Instant recognition

Experts at York are teaching computers the intuitive human skill of recognising faces.
Welcome

This is the first edition of Research & Innovation from the University of York. York is one of the world’s leading research institutions, and enjoys research partnerships with colleagues across the globe. We work with our partner universities in the Worldwide Universities Network, including the Universities of Nanjing, Zhejiang, Sydney, Washington at Seattle, Penn State, and many others.

In this issue of Research & Innovation, you will see how we work to solve some of the great challenges facing the world: our research includes developing artemisinin to cure malaria, how rigorous philosophical approaches can trigger unusual solutions in the worlds of science and industry, a better understanding of how Alzheimer’s develops, computer programs which will revolutionise face recognition, and understanding the complex systems which lie behind everything from economic behaviour to the the geometry of viruses and climate conditions.

We also explain how we work with industrial partners in areas ranging from music technology to sharing highly specialised equipment to develop new drugs and the development and processing of new crops.

And we feature one of our human rights defenders who is the first of a highly unusual type of research fellow, in a positive initiative from the Centre for Applied Human Rights.

I hope you enjoy reading this issue, and please get in touch if you would like to find out more about our research and innovation activities. All our contact details are on the inside back cover.

Professor Brian Cantor  Vice-Chancellor

Key facts

- Total income 2007 £187 million
- Total research income 2007 £66 million
- 3rd highest research income per academic in England (HEFCE)
- 6th for research quality in UK (LSE)
- 15th for Research Council Grant Award Success rates (THES)
- Over £75 million invested in last five years in new research facilities
- 1,000 academic staff and research staff
- Over 950 research students, including 400 international postgraduates from over 50 countries
York – our approach to research and innovation

The University of York operates firmly on the national and international stage, ranked in the top echelons of every measure of quality – excellence in research achievements, teaching, and the satisfaction of our students.

Most of our researchers work in departments ranked of international standard for research. The thriving Innovation, Bioscience and IT Centres on our Science Park are proof of our solid culture of enterprise and innovation. Successful spin-out and commercial collaborations have been built around our research expertise, and when it comes to research value for money indicators we out-perform both our peer universities and our own national benchmarks.

Our international research programmes focus increasingly on the challenges of the modern world, including adaptation to climate change, disease prevention and health promotion, and sustainable energy – and on how people and governments can best respond to and share the issues they face.

Our dedicated Research and Enterprise Office supports researchers in finding new opportunities for partnerships, encouraging close collaborations with commerce and industry regionally, nationally and around the world. Science City York – a collaboration between the University and the City of York to use the University’s excellence in research and teaching to drive the growth of the knowledge economy in York – has helped to create 80 new companies and 2,700 new jobs since its launch in 1998. The recognition of York as a bioscience cluster owes much to our world-leading research and commercial outputs in this sector.

York stands out from the crowd in the breadth and depth of the areas where we have research expertise, and in the way in which these varied disciplines interact. Our researchers approach the difficult questions of the modern world from a variety of innovative angles informed by expertise in humanities, social sciences and sciences, with measurable success. Over the next few years, a major expansion of the University’s research and knowledge transfer will facilitate new and exciting collaborations.
An ageing population means that neurodegeneration is one of the major health problems in the developed world. But researchers at the University of York and Simon Fraser University in Burnaby, British Columbia, have designed an enzyme inhibitor which could trick the brain into helping to halt neurodegeneration.

One of the causes of neurodegeneration is a modification to the protein ‘tau’, which helps to maintain the stability of neurones in the brain, causing them to form aggregates termed ‘tangles’. These diseases, or ‘tauopathies’, are believed to be caused by a form of the protein tau which has been excessively modified with phosphate.

By studying the chemistry and structure of relevant enzymes, the research teams at York, led by Professor Gideon Davies (right), and Simon Fraser, led by Professor David Vocadlo, have designed an enzyme inhibitor that prevents the phosphorylation of tau in animal models. They have effectively tricked the brain’s own enzymes into installing a sugar onto tau in place of the detrimental phosphates.

The enzyme inhibitor, termed a ‘thiazoline’, is not yet a drug, but it is a major breakthrough in finding compounds that cross the blood-brain barrier to elicit beneficial effects that prevent the onset of tauopathies.

