for Ecology and joined the board of the Cornwall and Isles of Scilly Local Nature Partnership. In collaboration with the RSPB, our gannet-cam news story made headlines around the world, as did our research on the decline in the numbers of European birds. ESI researchers contributed to the prestigious World Social Science Report and our Solar Research team was recognised with a combined award in the Outstanding Impact in Sustainable Futures category of the University of Exeter's Impact Awards. We also welcomed politicians of various persuasions to the building, and hosted a significant ceremony when the Cornwall and Isles of Scilly Growth Deal was signed.

The year in numbers

1st place in Eco Building of the Year in the Michelmores/Western Morning News Property Awards

£16 million, our external research income, as of the end of November 2014

25 academics, 32 researchers and 45 PhD students in the building at the time of writing





Our research

Introduction

Much of our research is embedded within Cornwall and the Isles of Scilly, but its impact is far wider and has practical applications, nationally and internationally. Projects based in and around the county bring direct benefits to participating businesses, stakeholders and communities, but their findings are of direct relevance elsewhere in the UK as well as around the world.

Our approach is interdisciplinary, drawing on the expertise of a diverse team of leading researchers from a wide range of disciplines, working in collaboration with partners from across the region. We are finding important solutions to challenging problems by bridging traditional academic boundaries.

Everything we do is linked by a common thread of working together and thinking differently. Our researchers tackle an extensive range of topics in looking for solutions to problems of environmental change: some solutions are technological, others might relate to land-use, sometimes they depend on a change in human behaviour. Most involve combinations of all three. This is why our research spans three interrelated themes: clean technologies, living landscapes, and people and sustainable communities.

“The complex natural world around us is the life support system upon which humans depend. There are many threats to this system, and to alleviate these we need to know the causes, symptoms and cures. This can only be achieved by bridging traditional disciplines and by combining empirical and modelling work, and a range of qualitative and quantitative approaches.”



Dr Ilya Maclean

Lecturer in Natural Environment

Clean technologies

Our research into clean technologies combines two distinct strands: renewable energy and sustainable mining and minerals resourcing. Both involve close collaboration with colleagues within the University’s Camborne School of Mines and the College of Engineering, Mathematics and Physical Sciences. ■

Living landscapes

Our research into the natural environment encompasses biodiversity, ecological processes, agriculture, remote sensing, conservation biology, diseases, and land and marine management. A number of recent and ongoing studies are delivered in conjunction with researchers based within the University’s College for Life and Environmental Sciences. ■

People and sustainable communities

This research includes studies into behavioural change, environmental economics, law, public policy, and governance and regulation. Our focus on social science and sustainability helps to inform the transition from resource-intensive economic growth to resilient, environmentally sustainable economies. Our researchers work closely with those within the University’s Colleges of Life and Environmental Sciences, and Social Science and International Studies. ■

Over the following pages, brief examples of research within each theme give an insight into, and snapshot of, some of the pioneering research we’ve undertaken since opening. A wider range and larger number of examples can be found on our website’s Research section: www.exeter.ac.uk/esi/research

Clean technologies

Technological innovations are an important aspect of many solutions to problems of environmental change, from managing the ecological impacts of the Cornish mining industry, to developing new cutting-edge technologies, including solar and tidal energy.

The clean technologies theme is a fast-growing area of our research, with additional appointments during 2013 to our award-winning solar team.

SUNTRAP SUPERGEN Solar Challenge

This four-year project sees ESI researchers – led by Professor Tapas Mallick – joining forces with colleagues from the Universities of Glasgow, Heriot-Watt, Manchester and Cardiff; it aims to reduce the cost of electrical and thermal solar energy generation in order to make it more widely and abundantly available.

The technical processes that the ESI team hopes will make this possible include: developing enhanced optical concentrator systems (which exhibit improved luminance uniformity over the photovoltaic (PV) cell); using active thermoelectric cooling to extend the lifetime of the PV cells to beyond 50 years; and integrating a thermal storage system with the PV or thermal energy receiver. In addition, the team will use various techniques to increase energy conversion efficiency.

