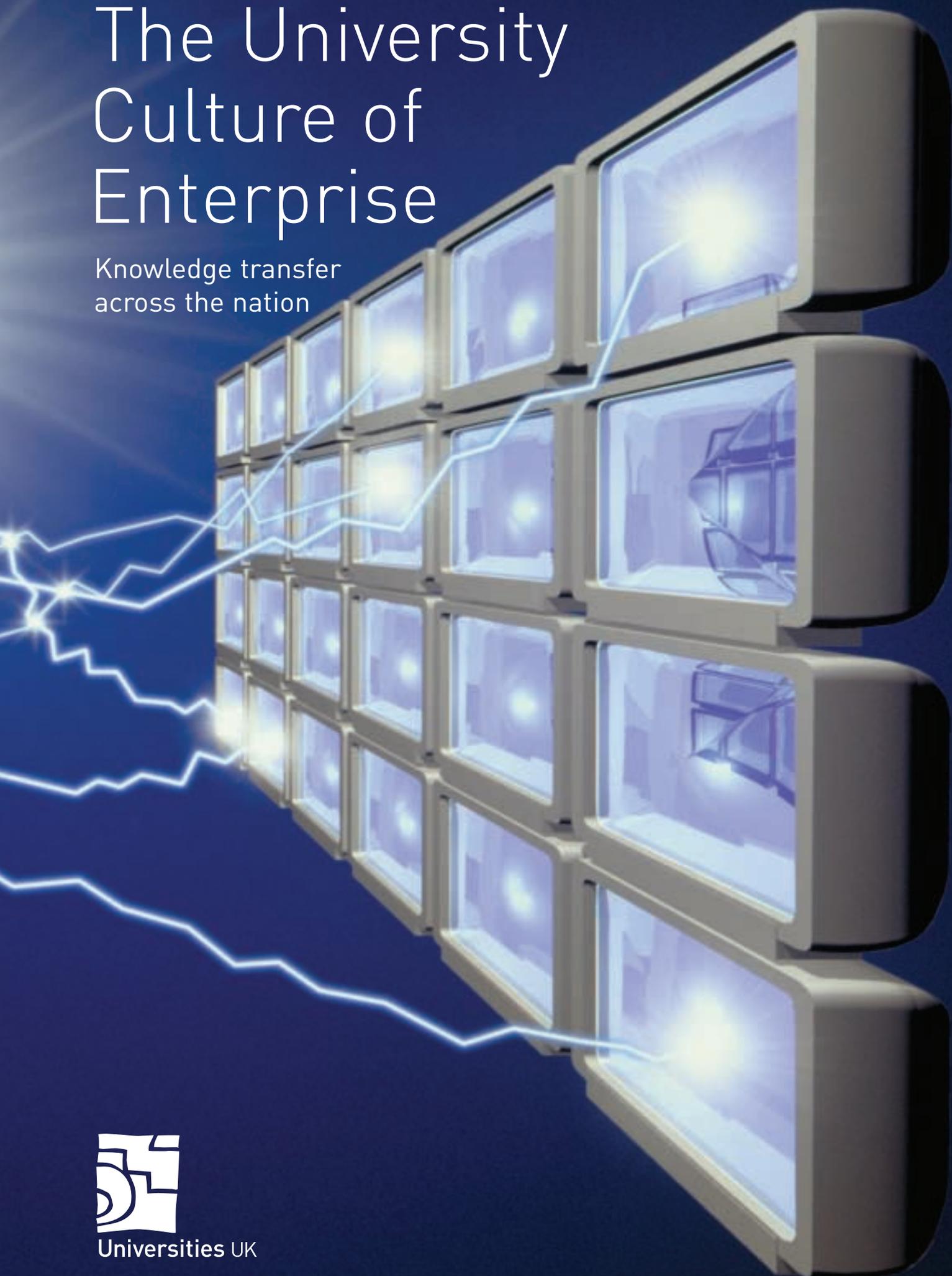


The University Culture of Enterprise

Knowledge transfer
across the nation



Universities UK

The Higher Education Business Interaction Survey December 2001

Commissioned last year by the UK funding bodies and the Office of Science and Technology, this pilot survey of exploitation activity across the higher education sector showed that:

Industrial research income for university research continues to increase:

- Research income from business rose from 10.9 per cent in 1995/96 to 12.3 per cent in 1999/2000, compared to a figure of 10.1 per cent in the US for 1999.

The number of new patents filed by higher education institutions is on a rising trend:

- Total patents filed increased by 22 per cent from 1259 in 1998/99 to 1534 in 1999/2000.

Higher education institutions are making rapid progress in generating businesses from the UK science base:

- There were 199 spin-off companies in 1999-2000, compared to 338 in the previous 5 years.
- Half of UK higher education institutions offer incubation facilities and 70 per cent have some access to seed corn investment.

British universities' exploitation performance compares well with US universities:

The amount of research expenditure per spin-off company in 1999 was:

- UK universities £8.6million
- Canadian universities £13.9million
- US universities £53.1million

1. Charles and Conway, December 2001, Centre for Urban and Regional Development Studies, University of Newcastle Upon Tyne

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UK universities are way ahead of European rivals, and second only to those of the United States

Wealth and wisdom flow from academia

University knowledge transfer activities are an increasingly important and integral part of the work of the higher education sector. They are essential drivers for this Government's economic and modernisation agendas, including enhancing competitiveness and improving quality of life.

Knowledge transfer provides a route to innovation and development at all levels. The UK has a first class science and technology base.

To benefit from the major scientific advances taking place today, we in Government are keen to encourage the maximum return on our investment in research activities, and to enable the

knowledge generated by it to be exploited quickly and effectively for the nation's economic benefit and to improve our quality of life. The first class research produced by our universities and public sector institutions underpins the knowledge economy and our universities have an increasingly important role in stimulating knowledge and its transfer across all other sectors, including business and industry, government and the voluntary sector.

I welcome this report from Universities UK that shows how the universities have responded to this important Government agenda and to

initiatives such as the University Challenge, Science Enterprise Challenge, and the Higher Education Innovation Fund. The University Culture of Enterprise identifies the ways in which universities have contributed to wealth creation, expertise and skills across the economy and in the community. It illustrates the pervasive value of effective knowledge transfer in a variety of very different situations, and how universities are becoming regional centres of innovation - a fascinating and welcome development.

This report is a valuable contribution to the debate on how to take forward the knowledge transfer agenda.

Looking to the future...
Science Minister Lord Sainsbury (left) and Professor Martin Binks, head of Nottingham University Business School, stand outside its new £50million Jubilee Campus building



Making the most of our intellectual assets

Moving from one knowledge-based industry to another after 22 years I have discovered that, in their different ways, they both rely on one vital set of assets: their Intellectual Capital.

The past decade has seen a dramatic change in UK universities with the recognition that our research base is developing knowledge that has a value beyond its scholarship and additional to its traditional output in 'publication'.

Today, more and more universities are looking to exploit their intellectual assets in ways that more directly bring income and rewards to fund their work. Investors have faith in technologies based on high quality research and UK universities have a strong and credible track record in supplying it. Markets may swing up and down but there will always be a place for inventions that address healthcare, quality of life or quality of environment needs and concerns.

Yet coming up with fantastic ideas and turning them into clever technologies is not sufficient by itself. A clear understanding of how each new technology addresses a real market need is essential, and for this, universities require both new skills and a new organisational infrastructure.

Universities must be in a position to commit money up-front and build the right organisation such as our technology transfer company, Imperial College Innovations. Any institution serious about commercialisation of intellectual assets must have ready access to professional and proactive support. This requires Government to fulfil its pledge to put "third mission" funding on a sustained footing.

Successful technology transfer companies will guide universities towards the best path for maximising the return on their intellectual property, whether it be via spinouts, technology licensing or partnerships.

Such companies also educate their academic community about the issues surrounding intellectual property protection and the requirements for successful technology transfer, helping to develop the groundwork for a portfolio of commercial opportunities



Serious about exploitation: Sir Richard Sykes believes technology transfer skills will be crucial

that will be extremely valuable to the researchers themselves and the future of the institution as a whole.