“We hope that the work will evolve into new drugs to treat Alzheimer’s disease,” said Professor Davies of York. “The work highlights the synergy of studying the chemistry of enzymes in living cells.”

The research is published in Nature Chemical Biology. The York/Simon Fraser collaboration also revealed the first structure of the enzyme responsible for the installation of these protective sugars in a paper in Nature Structural & Molecular Biology.
Human rights campaigns are driven by key individuals. These people are usually working at a local level, often in a hostile environment and without adequate support or training. The work of these ‘human rights defenders’ is crucial to making progress towards creating a more just society in places across the world where they are desperately needed.

But over time, the cumulative challenges of working in such an environment can have a negative impact on the sustainability of the work they do – not to mention on the individuals themselves. Sometimes, what activists need is simply a little time away from their campaigns to take stock and refocus their energies.

Earlier this year, the new Centre for Applied Human Rights at York announced an innovative response to this challenge: the new Protective Fellowship Scheme. Under the scheme, which is unique in the UK, human rights defenders are invited and funded to come to York for a period of time ranging from three to six months. During this time, they benefit both from time away from a difficult environment, and from educational resources designed to increase their effectiveness and their ability to influence policy and practice when they return home.

The scheme is already making a valuable contribution to the sustainability of social activism – and it is a two-way process. At the same time as it provides sanctuary for its Protective Fellows, staff and students at the Centre benefit from their immense experience.

Sharon Gwati (pictured) is one of the first activists to benefit from the scheme. She runs an HIV/AIDS information website in Zimbabwe, and works with abused women and as an educator with young people in the low-income communities of Harare and Norton. She also manages a new website which co-ordinates voluntary help for Africa from Africa.

“What comes out of the programme here in York is time to reflect on my work, to see what I have been doing right and what needs improvement,” says Sharon. “I can look at human rights as a broader picture. It will help me to tackle the challenges that we face in a holistic way.”

Starting this autumn, the Centre will offer five Protective Fellowships a year.

**Sometimes, activists need a little time away from their campaigns to take stock and refocus their energies**
Teaching computers the human gift for instant recognition

Experts at York are teaching computers the intuitive human skill of recognising faces

“Put simply, people are face-spotting specialists. Persuading a computer to develop the same kind of expertise is a difficult task”
An illusion devised by Professor Richard Gregory. These markings could equally be interpreted as mounds or dimples, but the brain prefers one interpretation over the other, working on the assumption that light tends to come from above. Try turning the page upside-down and see how your perception changes.

E
asy? Not according to Edwin Hancock, Professor of Computer Vision at York, who works on the so-called ‘shape-from-shading’ problem in York’s Department of Computer Science.

“We humans can glance at a flat image and immediately interpret it correctly in three dimensions. But in its simplest form, that task – generating a 3D shape from a 2D picture – is mathematically unsolvable,” Professor Hancock explains. “So the fact that we can do it is very interesting. It means our brains must be doing some work in the background.”

Think about the vase photograph again for a moment. For each pixel on the photo, you only have one piece of information, namely its brightness. But a light-coloured pixel might be a dull patch on a raised surface, or a shiny patch on a recessed one, or it might simply be close to a light source. Somehow, your brain has to resolve multiple variables to make sense of the whole picture – and when you get right down to it, a set of pixels could be interpreted according to any one of infinite number of possible values for those variables, with each interpretation representing a different 3D shape.

According to Professor Hancock and his team, our brains get around this problem by relying on some automatic assumptions: that areas of similar lightness are likely to represent smooth surfaces, that light sources generally come from above, and so on. By making educated guesses about some of the variables, the brain can eliminate uncertainties and reduce an unsolvable problem to an approachable one. The Gregory illusion (right) shows these assumptions at work.

This technique means the brain can be fooled, of course. The use of ‘forced perspective’, where a shallow stage backdrop is made to look like a long corridor leading into the distance, has been a favourite theatrical trick since Victorian times. But the ability to visualise 3D objects reliably has been crucial to our success as a species, and the fact that we fall into the occasional trap is a small price to pay.