Thermal energy created by solar-to-electrical conversion can also be used to enhance the efficiency of co-generation plants or displace fossil fuel combustion.

Various industrial partners will be able to commercialise the new technology arising from this project; it will be suited equally to domestic use or utility-scale power plants. ■

Up and running

Biomining mine wastes

Our researchers, in particular Dr Chris Bryan, are investigating how microbial populations such as bacteria can be used to recover polluting, but often valuable, metals from ores and mining wastes.

Because Cornwall has a rich and varied mining history, this project has a strong local focus. Mining wastes in the county date predominantly from the 18th and 19th centuries, when mineral processing methods were less effective.

The bacteria which occur naturally in mine wastes cause metals like arsenic, cadmium and lead to leach out, creating significant pollution. The team is currently examining this phenomenon within a few miles of the Penryn Campus, in what used to be Cornwall's mining heartland. They aim to find out what concentrations of valuable metals these wastes contain. Then they can see if it's possible to collect the wastes and use bacteria to leach out the metals in a controlled way, so the metals can be recovered and sold. If the project is successful, it will mean we can create value from the recovered metals at the same time as protecting the environment by reducing pollution. ■

Living landscapes

The natural environment provides diverse ecosystem services. These range from food, water and energy to cultural and social benefits; increasingly, however, demands from a rising global population will place these ecosystems under ever greater pressure. Understanding and managing these pressures, while conserving the natural environment and its processes, are an important part of our work.

Impact of emerging epidemic disease on populations

Diseases don't just damage human and livestock health, but also biodiversity. The impacts of particular diseases on individual species are often well understood, but there is surprisingly limited information available on the wider impacts of diseases on population dynamics.

In partnership with collaborators such as the Cornwall Wildlife Trust, ESI researchers are using amphibian diseases as a case study for investigating the impacts of epidemic disease on population genetic structure, and for understanding how populations adapt to disease at the genomic level. Diseases are a major cause of global amphibian extinctions and population declines; therefore, this research not only provides a greater theoretical understanding of disease-induced changes to populations and genomes, but also is directly relevant for amphibian conservation.

The research project, run by Dr Amber Griffiths and funded by an EU Marie Curie Intra-European Fellowship, covers a range of amphibian species in the UK, Spain and India. Its primary focus is a viral epidemic called *Ranavirus* which, having spread across the UK, is now present in Cornwall. ■

An integrated model for predicting bumblebee population success and pollination services in agro-ecosystems

Pollination is a critical ecosystem service which underpins agricultural production. There are serious concerns that populations of key pollinators, such as bees and other insects, are declining. This could lead to profound impacts on crop yields and on natural plant communities.

In collaboration with researchers from Rothamsted Research and the University of Sussex, Professor Juliet Osborne is leading ESI scientists in using a combination of experiments, modelling and field surveys to predict bumblebee nest density, distribution and survival in agricultural landscapes. The models describe bumblebee colony dynamics and foraging behaviour, and help researchers predict the distribution of pollination services provided by bumblebees. The researchers' aim is to provide a powerful tool for shaping recommendations so that land managers and policy-makers can ensure that sustainable pollination is able to thrive in tandem with successful arable farming. This project is funded by the Biotechnology and Biological Sciences Research Council. ■



People and sustainable communities

As society transitions from resource-intensive economic growth to resilient and environmentally sustainable economies, the ESI is leading interdisciplinary research seeking to understand, communicate and inform the social changes required.

Our researchers include specialists in environmental law, politics and the social sciences. Their expertise and contributions are highly valued, not only by the Institute, but also more broadly by the prestigious bodies which regularly seek their advice. In 2013, our experts provided support to the Expert Panel of the National Ecosystem Assessment, The Royal Society, and the World Social Science Report.