Entrepreneurship Centres within universities offering practical courses and advice, running business-plan competitions and networking events are invaluable in helping to foster the attitude that we can all gain from our intellectual property.

The cultures of our universities are diverse and what works for one institution may not be readily

transplanted into another. I believe all UK universities can benefit from examining the successes of some of their peers and the examples of best practice in this timely publication.

The combination of first class research and a well-founded technology transfer organisation will increasingly offer staff and students the opportunity to develop their ideas in an entrepreneurial environment.

**Sir Richard Sykes DSc FRS
Rector, Imperial College London**

A British renaissance?

The first phase of knowledge transfer at UK universities has been a great success

This report summarises the remarkable record in knowledge transfer achieved by British universities. While a wide range of case studies from around the UK have been included, the sheer scale of current activity means that this is not a comprehensive survey. Many excellent schemes have had to be omitted.

First and foremost, the greatest contribution to knowledge transfer by UK universities must be the education of around 500,000 graduates each year. Eighty per cent go directly into jobs, the majority of which are relevant to their degree subjects. The education of a new generation in original concepts as well as artistic or technical expertise must surely rank as the greatest single act of knowledge transfer in the UK. It delivers immeasurable results to the UK in terms of economic productivity and international competitiveness.

This is further enhanced by the increased volume of professional development and training provided for those in jobs, contributing directly to the organisations in which they work.

But there is another important dimension to knowledge transfer which represents a 'third stream' to activities in addition to education and research: a new zeal for entrepreneurship, wealth creation and the commercialisation of science and technology taking place across the UK. Academics are no longer content simply to invent, but are keen to see their solutions applied to real-world problems and their potential harnessed for the good of the economy.

Following the Dearing report's consideration of the economic role of higher education institutions and its recommendations to government to help stimulate such activities, the then DfEE, the Department of Trade and Industry and the Higher Education Funding Council for England came together to offer public funding for the first time to support knowledge transfer activities from universities and colleges to business and the community.

The new policy was announced in 1998 with the publication of the White Paper, Building the Knowledge Driven Economy, which challenged business "to turn into commercial success the technological knowledge in our

universities, to form collective partnerships with suppliers, customers, schools and universities to build networks and clusters of excellence to win competitive advantage".

Universities and higher education colleges had already been active in exploiting their publicly funded research activity prior to the introduction of third stream funding. For example, in 1999/2000 they generated nearly £2billion from research grants and contracts, more than twice the funding received from the funding councils for research. Many of the examples quoted in this report rest on that existing public exploitation of research.

Third stream funding remains modest in comparison to the funds provided for teaching and research, totalling no more than £100million per annum by 2004/05. Based on the number of high quality but unfunded bids for third stream funds, Universities UK estimates

"Universities' immense reserves of creativity and innovation must be made to work for the nation"

that central funding needs to rise by approximately £150million per annum. It is seeking a government commitment to provide these funds in the 2002 spending review.

Although it needs to be increased, current public funding has enabled higher education institutions to build an infrastructure for more effective relations with businesses. It is broadening the potential for knowledge transfer from a wider range of institutions and activities.

University enterprise activity has already resulted in what is little short of an economic renaissance which, though often still localised and currently concentrated in the larger, technology-driven universities, is fast spreading to the farthest reaches of the UK. Third stream funding helps spread research and development into new, highly ambitious university knowledge nodes around the UK such as the smaller city universities, the new universities and those located in inner city centres. The £6million White Rose Technology Seedcorn Fund, established by the University of Leeds, the University of Sheffield and the University of York, uses public funds to exploit the financial potential of academic research.

Licensing and consulting have long been the traditional methods by which universities have spread the skills and experience of academics into the wider world beyond, most especially into the world of commerce. But in the past few years the rapidly emerging new sector of university spinout companies has become a major third stream activity. Knowledge transfer performance is not easy to measure but if the rate of spinouts is any guide, the track record of universities is impressive.

According to the latest figures, more than 200 spinouts with exclusive intellectual property invested in them were started in 2001, and around 325 spinouts will be created each year from 2003.

One of the principal aims of third stream funding is for universities to relate more closely to the needs of small business. These needs often depend on the application of relatively

modest technology rather than on that at the frontiers of knowledge and a wider range of institutions is able to engage in these relationships.

TCS, the former Teaching Company Scheme, managed by the Small Business Service, is a specific example of higher education institutions working with small companies on knowledge transfer. There are currently (May 2002) over 900 such partnerships, ninety per cent of which are with small or medium sized companies with places for around 1100 graduates.

In addition, new and energetic investment networks such as Spinout Wales, Connect Scotland and Connect Midlands, many dozens of science parks adjoining university campuses, and professional and pan-sector networks such as the Faraday Partnerships, have been formed.

Of the 152 fields of scientific research, the UK is a world leader in 26, and scientific papers by UK academics remain among the most highly cited. But the universities have also taken a leading role in contract research, a vital UK sector, and helped to sustain the research base of UK industry.

These rapidly expanding activities are the foundations on which the future success of the knowledge-based economy will be based.

The new kids on the block

Many of the UK's new universities are developing highly profitable solutions to a host of difficult problems - and often they are perfected on the slimmest of budgets

At Glasgow Caledonian University, chemistry experts Dr Richard Tester and Dr John Karkalas are urgently seeking additional cash to fund new applications for carbohydrates, the substances which form the main constituent of pills, and novel oral delivery systems, developed by their Glasgow-based firm, Glycologic.

The first of these ventures is a slow release variant of aspirin which could help prevent air travellers suffering from deep vein thrombosis. In addition, the aspirin variant could become important in therapies for chronic analgesia, long term pain relief and in the treatment of cancer.

Glycologic recently received a DTI Smart award of £45,000 to kick-start the research.

The company has also received considerable financial help from the former Glasgow Development Agency, since renamed Scottish Enterprise Glasgow.

A second major area of inhouse expertise awaiting exploitation is in 'taste-masking' and other innovative drug delivery compounds.

Dr Tester is keen to emphasise that such compounds can have a dramatic commercial impact on the pharmaceutical sector. "Our systems have a strategic financial focus," he added.

"We are primarily a chemistry solutions company. Not only do we supply our expertise to international



pharmaceutical and healthcare companies, Glycologic wants to find partners who will help us develop and perfect our own product concepts."

Glasgow Caledonian University currently owns 20% of the equity, in return for handing over all of the intellectual property to the company. The former continues to pay Dr Tester's salary; the founders hold 45%.

The director of Glasgow Caledonian's research and commercial development department, Professor John Marshall, said: "It is our first spinout, and we are

excited about its potential.

"We are very happy to continue hosting Glycologic during its incubation stage."

The world market for drug delivery systems is estimated at £50billion by 2005, an indication of its relevance to the pharmaceutical sector.

"Glycologic represents a fusion of carbohydrates and logic," concludes a delighted Dr Tester.

The pair are confident that revenues will reach £5million, and the workforce rise to more than 40 by 2006.

Pill pioneers...
Richard Tester (right) and Professor John Marshall, have formulated ambitious plans at Glasgow Caledonian University

Glamorgan harvests hydrogen fuel for the future

At the University of Glamorgan, Professors Dennis and Freda Hawkes and Dr Richard Dinsdale are producing hydrogen, a non-polluting energy source and the most abundant element, from the fermentation of green carbohydrate-rich energy crops which grow in abundance.

Hydrogen-driven cars and fuel cells are one of the most promising energy options for the post-carbon, or zero carbon emission, age.

The team, the only one of its kind in the UK, has calculated that if just 10 per cent of the arable land in Wales were to grow sustainable crops, enough energy could be generated to replace 10 per

cent of the transport fuels in Wales, at a value of £300million a year.

A second team from the University of Glamorgan, led by Professor Stan Wild at the Building Materials Research Unit, is making concrete that contains far less cement by substituting waste or recycled materials.

New cement constituent substances created by the team include wastepaper sludge ash, a waste product from the paper recycling industry, and ground-granulated blast furnace slag, a by-product of the steel industry.

Another advantage is that cement production is immensely costly in environmental terms: the production of



Full of energy...
Dr Richard Dinsdale fine-tunes another experiment in his laboratory at the University of Glamorgan

one tonne of cement results in the emission of one tonne of carbon dioxide into the already vulnerable atmosphere.