So how far are we from being able to use these new tools in real-life applications? “Day-to-day applications are emerging,” Dr Smith says, “but being able to derive an accurate model from a single facial image such as a CCTV snapshot is obvious. And constructing a biometric recognition system is very much within our sights.”

Place a plain-coloured vase on a table. Take a photo and print it in black and white. Now smash the vase into pieces, gather them up, and try to rebuild it based entirely on the picture...
A pioneering York initiative has put leading scientists and philosophers around the same table to find innovative solutions to important global issues

Harnessing the power of thought

Modern science does not take place in a philosophical vacuum. Many important scientific problems are ‘hard questions’ that can’t easily be resolved by standard experimental testing: for instance, researchers can’t conduct experiments on 100 Earth-like planets to find out what causes global warming. There is only one Earth. The challenge is to know whether we can be justified in identifying a causal link on the basis of just a few observations.

Now specialists in the University’s Enterprise and Innovation Office have been working with academics from the Department of Philosophy in a project which transcends traditional disciplinary boundaries. A series of focused workshops is exploring opportunities for knowledge exchange between philosophers working on causality, and applied scientists working in the areas of epidemiology, climate change, health economics and law. It’s all part of a major University drive to break down barriers between academic study of the arts and business development.

The project is based on the idea that philosophers’ rigorous approach to the problems of causality might trigger, or identify, innovative solutions to a wide range of problems facing us, as well as correcting a few misapprehensions among scientists. This new approach has sparked international interest from philosophers, applied scientists industry, including the NHS, British Telecom and Smith & Nephew.

“Policy decisions have to be made under uncertainty, and this is where philosophy has an important role to play. We need to know when we know enough to make a decision,” says Dr Jon Lovett (right) of the Environment Department. “Philosophers have been studying the concept (or concepts) of causation since the time of the ancient Greeks, and they’re still refining theories and models of causal relationships. So they are well placed to help scientists interpret information for policy decisions, especially when the causes of important issues like global warming or the spread of disease are not completely clear.”

Professor Tom Stoneham of the Department of Philosophy (left) agrees. “When people think of applying philosophy, they almost always think of ethical issues. But we could see that researchers in other fields are making substantial philosophical assumptions about the nature of causation. And these assumptions are being actively debated in current philosophical research.

“We’re breaking down preconceptions on both sides: the traditional scientific view of philosophy as irrelevant, and the traditional philosophers’ view of their work as too specialised.”

A classic example: one 2005 paper in a public health journal draws on 250-year-old theories of causality which Professor Stoneham points out “would fail as a first-year undergraduate philosophy essay”.

It’s rather as if a modern researcher were to base his understanding of biology on the pre-Darwinian theories of the 19th century.

Philip Morris, the University’s Business Development Manager for Arts and Humanities, acknowledges that the links between industry and academia in his field are sometimes not obvious.

“Thought, insight and a willingness to invest time and effort are required to identify where opportunities might arise, how we might exploit them and who might be involved - but the opportunities are there,” he says. “Opportunities and how to identify them are becoming better understood. It’s a field offering significant potential for academic and commercial rewards.”

The University is undaunted by the lack of tradition in this area and the consequent virtual absence of best practice. Quite the opposite, in fact: staff now hope to build on these interests, and are already exploring ways of developing an international project that will include partners from the USA, China and Scandinavia.
Research at York frequently bridges the arts/sciences divide, but rarely more decisively than in the world’s largest laptop orchestra, where digital processing became an art form.

The breathtaking multimedia performance was designed and directed by the Department of Music’s award-winning composer Dr Ambrose Field, working with Apple Computer Inc. State-of-the-art Macbook computers supplied by Apple were equipped with video detection technology and became musical instruments in the hands of the orchestra’s 50 instrumentalists – all Music students at the University.

Ambrose Field highlights the musical integrity of the project. “We set out to push the boundaries of human interaction with computers in the orchestra, exploring musical performance in a way which was previously not possible.”

Linked via a wireless network in the University’s concert hall, the laptop instruments used video technology to decode physical movements and convert them to musical events in real-time. Performers literally played the computers as instruments, creating a unique ensemble sound. An atmospheric lighting scheme displayed on giant video screens created an immersive musical experience for the stunned audience.