SPACES (Sustainable Poverty Alleviation from Coastal Ecosystem Services)

Researchers from the ESI and the University's College of Life and Environmental Sciences, along with those from 30 partners from Kenya, Mozambique, the UK and Canada, are leading a three-year project to investigate the relationships between ecosystems and human wellbeing. In collaboration with our principal partner, the Stockholm Resilience Centre, the ESI intends for the project to help alleviate poverty and improve sustainable resource use in the poor coastal communities of Mozambique and Kenya.

The project, run by Professor Katrina Brown, is providing new insights into how ecosystems benefit some of the world's

most disadvantaged. It aims to investigate how the conservation of valuable ecosystem services – such as reef fisheries and carbon sequestration by coastal mangroves – can help a community's poorest members. Other developing nations' coastal communities are expected to receive indirect benefits too, through the programme's international impact strategy.

SPACES has £1.9 million in funding over three years from the Ecosystem Services for the Poverty Alleviation programme, in addition to the Department for International Development, Economic and Social Research Council, and Natural Environment Research Council. ■

POLPART – How citizens influence politics

This project aims to examine political participation in both new and older democracies and to explore what motivates individuals to participate in both formal and informal politics – in other words, voting and protest, respectively.

Fewer people than ever now vote, or join political parties. Do these people join protests instead? If so, why? Which protests are they most likely to join? And what is the relationship between different forms of political participation?

The project is particularly interested in providing insights that might help stem the rising tide of dissatisfaction with formal political participation. Understanding how and why people take part in politics is important, as it can help us to build more democratic societies. Professor Clare Saunders, from the ESI, is the lead team member of the UK case. The project, which will end in September 2018, is a collaboration with colleagues in the Netherlands, Germany, Switzerland, Hungary, Poland, Brazil and Argentina. ■



Working with business

Crucial to the ESI's rich and varied mix – and the way we engage with and have an impact on local businesses – is our Knowledge Exchange Team.

The team's remit is to form partnerships with businesses, stakeholders and commercial investors, as well as local, national and regional support-providers, all with the aim of translating research expertise into innovative business practices, products and services.

It achieves this by linking businesses to the ESI's cutting-edge facilities, equipment and research, thereby helping to build a business's competitive edge. It also helps companies to develop collaborative research projects and to access business networks and student and graduate placements.



Our Business Network has grown to **450 members**

We've helped **171 businesses** to prepare collaborative research proposals

With our support, **23 businesses** have secured research funding

We've hosted **40 workshops and seminars** on topics ranging from sustainable fashion to local energy production

23 businesses have benefited from a student or graduate placement

Our experienced Knowledge Exchange Managers have worked with **453 businesses**

71 businesses have been advised by our expert Business Mentors

There are plenty more examples of case studies here: www.exeter.ac.uk/esi/business/casestudies