Jewels in the academic crown

The market capitalisation of young firms is adding millions to Britain's new economy

Driving force... Ian Page is the inspiration behind one of Britain's highest potential spinouts, Celoxica



Three years ago one of the few lecturers at the University of Oxford's Department of Computing without a PhD secured venture capital for his company, now named Celoxica. Its software greatly accelerates the overall process of software design by cutting out the arduous 'end stage' of hardware function programming.

In October 2001, Ian Page, who has a

long background in industry, helped the company attract a further \$30million and maintain the firm's reputation as one of the most high potential spinouts from any British university. One recent investor, Tod Bensen, chief executive of Cazenove Private Equity, said, "Celoxica has the potential to revolutionise the way digital electronic circuits are designed."

Segmentis generates a new software image

High culture... Segmentis software enables home users to transform images into impressionist illustrations on their PCs



Software also provided a golden opportunity for mathematician Dr Andrew Bangham, of the University of East Anglia in Norwich, who has designed a system capable of 'segmenting' any digital image into its constituent parts so that they can be identified, logged and characterised.

His company, Cambridge based

Segmentis, is now busy promoting his software for a remarkable variety of end uses. Any home PC owner can download his software and use it to alter any scanned image, filter out detail in set stages, and transform them into tranquil, impressionist illustrations.

But Dr Bangham, who was originally inspired by his portrait artist daughter,

has much more serious applications for his software. These include the electronic search for evidence of breast or cervical cancer in screening tests, which is much quicker and potentially more accurate than the human eye, the tracking of suspicious movements seen on high-street CCTV cameras, or a multitude of industrial inspection tasks.

SET FOR THE BIG TIME



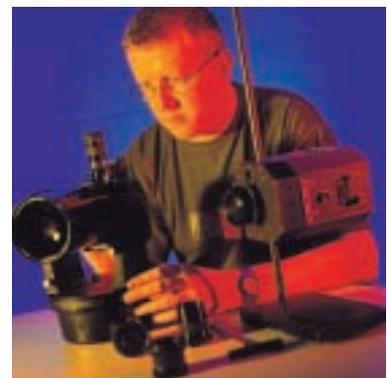
Image conscious... Michael Brown shows Andor's EMCCD camera, while Patrick Cullen (right) uses the iKon camera

Britain's smaller universities have spun out a remarkable series of companies, many of which are leaders in their field.

At Queen's University, Belfast, Andor Technology has built a camera capable of highlighting a single photon - a unit that is the most sensitive imaging detector yet constructed. Started in 1997, the company last year received £2.1million in venture capital funding to expand production and double its workforce to 150.

As early as 1994, Newlands Scientific was begun by a small team of researchers and technology transfer officers from Hull University, who had jointly developed a solid lead in the technology of materials which respond to a magnetic field.

The company, now listed on the Ofex market, has produced its first



product, Soundbug, which converts almost any surface - table top or windscreen, for example - into a loudspeaker. A second product, Soundbug Mobile, will allow more than one person to listen to a mobile phone conversation - opening the era of mobile tele-conferencing.

Empire building in Kensington

High potential small companies by the score are being created thanks to a brilliant innovation infrastructure pioneered with energy and enthusiasm at Imperial College

One of Europe's largest research universities, Imperial College London excels in a wide range of technologies across medicine, biosciences, computing, materials, energy and the environment.

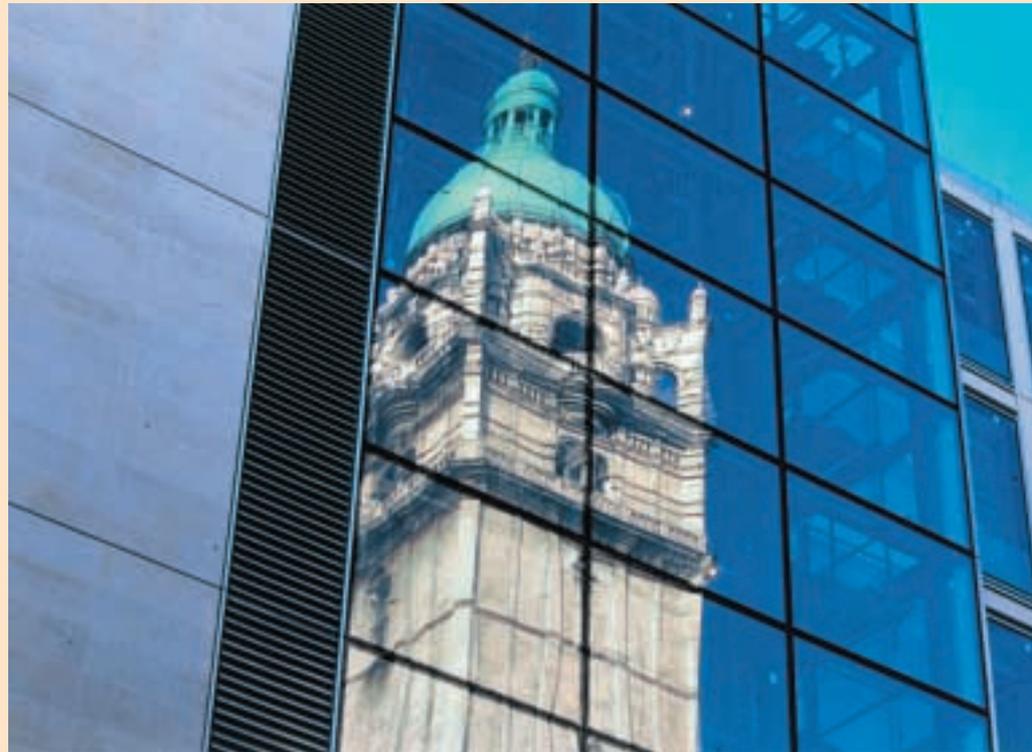
Over the years a portfolio of 53 spinout companies has been created by Imperial College staff, with the advice and backing of the College's technology transfer arm, Imperial College Innovations Ltd.

Susan Searle, IC Innovation's managing director, says a special 'company maker' service unit has been started to provide services to spinout companies such as lawyers, tax advisers and business planning.

In March 2002, Imperial College's track record prompted the Japanese bank Nikko to establish a £20million fund with the college for investment in early stage companies.

This is in addition to the £25million given to the college for a new business school by alumnus Dr Gary Tanaka of Amerindo Investments.

In a single year, 1998/99, it notched up 137 invention disclosures, 27 new patents filed, 59 licences signed and 19 new development contracts completed. The college maintains an active network of business angels, venture capitalists, investment banks and funds and, so far,



two major events have been held to promote a new generation of spinouts.

IC's £4million seed fund, supported by the Government's University Challenge initiative, has made seed investments of £250,000 in seven spinouts, and pathfinder investments of

up to £25,000 in 21 potential spinouts. "This fund has already increased in value with one investment increasing its value 10-fold," said Mrs Searle.

IC also runs the UK's largest academic consultancy, ICON, which has a turnover in excess of £10million.

Mirror on the future... The Queen's Tower reflected in the Sir Alexander Fleming building, at the centre of the South Kensington campus

IMPERIAL'S TREASURE CHEST

MINE OF INFORMATION

In 2000 another Imperial College hi-tech spinout named InforSense won the contract to provide sophisticated data mining and pattern recognition software to the Sanger Centre in Cambridge, the hub of the UK's contribution to the human genome project.

Crucially, InforSense's software can handle and evaluate the very large amounts of genetic information present in not just one database, but any number of data hubs located across many websites.

A grant of £1.6million from the joint infrastructure fund enabled the three founders of Powerlase, Alan Taylor, David Klug and Ian Mercer, to produce high-power laser-based tools for solving problems in generating very short wavelength energy.

GATEWAY TO COMMERCE

Alongside these companies stands a variety of innovation initiatives. IC Innovation carries out some 100 technology assessments each year.

Within the management school, the entrepreneurship centre was formed in January 2001 to enhance the culture and disseminate examples of best practice.

A recent grant of £1.2m from the Higher Education Funding Council for England has promoted links between higher education and commercial partners via the creation of a business gateway. In September 2002, Imperial will host the entrepreneurship in technology competition, open to spinouts from 12 European universities.