“This project is particularly exciting for us because it’s innovation at its most creative. It opens up a whole new vista of technology in performance,” said Paul McFadden of Apple Computer.

The performance was streamed live on the University’s website.

York and Apple create the world’s largest laptop orchestra

“We set out to push the boundaries of human interaction with computers in the orchestra, exploring musical performance in a way which was previously not possible.”
The Centre for Novel Agricultural Products is applying fast-track breeding technologies to artemisinin, the World Health Organisation’s recommended treatment for malaria.
With more than 500 million infections every year, malaria is one of the world’s most devastating diseases. It targets young children and pregnant women in particular, killing an African child every 30 seconds. The disease also undermines development in some of the world’s poorest countries. A World Health Organisation report in 2006 estimated that malaria accounts for as much as 40 per cent of public health expenditure in the most severely affected countries.

Until recently, acute malaria infections were typically treated with drugs such as chloroquine, an effective and relatively cheap substance related to quinine. But the malaria parasite has evolved resistance to these conventional treatments, prompting researchers to search for alternatives.

Enter artemisinin, a compound occurring naturally in the shrub Artemisia annua, ‘Sweet Annie’, which grows wild in the UK and elsewhere. The plant itself has an intriguing history: its first recorded use in traditional medicine is in a book of ‘Fifty-Two Prescriptions’, unearthed in a Chinese tomb dating from 168 BC, and it has been used to treat specifically malarial symptoms in China since at least the 16th century. Its active antimalarial compound, artemisinin, was first isolated in 1972 as part of a project by the Chinese military which had already tested and dismissed nearly 200 other traditional remedies in its search for an effective treatment.

When used in conjunction with a partner drug, as a combination therapy, artemisinin is so effective that in 2001 the World Health Organisation adopted it as the main recommended treatment for malaria. But this has thrown up a new set of problems.

“Demand for artemisinin combination therapies (ACTs) has rocketed since 2003,” observes Professor Dianna Bowles, who founded the Centre for Novel Agricultural Products (CNAP) in the Department of Biology at the University. “But many of the people who need these drugs can’t get access to them because they are much more expensive than the drugs they are replacing. This is largely because artemisinin yields from Artemisia are so low.”

So now staff in CNAP are working to develop new varieties of the shrub. Using the highest-yielding plant available – the Swiss variety ‘Artemis’ – as a starting-point, co-investigators Professor Bowles and Professor Ian Graham, current Director of CNAP, and their team hope to increase its useful yield by anything up to a factor of ten.

The scale and sophistication of this project is a step change from previous breeding efforts with this crop. The scientists are tracking the metabolic and genetic profile of thousands of plants in order to identify individuals that produce more artemisinin and understand the molecular basis leading to high yields. The best plants will then be used as breeding stock for high-yield cultivars and a set of internationally dispersed field trials will ensure that new varieties can perform in the world’s major Artemisia growing regions. The project is working with the global health community and with industry to ensure that the new varieties can be adopted smoothly.

“By improving the effective yield of the crop, we can reduce the drug’s cost and increase availability,” says Professor Ian Graham. “And there’s another valuable side-effect. Because they are expensive, ACTs are very attractive targets for counterfeiters. Estimates are that fake malaria drugs are responsible for 200,000 deaths every year. The cheaper and more effective we can make the real thing, the less people will be driven to rely on dangerous alternatives.”

“The cheaper and more effective we can make the real thing, the less people will be driven to rely on dangerous alternatives”
A team approach to solve the world’s most complex challenges

What do a plant’s branches have in common with the ups and downs of the economy, a modern airliner’s control system or the world’s climate? More than you think: these are all examples of systems so complex that they push the envelope of what humans are capable of understanding.

Scientists and philosophers have been studying systems like this for centuries. But to understand what really makes them tick takes an entirely different kind of study. It’s a big challenge because the properties of these systems – how they respond to stimuli, how they adapt and develop – emerge from the interaction of their lower-level parts in non-intuitive ways.

Complex systems are at the core of many things that we want to understand – our society, our planet, even ourselves – but, paradoxically, getting a grip on them is also right at the limit of our capabilities. ‘Complexity’ as a mathematical concept is well-defined, and has benefited in recent years from the vast increase in computing power available to researchers. That’s just as well, because complex systems simply do not yield to the straightforward linear equations of the pre-computer era. Modern research in this area is characterised by building intricate mathematical models.