Working with business – case studies

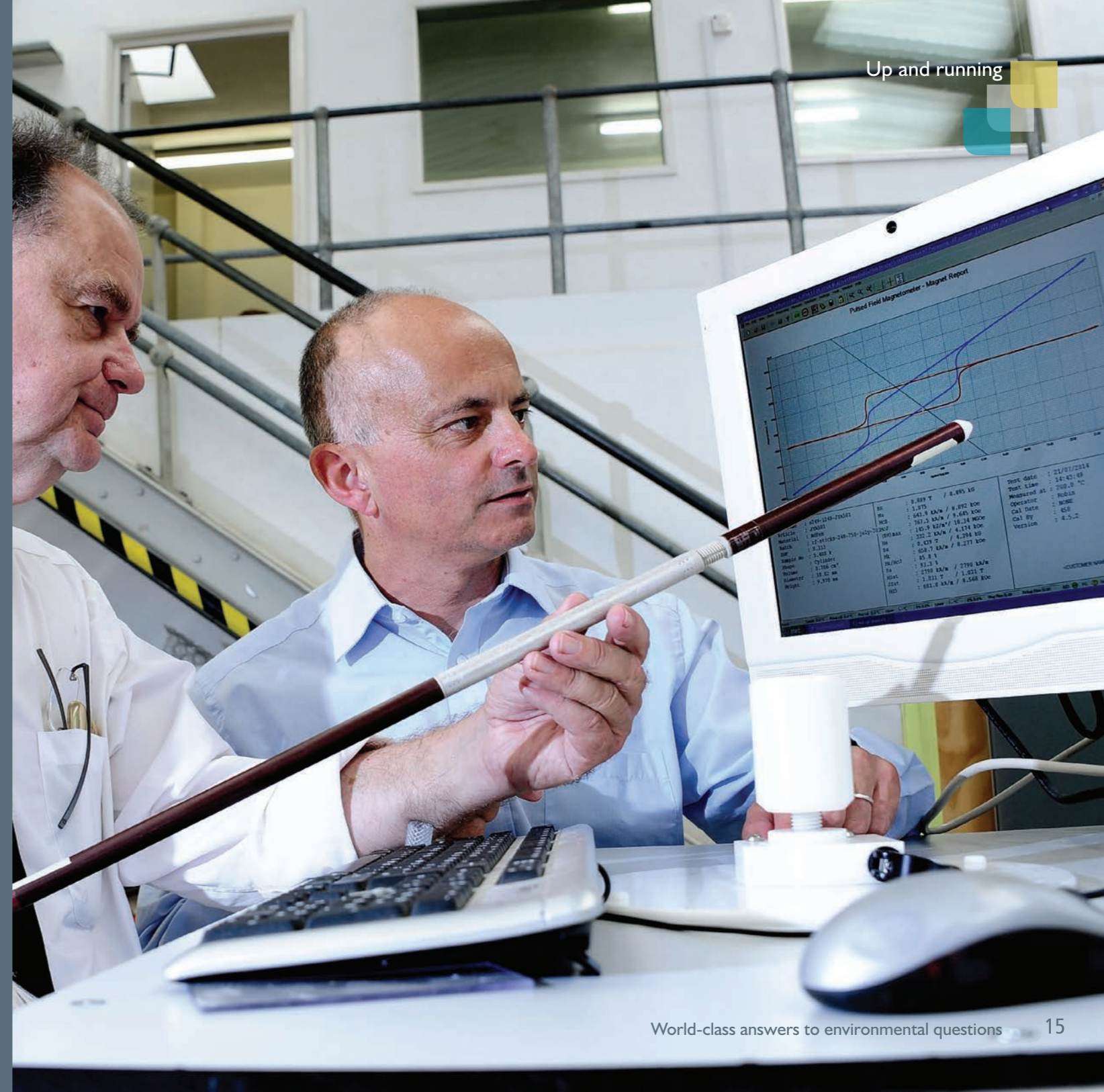
CASE STUDY ONE

Hirst Magnetics is a UK market leader based in Falmouth, just a couple of miles from the ESI. Since 1938, the company has been designing, developing and manufacturing magnetic instruments for a wide range of businesses, securing a global reputation and a particularly strong presence in China.

An integral part of the company's activities is characterising magnets – or assessing their properties – in order to optimise their use in applications ranging from scanning a brain to generating wind power from a turbine.

Although Hirst had long worked to improve this quality-testing process, a solution was not forthcoming. They suspected that the ESI's mathematicians, led by Professor Stuart Townley, might be able to lend a hand. First, however, the company needed to find a common language with the ESI researchers. Over time, Professor Townley's team realised that the issue was actually a classic example of what is known in mathematics as an 'inverse problem', which involves working backwards to discover the important data behind a result. After a few months of calculating, the mathematicians produced a means of characterising magnets with absolute accuracy.

A patent for the process is pending, but Hirst is already enjoying its new edge over international competitors and its ability to access new markets. Given the many industrial applications of magnetics – including medicine, aerospace, and energy generation – the long-term benefits of this collaboration may well prove to be far-reaching.