The event is being sponsored by the US IT giant Hewlett Packard.

Star turns

Imperial College's most successful spinout has been the engine maker Turbo Genset, listed on the London Stock Exchange in 1993, with an initial market capitalisation of £740million.

Other star spinouts include biomedical imaging firm ComMedica, ultra low power CMOS chip designer Toumaz Telecom, and e-commerce platform provider Orion Logic. ComMedica is likely to alter the way doctors and hospitals work because it is designing handheld monitoring units that carry vital information such as electronic patient records.

One of Imperial's most innovative scholars is Kwang-Leong Choy, pioneer behind materials coating firm Innovative Materials Processing Technology. Still in her 30s, Ms Choy is ready to launch her second firm, producing a sensor system for the aerospace industry.



Brain power... Kwang-Leong Choy, the force behind Innovative Materials Processing Technology

Bridging town and gown

Few universities are more in tune with the community than this Tayside institution

In the past two decades, Dundee University has become the primary force in the revival of the city's declining 'jam and jute' industrial economy and built the third largest biotech cluster in the UK after Cambridge and Thames Valley.

This is no mean feat for a city once regarded as one of the grimmest and least attractive in Scotland.

The work of integrating the university into city life has taken many forms.

On three separate occasions in the past 10 years the citizens of Dundee have raised £5million for major research projects at the university, in a city that is anything but rich.

"The community here feels a certain ownership for the anti-cancer gene p53, which was discovered by Professor Sir David Lane," said Vice-Chancellor Sir Alan Langlands. "It is now the



Concrete evidence... the Wellcome Trust Biocentre is a testament to Dundee's biomedical success

single most researched gene in the world."

A tiny cadre of far-sighted, tough-talking biotech academics, led by Professor Sir Philip Cohen and Professor Sir David Lane, have worked tirelessly to create a renowned research base.

From his panoramic top floor office in the £13million Wellcome Trust Biocentre overlooking the Tay estuary, with the snow-tipped hills rising beyond, Sir Philip enjoys the best view in British academia.

"Dundee is amazingly supportive of the university," he said. "Here we have 50 research groups - that's equal to three quarters the size of the National

Institute of Clinical Research in London." Such strengths have helped to forge links with global pharma giants such as Pfizer, Novo Nordisk, GlaxoWellcome and Upstate Discovery.

"The profits come back into this building," says Sir Philip. Three per cent of Dundee's workforce - around 2,100 people - work in the biotech sector, adds the professor. Since 1994 the number of local biotech companies has risen to 29, many of them university spinouts.

Community backing is energetic. Whereas many universities struggle to win over people to take part in crucial medical tests, Dundee finds no shortage of willing volunteers.

One in two local schoolchildren going to university choose Dundee, and the elderly, remarkably, have not been neglected on Tayside.

The computing department recently launched a £10million research unit, the Queen Mother Centenary Research Centre, to pioneer ways in which IT can help the elderly, one of very few such centres in the world.

"Our research is a greatly neglected area," says department head Professor Alan Newell. "In seven years time, pensioners will outnumber children."

Sir David Lane says the "relaxed atmosphere, cross-discipline stimulation and lack of hierarchy at Dundee have been central to the creation of its 'frontier spirit'."

After all, he shrugs, "We're selling molecules, not marmalade."



Frontier spirit... Professor Sir David Lane (above): working tirelessly to build a renowned research base at Dundee



Commitment: Vice-Chancellor Sir Alan Langlands



Unique role: Prof Alan Newell cares for elderly

A tonic to southern comfort

Bournemouth University's commercial focus has led it to specialise in courses as diverse as intellectual property, digital mapping techniques and cartoon animation

In the past few years Bournemouth University has demonstrated what a new university can achieve in terms of innovation and entrepreneurship.

With its motto *Discere Mutari Est* - 'to learn is to change' - in mind, the university's 13,000 students have benefited from courses focused on commerce and innovation. As a result, the university lies among the leaders in the UK for graduate employment.

Vice-Chancellor Gillian Slater, zealous in her encouragement of innovation activities at the University, said: "Our long-term growth and development are dependent upon our ability to generate income and tap into streams of external revenue."

Bournemouth has been careful to invest in specialist, highly business-focused areas within its academic schools. It opened the UK's first research centre dedicated to intellectual property, The Centre for Intellectual Property Policy and Management (CIPPM), and ensures that 15 per cent of



Gillian Slater: pushing for university innovation

all graduates receive an intellectual property module in their courses.

Dr Martin Kretschmer, the centre's co-director, said: "Our percentage, though still too low, must be among the highest in the country.

"It is vital for students to be given the opportunity to understand the ways and means of obtaining wealth from their intellectual gifts and pursuits."

The centre also provides training and consultancy to a range of organisations.

One success was Gillette UK, whose intellectual property policy was developed in conjunction with Ruth Soetendorp, co-director of CIPPM.



A function of the imagination

The University is also home to the National Centre for Computer Animation (NCCA), which is at the forefront of one of the world's fastest growing industries - computer animation and digital special effects. NCCA alumni now work for major players such as Dreamworks and Industrial Light and Magic.

Enterprise activities include animation for commercially produced, innovative simulator rides, and collaborations with established creative artists including the Random Dance Company, which commissioned student-led computer animation sequences for use in a unique live performance, 'Nemesis'.



An image created by former student Miles Green, who is now a demonstrator at NCCA

Last year an Innovation Centre was opened to foster start-up, incubation and development of knowledge-intensive companies in the region.

Bournemouth has promoted its research and innovation through the S2B, or Services-To-Business brand.



Images by NCCA students Kevan Shorey (top) and Edmund Kolloen (bottom)

MILESTONES

Bournemouth University will soon reach a milestone with its 50th project under the teaching company scheme, a figure that includes both new projects and those completed.

"Our teaching company scheme earnings over the last two years will soon reach £2.2million - if all nine proposals in the pipeline come through," said Gillian Slater.

The university's first spinout, cartographic services company Digi-Data, has been an early success. Founded by Dr Rob Watts, senior lecturer in spatial information management, the company has rapidly increased its income as demand soars for the digitisation of printed map information.

Dr Watts says he is confident revenues "could reach £2million in 2002." Digi-Data also has a patent pending for its specialist Geographic Information Systems software, which speeds up searches for spatially referenced data, functioning much like a library catalogue. "There is nothing like it for maps," remarked Dr Watts, who is aged just 29.

Sense of direction... Dr Rob Watts of cartographic services firm Digi-Data, whose revenues "could reach £2million in 2002"



To learn is to change... Bournemouth University's Talbot campus

Our nerve centres of the future

As industrial research declines, university initiatives are increasingly important in keeping the UK ahead in the race to develop the crucial technologies of tomorrow

In areas such as photonics, bioscience, lasers, and nanotechnology - the art of studying and re-making materials at the atomic level - many of the crucial breakthroughs are expected in academia rather than in commerce. The launch in December 2001 of a

nanotechnology research centre at Birmingham University was aimed at revitalising an area of the West Midlands, where the level of employment in manufacturing has fallen below 25 per cent of the workforce. The I2 Nanotech Centre will

focus on nano-particles and nano-engineering, with applications ranging from microfabricated devices to food production. Already, two high potential nanotechnology spinout firms, Hybrid Systems and Adelan, have been created by staff working at the centre.



Brighter than 10,000 suns...

Photonics is at the heart of future telecoms and ultra high speed internet links.

At the renowned Optoelectronics Research Centre at the University of Southampton, Professor David Payne leads a team that invented the optical amplifier, the technology behind high speed communications (DWDM) that enabled the Internet's explosive growth.

Professor Payne himself became famous for inventing the erbium-doped fibre-optic amplifier.

At a second centre for optical communications, at the University of Bath, a spinout led by Professor Phillip Russel, Blaze Photonics, has designed a new optic 'cobweb' fibre which is



Inventor of genius: Southampton's David Payne

brighter than 10,000 suns at its core. This may revolutionise communications in the same way that fibre optics took over from copper wire 20 years ago.

Where materials truly count

Materials science is another area of great potential. At the University of Nottingham, one of the largest bodies of inter-disciplinary materials research expertise in Europe, a virtual Institute for Materials Technology (UNIMAT) has been established.