Reliable modelling of a complex system is an extraordinarily difficult task, often nigh-on impossible for an individual research team to tackle. The York Centre for Complex Systems Analysis brings together nearly 50 experts from Biology, Chemistry, Computer Science, Electronics, History, Management Studies, Mathematics, Physics, Psychology, Social Policy and Social Work.

In this multi-disciplinary research environment, the toughest problems can be tackled from a variety of perspectives. Here the distinctions between disciplines dissolve as scientists learn about each others’ different ways of thinking and working.

“The term ‘complex system’ is used very broadly across an ever-expanding set of disciplines, from economics to management, sociology and education,” says Dr Kiran Jude Fernandes, of the York Management School and a member of staff in the Centre, “but social scientists don’t necessarily grasp the methods used to describe and model these systems, which can limit their work quite severely.”

It’s obvious that an accurate model of climate change or the economic cycle holds immense value. But the Centre’s remit is far broader: recent work includes a project to model gun-crime networks and research into the feasibility of ‘nanotech assemblers’, tiny robots designed to build larger-scale artefacts which could be used in advanced surgical procedures.

In another collaborative project, researchers developed a computer model showing how marine predators such as sharks and turtles forage the ocean for food. This work could be used to identify sustainable ways of managing fisheries, and understanding whether marine reserves can be effective in European water. And Dr Reidun Twarock, of the Departments of Biology and Mathematics, is studying the geometry of viruses, which will help to develop new anti-viral strategies.

“If we want to be able to predict and influence the behaviour of complex systems, or to engineer entirely new ones with specific properties, we need to understand how they work,” says Professor Ottoline Leyser of the Department of Biology. “Fortunately, there are core fundamental principles applicable to all complex systems, offering the extraordinarily exciting opportunity to tackle many different problems together.”
Researchers and industrial partners at the University of York use some of the world’s most sophisticated technical equipment to tackle a wide range of complex challenges

World-class facilities for research and industry

The University has invested in a powerful array of the latest analytical instruments. The £5.5 million York Neuroimaging Centre (YNiC) is one of the world’s leading research facilities for investigating human brain function with non-invasive imaging techniques.

The centre has strong links with the Hull York Medical School, the NHS and industry. It includes academic research, teaching, commercial and industrial activities. Through a partnership with Lodelstone Patient Care, YNiC also provides clinical scanning services to both NHS and private patients.

YNiC’s £1.1 million MagnetoEncephaloGRAPHy (MEG) scanner, maps the magnetic fields created by electrical activity in the brain, while its £2.5 million high field Magnetic Resonance Imaging (MRI) machine has twice the power of a typical hospital device. It was established with the help of a £1.2 million grant from the Wolfson Foundation.

The University’s Centre for Magnetic Resonance (CMR) includes high magnetic field spectrometers and the first commercial HyperSense polariser. It is the first facility in the UK to have spectrometers, imaging equipment and polariser in one location.

CMR’s scientists, drawn from the Departments of Chemistry, Biology and Psychology, address problems including the development of new catalysts for use in the production of everyday materials such as plastics and margarine. They are also working on the development of novel medicines, particularly new antibiotics.

YNiC and CMR work closely on devising new approaches that allow precise imaging of specific chemical reactions in the body.

The York JEOL Nanocentre opened in 2007 with a powerful electronic microscope (right) which is one of only four in the world, and the only one set up for fully remote operation in its own purpose-built pod. It will allow scientists to carry out single atom analysis.

The other unique feature of the York equipment is a special chamber which allows scientists to observe materials during natural reactions.

It is a £5.5 million investment by the University, Yorkshire Forward, the European Union, and by scientific instruments supplier JEOL.

The University’s mass spectrometry facility, a joint initiative between the University’s Departments of Biology and Chemistry, helps scientists to tackle some of their most testing analytical challenges, and provide a highly specialised technical service to industry.