Working with business – case studies

CASE STUDY TWO

Riviera Produce, near Hayle, is Cornwall's leading vegetable growing company; its collaboration with the ESI has the twin aims of boosting both its profitability and sustainability by providing the best environment for bees.

Riviera Produce currently markets nearly half of Cornwall's cauliflower and spring greens and, over the summer, is also one of the region's leading suppliers of courgettes. Courgettes are a high-value crop which is increasingly popular with UK shoppers, and just a small rise in yield could have a significant impact on the company's profits. Courgette pollination has never before been studied in the UK; Riviera Produce hopes the results of the current research will help the company to develop the way it manages its natural environment.

The research, which started in early 2015, will uncover which species are pollinating Riviera Produce's courgettes. These plants, native to North America, are pollinated by squash bees that have evolved to exploit the flowers' heavy, sticky pollen grains. Very little is known about the impact of British bees – or other insect species – on courgette pollination.

The PhD student carrying out the research will use nets to exclude pollinators from some plants, while increasing numbers among others; this will make clear the difference pollinating insects make to the yield. The research will also experiment with different ways of attracting more pollinators; this might involve growing wild flowers nearby to see if they provide an attraction or distraction, or introducing more pollinating species, for example honeybees or commercial bumblebees, to the plants. As well as benefiting Riviera Produce, the research findings could be relevant to other commercial growers in the UK as well as amateur gardeners and allotment holders.

This collaboration shows how cutting-edge science can be of direct benefit to a local business, with a chance of making a difference not only to the business's bottom line, but also to Cornwall's local food agenda. The project shows how the interests of bees can also coincide with the interests of business.





Creative Exchange Programme

The Creative Exchange Programme, launched in 2013, is a joint initiative between the ESI and Falmouth University's Research in Art, Nature and the Environment (RANE) research group.

As part of the programme, a resident artist scheme enables close collaboration between ESI researchers and creative practitioners with an interest in environment and sustainability. We hold regular events, many open to the public, ranging from workshops to exhibitions. These provide opportunities for collaborative learning and engagement with the wider community.

Through the programme, the ESI is helping to develop the region's creative industries, inspiring research and developing new ways to view and understand human relationships with the environment. The Creative Exchange hosts regular 'Melting

Pot' events in the ESI to provide an opportunity for researchers and creative practitioners to meet each other and identify shared interests.

Since our opening, we've worked with a number of Creative Affiliates.



X-Ray Art & Design, by Chris Thorn, our inaugural creative affiliate, saw

the artist collaborate with Dr Richard Inger, Professor Juliet Osborne, Dr Ilya McLean and Professor Robbie McDonald to develop original work combining x-ray imaging with traditional ink drawing methods.

Subsequent collaborations included:

Night Walks, which involved the public and culminated in a photographic exhibition dealing with the aesthetic, environmental and

human health impacts of artificial light pollution.

Re-shaping Fashion Norms, which examined the possibilities for sustainable fashion in a globalised world.

Natural Alchemy, which created artwork by combining the unique properties of plants, rocks, minerals and metals with the systems and organisms that surround them.

All Washed Up, which featured a variety of pieces made by local artists from different kinds of beach waste, culminating in a large abstract mural made with help from a group of 100 school children, now displayed in the ESI atrium.

You can read more about this aspect of our work here:

www.exeter.ac.uk/esi/research/creativeexchangeprogramme

Interdisciplinary working

We often talk about 'interdisciplinary research' but rarely see it in action, especially in the form of a real, physical building rather than a virtual collection of disparate academics bound only by a shared label.

At the ESI, we made a conscious decision when planning the building's layout to make sure academics and researchers share offices and social areas regardless of their discipline. That's why you'll find, for example, a specialist in marine resource governance sharing an office with an expert in the politics of identity, culture and behavioural change.

Features like this are more than skin deep, however; a culture of shared space without barriers between specialisms breeds a culture of shared practice and cooperation. That's why a mathematician can help an ecologist map biodiversity and species evolution; it's also why an Associate Professor of Politics collaborates with a Chair in Natural Environment on the science and politics of the bovine tuberculosis debate.