The new institute's director,

Professor Steve Howdle, said the skills and knowledge of more than 120 researchers drawn from 15 different academic schools will focus on developing more effective links with industry. Teams will concentrate on key sub-sectors such as light alloys, ceramics and biomaterials.

Opening Day at UNIMAT: Prof Steve Howdle (left) with Sir Colin Campbell, Vice-Chancellor of Nottingham University, and Prof Anthony Ledwith, past-President of the Royal Society of Chemistry, discuss the impact of new materials on science



IN THE GENES



Molecular science, medical sciences and biotechnology are important research areas for many UK

universities, especially at York, Cambridge, Oxford and Bristol, and are vital if the UK is to capitalise on the economic rewards flowing from the completion of the human genome project.

At the University of Edinburgh, Dr Peter Ghazal (above) has been lured back from the US to head the Scottish Centre for Genomic Technology and Informatics. He believes the centre will become "one of the very few chosen global centres for gene expression, pulling together computation, analysis and storage to create a true centre of excellence."

Remarking on the link between academia and commerce he said: "Universities build the tracks; but companies create the trains that will eventually run on those tracks."

Winning flair for research

Oxford and Cambridge have competed - with very different approaches - to create two of the greatest sources of intellectual expression across the whole of Europe

Two of the best-known universities in the UK have both succeeded in creating well established technology clusters over the past 30 years.

Cambridge, which enjoyed early success with its entrepreneurial drive in the 1980s, has recently seen its track record rivalled by Oxford which, with its greater space for development and easy proximity to the many state research institutes on its doorstep, now sits comfortably at the heart of Europe's primary intellectual hub, the south Oxfordshire region.

Both ancient institutions have found that wealth is created quickest by chemists, biologists and computer scientists. Oxford has floated six companies of substance on the London

Stock Exchange. The Cambridge cluster comprises around 1,500 hi-tech businesses employing more than 35,000 people. Both have been energetic in their enterprise activities, with science parks, well-endowed business schools, annual venture fairs, collaborations with multinational companies, fund-raising and investment groupings such as the Great Eastern Investment Forum and Oxford Innovation Opportunities Network.

The strategic alliance between Cambridge and the Massachusetts Institute of Technology was formed in 2000, and is worth £84million in total, including £68million from the DTI. Later, Oxford and Princeton Universities formed a close research-based link.

HUB ON THE CAM

The University of Cambridge has a formidable track record when it comes to breaking down barriers between academia and business.

In recent years, university-generated intellectual property rights have formed the basis for 33 new companies, 15 of which were established in the last three years.

Cambridge people and ideas are also central to more than 120 new technology ventures and companies such as ARM, Virata, Autonomy, Cambridge Antibody Technology, nCipher and Biorobotics.

Founded in 1999 with £2.9million from the DTI's Science Enterprise Challenge Fund, the University of Cambridge Entrepreneurship Centre now delivers 5,000 student hours of innovation focused training via 10 core programmes. In 2001 it provided advice, support and mentoring to 100 nascent ventures.

The university has signed partnerships with BP-Amoco (£25million), Unilever (£13million) and Toshiba. Microsoft also chose Cambridge as the home for its European Research Centre.

The university's technology transfer office plays an active role in helping to create new companies. One of the most promising is TeraView, the first spinout from Toshiba Europe's Cambridge Research Laboratory.

Oxford: 800 years of discovery

In late 1997 Dr Tim Cook, an experienced entrepreneur who helped launch Oxford Asymmetry, was appointed director of the University of Oxford's technology transfer company, Isis Innovation. Since then Dr Cook has introduced one of the most generous packages for academics wishing to commercialise their technology. The result has been one of the quickest outpourings of academic innovation in recent times, with more than 25 high potential small companies being launched in the past three years.

The combined value of all of Oxford's spinout companies - which have created more than 3,000 jobs - has reached

£2billion. "Drawing on an 800 year tradition of discovery and invention," said Oxford University's Registrar David Holmes, "modern Oxford leads the way in creating jobs, wealth, skills and innovation for the 21st century." Perhaps the most influential initiative has been the establishment of Oxford Entrepreneurs. By 2005 it aims to ensure that all undergraduates, postgraduates and researchers at the university will have acquired core entrepreneurial skills via a series of master classes, seminars and study modules which will count towards a final degree. Other universities seem certain to adopt similar schemes.



Investing in innovation... an illustration of Oxford University's new Chemistry Department building on South Parks Road

Forging a better life... for all

We salute the work of thousands of scientists who struggle to improve the lot of mankind - and have an impact far beyond the walls of the university laboratory

In addition to the great efforts made by countless university scientists in solving society's biggest problems, a number of academic staff have made tremendous individual contributions that improve social and human conditions, both in the UK and beyond.

Professor Nicholas Talbot, a biologist at the University of Exeter, is working to

control the fungus, *Magnaporthe oryzae*, which causes rice blast, the most serious disease of cultivated rice.

Each year, epidemics occur throughout the rice-growing regions of the world, jeopardising the staple crop for more than one third of the planet's population.

It is the only plant disease whose

ravages can be seen from space.

"Each year between 11 and 30 per cent of the world's rice harvest is lost to rice blast - enough rice to feed 65 million people," he said.

His Exeter team is now busy deciphering the genetic blueprint for the disease agent to open the way to effective control measures.



Life saver... Steve Tonge's research could help save the lives of thousands of premature babies

Saving lives by the thousand

Steve Tonge, a senior lecturer at Aston University in Birmingham, has worked tirelessly for more than a decade - often on his own - to find out why premature babies die. Current therapies that halt the collapse of babies' lungs involve animal proteins, but these are extremely expensive. Dr Tonge has found a synthetic polymer molecule whose structural properties could keep babies' lungs open - and it is 10,000 times cheaper. If proven in trials, his idea could give the Third World a way of preventing thousands of early deaths.

Bone cell engineers get set

Dr Bradley Stringer, cell therapy specialist and reader at the University of Sheffield, has pioneered a method of inducing the body to grow new bone cells which will help combat osteoporosis, a scourge that afflicts the elderly most of all. His spinout company, CellFactors, is currently valued at £23million.

His co-founder, Dr George Foster, who is based at Cardiff University, is currently applying the same techniques to help replicate mature dopamine-producing neurone cells, a lack of which causes the debilitating Parkinson's disease.



Perfect specimen: Dr Foster (left) and Dr Stringer

GOOD IDEAS THAT CHANGE SOCIETY

EYE CATCHING IDENTIFICATION

A single breakthrough can sometimes build an entirely new industry. Dr John Daugman's work on algorithms at the University of Cambridge proved that the iris in the human eye was unique to the individual - and this led directly to the formation of the iris-scanning industry, a cornerstone of the fast-developing biometrics industry.

Already worth \$200million a year, the technology is set to become the principal way in which millions of people are formally identified and verified. As criminal impersonation rises, proof of identity will become a ubiquitous part of our modern, security-conscious society and Dr Daugman's work will have ramifications for years to come.

Many airports worldwide have recently installed these algorithms for security and immigration control, including Heathrow, Schiphol, Frankfurt and Charlotte airports.

BACK TO THE GOOD ALE DAYS...

Students' dreams came true when a university started its own brewery, and then spun it out as a separate business after the last brewery in town closed. In 1999 Sunderland University spun out BrewLab, which offers specialist courses in beer-making and fermentation to the brewing industry.

Now renamed the Darwin Brewery, it produces 2,500 bottles of rich real ale per week. Its director Dr Keith Thomas believes he is benefiting the local community, and the university, in the most popular way possible!



BrewLab: every student's dream come true

Welcome to the innovators' club

The rapid rise of the serial academic entrepreneur in the UK has taken many by surprise

It is estimated that the total wealth created by the most successful echelon of university entrepreneurs exceeds £150million.

In the past few years, academics who launch not one but several successful companies have become a feature at British universities.

Professor Deborah Withington, an auditory neuroscientist at the University of Leeds, began Sound Alert, which put directional sound into evacuation beacons to help people escape from emergencies in buildings, car parks, ships and other confined spaces. Sound Alert is currently valued at £15million on the Ofex market.