It was created thanks to a major capital investment of £1.6 million through Science City York, supported by Yorkshire Forward with funds from the Northern Way Initiative.
The Department of Biology at York was placed in the Excellence Group by the Centre for Higher Education Development (CHE) in Germany, with a gold medal for citations, silver medals for outstanding researchers and Marie Curie Programmes, and a bronze medal for publications. High placings were also given to the Departments of Chemistry and Mathematics at York.

The University has been awarded three Queen’s Anniversary Prizes for Higher and Further Education – for technology transfer in Computer Science, for plant-based renewable resources at the Centre for Novel Agricultural Products, and for health economics at the Centre for Health Economics.

The National Science Learning Centre on the York campus is also to become the national centre for Science, Technology, Engineering and Mathematics.

The Institute for Effective Education was founded in York in 2007, dedicated to evidence-based research which will improve teaching practice in the classroom and inform education policy. It will be the major occupier of a new purpose-built building, which will also provide workspace for over 200 research students and postdoctoral researchers in the Arts and Humanities.

York is ranked fourth of 108 UK higher education institutions for its research activity, according to Research Fortnight. Researchers at the University of York had one of the highest success rates in the UK from the 197 research grant applications they made last year to Research Councils.

The Department of Chemistry is the first academic department in the UK to win the Athena Swan gold award for its commitment to women in science. The Departments of Biology and Psychology hold silver awards, and York holds more awards for good employment practice for scientists than any other university.

The Training Gateway was launched by Ministers in July 2008 to provide a single point of contact for business, business support organisations and skills brokers who wish to procure high quality corporate and professional training from across the range of UK universities. It was initiated by and is hosted at the University of York.

York was ranked 74th in the QS/THE world top 100

1 Professor Haleh Afshar, who teaches Politics and Women’s Studies at York, became a non-party political peer in 2007. Baroness Afshar is also an advisor to the Government on public policy relating to Muslim women and Islamic law.

2 Professor Jonathan Bradshaw was awarded a Lifetime Achievement Award by the Social Policy Association in 2007.

3 Professor Ottoline Leyser FRS was elected a member of the European Molecular Biology Organisation (EMBO), a group that includes Europe’s leading researchers, among them 43 Nobel Laureates. EMBO membership is a lifelong honour.

4 Professor Robin Millar, of the Department of Educational Studies, was awarded the Bragg Medal and Prize by the Institute of Physics for outstanding leadership in the teaching, learning and assessment of physics.

5 Professor Robin Perutz, of the University’s Department of Chemistry was the first Briton to be awarded the Luigi Sacconi medal for inorganic chemistry from the Italian Chemical Society. He received the award for outstanding achievements throughout his career.

6 Dr Evgeny Sklyanin of the Department of Mathematics was elected a Fellow of the Royal Society in 2008.

Five researchers from York out of the country’s 100 were appointed to the NHS NIHR College of Senior Investigators in April 2008, a title given by the National Institute of Health Research to experts whose work makes the most outstanding contribution to research in health and social care. They are Professor Martin Bland, Professor Mary Renfrew, Professor Nicky Cullum (all Department of Health Sciences), Professor Simon Gilbody (Hull York Medical School), and Professor Lesley Stewart (Director of the Centre for Reviews and Dissemination).
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Dr Chris Henshall, Pro-Vice-Chancellor at York since 2005, leads the University’s work in promoting innovation and enterprise. Key partnerships include Science City York, the White Rose University collaboration, with Leeds and Sheffield Universities, and the Worldwide Universities Network.

He joined York from the UK Government’s Office of Science and Technology in the Department of Trade and Industry, where he had responsibility for the UK Science Budget, worth £3 billion a year. Before that he worked in the Department of Health, managing the NHS and Department of Health research portfolio. He has also worked as an academic at the Universities of Southampton, Warwick and Maryland.

Professor Alastair Fitter FRS is one of Britain’s leading ecologists. Formerly Head of the Department of Biology at the University of York, he has led the University’s research strategy as Pro-Vice-Chancellor since 2004. He is also a member of Council of the Natural Environment Research Council.

His research focuses on plant and microbial responses to climate change and on the role of biodiversity in the delivery of eco-system services. With his father, the naturalist and author Richard Fitter, he published in 2002 a seminal article in Science on the changing phenology of wild flowers due to global warming. They have also collaborated on numerous field guides and other natural history books.