This is about more than sharing for sharing's sake: it's about effective research, because we know that by working together, researchers from different backgrounds, with different perspectives, can address problems with solutions beyond the scope of a single subject.



Our building

Our exceptional, cutting-edge work is done in an exceptional, cutting-edge building.

BREEAM (BRE Environmental Assessment Method) is the leading, most widely-used environmental assessment method for buildings. At its design stage, the ESI scored 91.57%, a rating which rose to 94.33% at the post-construction stage. This means it's not just 'Outstanding' (the highest available rating) but is also one of the UK's five most sustainable buildings.

What does this mean if you're in the building?

Triple glazed windows provide a clear outlook and natural ventilation, while also delivering ultra-high levels of insulation and low air permeability. Eight Controlled Temperature (CT) rooms on the ground floor provide reliable temperature and humidity control in a virtually airtight environment; these rooms run on energy from an innovative system incorporating Combined Heat and Power (CHP), water-cooled heat rejection and a 'coolth tank'. Compared to traditional energy systems, this reduces electrical demand by over 90% and carbon dioxide emissions by 94%.

Radiant panels with integral lighting and a translucent Kalwall maximise and harness the light falling on the north face of the building. A north light on the roof funnels natural light into the space beneath, meaning we greatly reduce the need for artificial illumination.

All of our fridges and freezers have their excess heat removed by a bespoke, chilled-water pipe system which then uses the energy elsewhere in the building. Acoustic baffles overhead reduce sound reverberation in open plan areas, large windows maximise natural light, and a 35,000-litre buried rainwater harvesting tank stores water for use in the building's toilets. We meet just under a quarter of our energy needs through on-site generation, which includes 250m² of solar panels.



A future in Cornwall, a future for Cornwall

When we officially opened the ESI in 2013 we chose to mark the day in the company of around 100 school children. They came to the building not just to open it, but to enjoy hands-on workshops which demonstrated our research in action. The visiting students not only investigated current environmental problems, but also considered what the future of Cornwall might be like.

One of our key ambitions is to inspire the children of Cornwall to consider a career in research. We hope that they will follow in the footsteps of the many leading academics who have come from around the world to make Cornwall, and the ESI, their home. Although it is not easy to answer the many questions raised by continued environmental change, those who research these issues will have the opportunity to improve the lives of billions of people worldwide.

We repeated many elements of our official opening a year later, in our now-annual Environment and Sustainability Day. Students from nine local schools enjoyed four hands-on workshops demonstrating our research. Pupils also explored our specialist facilities, chatted to leading researchers, and explored topics ranging from the development of solar technologies, to the dangers of plastic waste in marine environments, to the challenges facing pollinators.

Students also contributed to a new beach waste installation as part of The Creative Exchange Programme (see page 18).

We've also committed to fostering links between leading researchers and local schools and colleges via a Teacher Affiliate Programme, which aims to see a more structured and continuing link between research staff and local teachers. We hope to work with our partners in education to help raise aspiration and attainment across Cornwall, to produce materials for use in classrooms, and to create a programme of visits by and to schools which helps to extend the impact of our research.

Forging these links is not about simply ticking a box marked 'Outreach' or 'Community Engagement'. Current environmental changes affect us all, but future generations will be more aware of their impact. Our work will help to shape and change the world, not only as we know it today, but also as our descendants will know it in the decades to come.

Involving young people in what we do is about making those changes with them as well as for them. It's also a way to show that significant change can start with the work we do here in Cornwall, work that will have impacts far beyond this county and country.



Children from Cornish schools at the ESI's opening, April 2013.

PHOTOGRAPHY: Joaquín Delgado, University of Huelva, David Edmonds, Steven Hancock, Matt Jessop, Peter Kennedy, Susie Smith, Chris Thorn and Toby Weller.

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