Her second company, Sound Foresight, is working on an ultrasonic, electronic stick for the visually impaired, of whom there are 25 million in the developed world. Obstacles - even at head height - can be detected by



White hot... Professor Deborah Withington and Sound Alert Technology's MD, Mike Lunch, emerge from smoke during the Government observed trials of Sound Alert's technology

pulses in the handle, and so avoided.

Professor Withington is probably the UK's wealthiest self-made university academic. She also helped found a third

company at the University of Leeds, named Jopejo, which is making an innovative ex-vitro pregnancy alert kit for mothers.



Founding father... Professor Colin Besant

Turbo-powered prosperity

At Imperial College London, the two academics behind the spinout Turbo Genset, one of whom is Professor Colin Besant, each owned around 10 per cent of the shares in the company when it floated on the London Stock Exchange for an initial market capitalisation of £740million.

At the University of Southampton's Department of Computing Professor Wendy Hall started Active Navigation in 1995, a company which sells internet

search software that is faster and more accurate than other search engines.

At the University of Newcastle, Professor Colin Self recently launched BioTransformations Ltd, a therapeutics company exploiting light-activatable antibodies. These enable much greater specific targeting of anti-cancer agents. His earlier firm, Selective Antibodies Ltd, is focusing on diagnostics products for small molecular weight substances such as drugs, metabolites and toxins.

MAKING A MINT

Dr Steve Minter recently founded NCIMB Ltd, a firm with access to the unique University of Aberdeen collection of bacteria, from which a variety of medicines can be derived.

"Microbial genomics has attracted less media attention than human genomics but it is an area of huge future significance," he remarked.

This is Dr Minter's second major spinout. In 1992, he started Tepnel Life Sciences. In 1994, his co-founder at NCIMB Ltd, Dr Allan Syms, helped start electronic odour sensor ('e-noses') firm Osmetech, from technology first developed at the University of Manchester Institute of Science and Technology (UMIST).

How to turn ideas into money

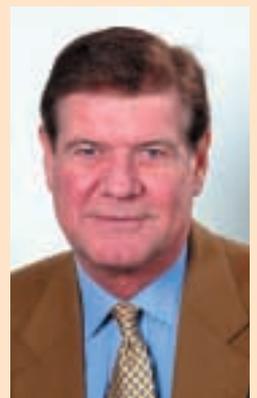
Dr Suran Goonatilake, co-founder of anti-money laundering software firm Searchspace, is an honorary research fellow at University College London. Suran also serves on the board of the Centre for Scientific Enterprise at the London Business School and has now started a business which produces perfectly fitting clothes from electronic images taken of each customer.

At Brunel University, Dr Argy Krikelidze helped found ASP Microsystems, makers of some of the world's fastest computer chips. Finally, Dr Hassan Shirvani, a serial inventor and now Reader in Collaborative Innovation at Anglia Polytechnic University, has created millions of pounds worth of

business for companies that have licensed his tough, impact-absorbing materials and novel heat exchanger designs.

But what is often forgotten is the significant number of academics who donate, or re-invest, much of their earnings.

Professor Graham Richards, head of the Oxford University Chemistry department and founder of a drug discovery spinout Inhibox, has given his entire share entitlement (25 per cent of the equity) to the National Foundation for Cancer Research.



Professor Graham Richards

The power of mass participation

Many thousands of skilled students are needed to satisfy the insatiable manpower demands of the knowledge economy in IT, maths, bioscience and the professions

The substantial numbers of skilled employees created by the universities' widening participation programmes form one of the most significant new resources available to the UK for filling the nation's shortage in key personnel such as IT workers, maths and science teachers, nurses and other professions.

IBM recently calculated that some 200 million people – the population of Indonesia – will be needed over the next 10 years to fill the available jobs in IT industries globally.

Many of the new universities in the UK have worked hard to attract those from disadvantaged backgrounds, from a whole section of society who never thought of reaching for higher education of any kind.

For three consecutive years the University of Sunderland has led the

sector in attracting young people from inner city areas. Some 29 per cent of young full-time undergraduates are recruited from neighbourhoods where there has been a low participation in education.

Such schemes will play an important role in achieving the government's aim of ensuring that 50 per cent of 18-30 year olds will experience some form of higher education by the end of the decade. At the University of East London, more than 60 per cent of the 12,000 students are from ethnic minority communities. The proportion of working-class students is among the highest in the UK - with 38 per cent of students coming from socio-economic groups III-V.

Many of the ethnic minorities, who often have imperfect English language proficiency, find a natural home for their talents in information technology, and the university's location, London's Docklands, has enabled it to put in place a successful access programme.

Students at the University of East London started Xor, one of the many new firms based at an incubator unit on campus. In conjunction with the British Council, Xor has created a learning management system to deliver global standards for e-learning, including a successful pilot scheme in India.



Fresh look... Docklands campus at the University of East London is a key player in widening participation



e-University learning initiative

The Higher Education Funding Council for England has published the business model for an innovative way of delivering high-quality education to students via the Internet. The e-University project aims to establish the UK as a leading player in the market for

"virtual" learning. Any UK higher education institution will be able to deliver courses and student services through e-University, which will not only develop its own programmes but will work with institutions to create and deliver a diverse range of courses.

HELPING HANDS

POSITIVE ACTION

At the University of Wolverhampton, a major scheme named Positive Action has been inaugurated to help graduate students from a broad range of disadvantaged groups gain high-quality, full-time employment.

Cheron Byfield, the head of Careers and Enterprise, said: "The drive behind Positive Action is to improve the employability of less advantaged students by providing them with a range of assistance. These students have exactly the same skills which are attractive to employers as many other groups."



Cheron Byfield, head of Careers and Enterprise at the Positive Action Scheme

TWIN BUSINESS GENERATORS

At the University of Huddersfield, which has a high intake of students from lower socio-economic groups, a thriving pre-business incubation project known as the Huddersfield Business Generator (HBG) has been launched.

At the University of Teesside, a graduate enterprise and incubation scheme has helped establish 23 firms on campus and provide support for more than 50 beyond.

PACTS WITH LOCAL SCHOOLS

At the University of Glamorgan, a series of 'compacts', or close relationships between the university and local schools, was established.

Via the scheme one student, 27-year-old mother of two Helen Kerlake, fulfilled her ambition to go to university. "Student tutoring gave me confidence.. Glamorgan gave me the ability to choose the path I wanted to take, and explore a whole new version of me," she says.

All the world is now our stage

Universities supply many of the talented recruits joining Britain's creative sectors

Britain's creative industries - film, media, fashion, advertising, design and architecture - are critical to the economy, and rely upon a highly skilled, competitive and above all extraordinarily creative workforce to survive. Creativity is one area where the UK is undoubtedly world-class.

Take one example. Many thousands of English Literature graduates enter the UK's £3billion publishing industry each year, and ensure that Britain maintains its lead in this vital cultural sector. 120,000 new titles are produced each year - a feat no other nation can match.

New titles grew five per cent last year.

And the roots of many careers in film, theatre, opera, drama and dance are found within the university system. In politics, many students experience their first public speaking at university political debating societies.

Take another: stand-up comedy has been another major British cultural export in recent years. Back in 1960s the comedy teams who first met and began performing at the Cambridge University Footlights went on to create highly popular TV series and helped change the social fabric of the nation.

Many of the comedians currently on stage at the Comedy Store in central London, the pioneer of the recent stand-up genre, honed their skills at British universities.

Last year the Creative Industries Higher Education Forum was created to strengthen links between academics and the music, film and advertising business sectors. On the way, universities have opened a strategic and advisory channel which runs parallel to that which currently exists between science and technology and its surrounding disciplines.

Courses that put the UK in a different league

Many universities maintain acclaimed art institutions. The University of Warwick's Art Centre is visited by 250,000 people each year and offers performances, exhibitions, films and conferences. Other successes include the University of Central Lancashire's Centre for Contemporary Art, the Sainsbury Centre for Visual Arts at the University of East Anglia, and Manchester Museum, owned by the University of Manchester.

Warwick runs a special MA in Creative and Media Enterprises. Stacey Arnold, a graduate, now at the Guggenheim Museum in New York, said, "I came to the course from an academic angle and found it unique for the way it combines both practical and academic disciplines."

Famous Warwick graduates include Jenny Bond and Torin Douglas, the BBC's royal and media correspondents respectively, and Hannah Waterman, star in the long-running series EastEnders.



Art house... the University of Warwick's Art Centre is the biggest arts complex of its kind outside London, and has 250,000 patrons each year

BETWEEN THESE WALLS

Britain's architects win dozens of international prizes and design competitions. Architectural education in Britain was first started at University College London in 1841 and today the university's Bartlett Faculty of the Built Environment is the UK's largest interdisciplinary faculty of its kind.

The faculty offers 22 Masters courses with just under 200 students enrolled, and some 140 students are registered on the PhD programme, 100 of them full-time. The value of current (2000/01) research grants exceeds £3million, and architects on the Bartlett's staff have won 25 prizes since 1996 for a wide range of urban office and housing projects.

Britain's designers are also considered world-class, and many students are snapped up on graduation by leading firms in fields ranging from fashion to auto-engineering.

Pupils go prolific..

Creativity stretches to schools, too. At Anglia Polytechnic University at Chelmsford, Essex, Professor Stephen Heppell runs Tesco SchoolNet 2000, now the biggest educational website in the world. More than half of all UK schools, and a staggering 134,000 children, are now involved in SchoolNet. Together they have published more than 50,000 web pages. No other programme around the globe has introduced so many children to the unlimited creative and networking potential of the Internet.



Casting a wider net... Professor Stephen Heppell, who runs Tesco SchoolNet

How the West was won

Strong links with industry plus world-class science equals early success at UWE

With 23,000 students, the University of the West of England is one of the largest and most popular universities in the UK.

The Bristol-based university has several key science-based research hubs - the Aerospace Manufacturing Research Centre, the Centre for Research in Biomedicine and the Centre for Fine Print Research - which are attracting larger amounts each year, including £1million just received to fund a Genomics and Proteomics laboratory.

The university is well known for the work of its Intelligent Autonomous Systems Laboratory in robot research. The unit, under laboratory directors Dr



Two men and a robot: Dr Chris Melhuish (left) and Professor Alan Winfield show off their latest toy

Chris Melhuish and Professor Alan Winfield, has produced a Linux-operated robot that works on low power. A feat achieved on a very tight budget.

This research opens the way to the next generation of endurance robots for tasks such as inspection, sorting mail and those dangerous to people such as the remote detection of pollution and landmines. Collective behaviour

patterns using robots is undertaken in a 140m² robotics arena on campus, and some of the robots can even be controlled by viewers via the Internet.

The laboratory has developed close with other leading institutions involved in robotics, including the Californian Institute of Technology, the University of Hokkaido in Japan, and companies such as British Aerospace and Consignia.

The University of the West of England's Frenchay campus



An international reputation for biomedicine

At the University of the West of England's Centre for Research in Biomedicine, the director, Professor Wendy Purcell, has helped establish a world-class centre for biosensor technology.

However, 20% of research students are from overseas, a tribute to the university's research status. For example, an important part of the research on one project was carried out

by the young French-born Breton Caroline Penault. In addition, the University's Centre for Appearance and Disfigurement Research has established links with professionals in the NHS and in education, and has recommended that psychologists be involved to help children come to terms with problems such as social exclusion.

The unit has also assisted clinics in Cape Town, South Africa, which deals

with the hundreds of children who are injured each year in shanty town fires. A high suicide rate among the children affected was causing particular concern.

University of the West of England scientists have also won a grant worth £133,000 from pharma giant SmithKline Beecham to support work on the use of lux genes - which allow creatures such as fireflies and glowworms to "light up" - in the battle against disease.

They aim to evaluate the use of these genes as a way of assessing the effectiveness of antibiotics.

Researchers are also developing safer testing techniques for inherited conditions in order to avoid the use of invasive pre-natal testing, which leads to around 310 miscarriages each year.

Linda Skinner, director of the Centre for Research, Innovation and Industry, said: "Our 'can do' culture allows new research areas to spring up, be nurtured and break new ground, despite the limited public funding available to us at the university."

'Can do' culture... Linda Skinner (right) and Professor Wendy Purcell (far right), director, of the Centre for Research in Biomedicine



Strategic enterprise - at a gallop

Glasgow has been a fast learner when it comes to turning research into wealth

In 1998 Glasgow University owned intellectual property worth less than £300,000. Today that figure stands at around £50million pounds.

As an institution Glasgow has a fine research record, but is only now earning its proper dues from innovation.

In August 1997 the Principal, Professor Sir Graeme Davies, took the decision to start a strategic enterprise unit, dedicated to winning - from business anywhere in the world - the best possible deals for its technologies.

A budget of £5million was allocated over the next three years to create one of the biggest university enterprise units in Europe.

The new department, Research and Enterprise, quickly identified photonics, or optical networking, as the untapped commercial jewel in Glasgow's extraordinary skills base - while not neglecting biomedicine, which receives 65 per cent of its research funding.

Within the first three years of the department's establishment, new funding awards increased by 112 per cent - from £52million in 1996-97 to £110million in 1999-2000.

Around six spinout or start-up companies are established each year. However, three key start-ups have helped make Scotland a world leader in optical technologies.

Optical chip maker Kymata, later sold



to Alcatel, licensed the university's flame hydrolysis deposition technology. These photonic spin outs were succeeded in March 2002, by Essient Photonics, makers of ultra high speed, low power components for the optoelectronics industry.

The university won contracts which stipulate that not only does it own a handsome stake in these companies but, unusually for a university, royalties are payable on future product sales.

Part of Glasgow University's commercial strategy is to 'grow' the company to a much greater extent before dilution occurs through external financing, and thereby retain a larger than usual stake.

Glasgow's highly experienced business professionals, some of whom still run their own companies, can "fix deals across the world through



Quick thinking...
(left) Intense Photonics team Dr Craig Hamilton and Professor John Marsh and, (right) Prof Moira Brown, whose team has created a cancer-attacking herpes virus

personal contacts, negotiate with the world's biggest companies, and exploit to the fullest their intimate knowledge of the technology".

Other promising spinouts from Glasgow University include Crusade Laboratories, a vehicle to commercialise the breakthrough anti-cancer therapies pioneered by Professor Moira Brown.

Although fewer than 50 cancer patients have been treated with Professor Brown's genetically altered herpes simplex virus - HSV 1716 - one has lived for more than four years, an astonishing achievement given that glioma, or brain cancer, is usually fatal within 12 months.

In September 2001, Glasgow opened a commercialisation office in Silicon Valley in California, the first European university to make this ambitious move.

Surrey heads for the research stratosphere

In the 1970s the University of Surrey opened one of the UK's most successful research parks, a 70-acre development created on its own land through its own investment, and an asset now valued at £80million.

The university has a long history of working with industry and commerce, and has developed a number of virtual centres of excellence, especially in digital communications. Commercially funded research in 2000-2001 exceeded £6million.

Today, the research park is a regional enterprise hub for technology-based businesses - more than 150 companies, employing more than 2,500 people, are located there. The park's incubator centre, the Surrey Technology Centre, has spawned a cluster of computer games companies such as Bullfrog, which in turn led to the formation of

Lionhead, both of which are world leaders.

The success of the university's space microsatellite company SSTL, pioneered by Professor Sir Martin Sweeting, is unique. The company has launched 20 satellites, generated £60million in export sales and has orders of £35million for 2002/03.

As a result of the activities of the research park, entrepreneurial academic activities such as SSTL, and its position as the largest employer in Guildford, the University of Surrey estimates that it contributes £450million to the regional economy annually.

It sees itself as a key driver in the knowledge economy, and has developed innovative third arm funding initiatives to develop its entrepreneurial activities.

A business skills unit to market



Reach for the stars...
Surrey's space spinout has launched 20 satellites

teaching and consultancy services has been started. The university has established the SET Squared partnership with Southampton, Bristol and Bath to target entrepreneurs.

The university has also started its own venture capital fund to support a further group of spinout companies.

New hubs of regional innovation

In both the Shires and Britain's inner cities localised economic growth and technological entrepreneurship inexorably gravitate towards the universities

NORTHERN LIGHTS

GREENHOUSE EFFECT

The University of Liverpool is the centre of the MerseyBIO initiative, which aims to promote the transition of quality bioscience research into new business enterprises. In March 2002, the university won £7million to construct a virtual biosciences network (NowGEN, or North West Genetic Knowledge Park), one of six such centres in England and Wales.

The schemes intend to make biosciences the leading growth sector in the region. Pro-Vice-Chancellor Professor Julian Crampton said, "The university is proud to be playing its part in the co-ordinated development of an exciting and vibrant business cluster."

The North West is the first English region to create its own Science Council, chaired by Dr Tom McKillop, Chief Executive of AstraZeneca.

UNITED WE STAND

In Manchester, a biotechnology incubator building built by the University of Manchester's technology development company, Manchester Innovation Ltd, has raised £14million in initial investment, created 10 spinout companies and reaped more than £1million in licence income to the university in 2000 alone.

Back in 1995 the five (now six) universities in the north-east jointly founded Knowledge House, a one-stop shop for small firms wishing to access rapidly the experts and facilities needed to help them solve their business and technology problems, financed by the universities, the Open University and the European Regional Development Fund (ERDF). To date, more than 300 companies have received professional help from the unit, says Graeme Young, liaison manager for Knowledge House at the University of Sunderland.

In the north west of England, the University of Manchester Institute of Science and Technology (UMIST) is aiming to confirm the region's place as a global premier aerospace centre, second only to Seattle. Together with the Universities of Manchester and Sheffield, UMIST has established the Northern Aerospace Technology and Knowledge Exploitation Centre, having won a £4.1million Higher Education Innovation Fund (HEIF) bid.

The north-west already boasts a manufacturing base which comprises Airbus, Boeing, BAe Systems and Rolls-Royce: a total of 200 aerospace related companies. UMIST's Professor Philip Withers, the project's originator, was inspired by the success of the UMIST-



Inspirational... UMIST's Philip Withers

University of Manchester Stress and Damage Characterisation Unit which he co-founded in 1998. After its foundation, the unit received considerable praise from the region's commercial sector.

Invaluable resource for SMEs

The University of Sunderland (right) allows small hi-tech companies to make ample use of the design and chemical analysis resources of its Centre for Automotive and Manufacturing Advanced Practice as well as its Institute of Pharmacy and Chemistry.

In the south west, where more than 80 per cent of businesses have fewer than 25 staff, a special centre at Exeter University's Harrison Engineering Building provides start-up companies with product development facilities such as advanced design simulation, rapid prototyping, remote testing, materials and electronics, many of which are beyond the means of smaller firms.



The University of Sunderland's Industry Centre

Since the scheme was launched, more than 300 small firms have received assistance in the development of novel engineering products, says the centre's manager Lee Bridger.



Rapid growth... the University of Manchester's Incubator Building, sponsored by Manchester Innovation Ltd



Powerhouse... the Harrison Engineering Building at Exeter University provides facilities for SMEs

Innovation widespread in Wales

Novel science and new funding are putting fire back into the Welsh dragon

Since the Wales Spinout Programme started in 2000, 23 businesses have been assisted by the scheme, says David Thewlis, spinout manager of the research and consultancy division at the University of Cardiff.

The nation's 11 higher education institutions have formed five clusters, each with a dedicated spinout manager, to help in the formation of small firms.

A further 52 business proposals are now being considered, and approximately 30 projects will be approved and operational by the end of 2002. One,



Impressive... Cardiff University's campus

Medelect, was started in January 2000 and offers one of the UK's most comprehensive guides to all areas of medical study for doctors. A second,

Optical Reference Systems, makes thin films, based on chemistry technology developed by Professor Stuart Irvine at Bangor.

Dinas Technology manufactures specialist antennae for satellites and receivers.

The three founders, Clive Willson of the University of Wales, Aberystwyth, and postgraduates Olympia Petrou and Rob Wartman, provide the technical and computing skills to create products with superior performance at a lower market price.



Performance enhancer... David Thewlis of Cardiff University

Lampeter leads the way

At the University of Wales, Lampeter, several graduates have recently received entrepreneurial scholarships through the knowledge exploitation fund, supported by the National Assembly for Wales.

Commercial success from core science is well established in Wales. At Bangor, the BioComposites Centre under Dr Jeremy Tomkinson has become a world leader in plant raw materials processing and is entirely self funding.

With an international client list, revenue income is around £1.2million each year.

Two companies have been spun out from the centre, and a long list of patents awaits commercialisation by British industry in the coming years.

A CATALYTIC CONVERTER

The University of Wales, Swansea is at the forefront of a multi-million pound initiative, described as a catalyst for economic change, to spearhead the transformation of the Welsh economy.

The institution, which has a long-standing record of excellence in engineering, electronics and computer science, is a major partner in the innovative technium concept, a still developing, rolling programme of hi-tech centres that will provide a hothouse environment to enable new, young, innovative companies to thrive and expand and act as a magnet for attracting high value satellite research and development operations from international blue chip companies.

In the short term, six new technium centres will be set up at a total project cost of £49million. The original Swansea Technium, built alongside

the city's docks with the university's support, was over-subscribed before it opened. Now it is to be followed by the roll-out of the technium concept throughout Wales.

"Our university is a research-led institution and has a huge role to play in providing the technical and research expertise needed to support hi-tech businesses seeking to develop their potential in South West Wales," explained Vice Chancellor Professor Robin Williams. "The research, the trained people and the support staff, taken together, can act as a catalyst for the economic regeneration of the region".



Hothouse... The Technium Centre at Swansea

The right note

In October 2001 the University of Glamorgan Business School started the £5million Enterprise College Wales, Europe's largest online learning project, with 200 students in the initial intake.

Vice-Chancellor Sir Adrian Webb said: "We are receiving enquiries from across Europe and the Far East. It could become a great educational export for Wales."

In addition, the university's graduate teleworking initiative - in which £650,000 has been invested - has helped 20 businesses get underway including Perfect Pitch Music, a music teaching supply company started by young entrepreneur Erica Rowland.



In harmony... Perfect Pitch Music (left), facilitated by the graduate teleworking initiative

Top of the league table?

The UK stands in second place behind the US in most league tables that summarise the quest for the commercialisation of university research in absolute numbers, although Israel has more spinouts per capita than the US. But this position tends to hide the fact that the research undertaken by many UK spinouts is of the highest quality.

Indeed, it is an extraordinary fact that Scottish universities now own more intellectual property than Scottish industry, and Scotland is thought to be unique worldwide in this respect.

Mr Ajay Vohara, of Nottingham University Business School, said: "The US is better at building billion dollar companies but the UK is very good at the early research stages of small company development."

Sheffield University alone intends to create 80 firms in the next three years.

In December 2001 the UK's Higher Education Interaction Survey found that in 1999-2000 UK universities identified one spin-off company for every \$8.6million of research expenditure, whereas Canadian Universities achieved the same for \$13.9million, and the US for \$53.1million.

Lord Sainsbury commented: "These figures seem to confound the received wisdom that UK Higher Education Institutions are much less entrepreneurial than their North American counterparts."

In the US almost three-quarters of patents registered by US firms cited scientific papers relating to research carried out by universities.

However, the rate of spin-off formation, according to the Paris-based Organisation for Economic Co-operation and Development's report published in March, 'Benchmarking Industry-Science Relationships', is about three or four times higher in North America than in other OECD countries.

Elsewhere in the world British universities stand head and shoulders above their national rivals in their passion for commercial exploitation.

Japanese universities hold a negligible share of the total patents in Japan - less than 0.1% compared to about 3% for US universities, while universities in the Irish Republic have produced several outstanding spinout companies, including Ntera, a group involved in developing ultra-thin PC screens using

nanotechnology, from University College Dublin. According to research by Nottingham University Business School, Finland and Australia have also launched active start-up schemes at many universities. The Netherlands has a high start-up rate, but many of these have been launched by students and possess little 'real science' intellectual property.

In Germany, patenting by universities is prolific and represented around 4 per cent of total national applications in the mid-1990s.

In 2002 a new law will shift the title of the invention from the professor or academic inventor to the university, and make provisions for the equal sharing of royalties between the university, the inventor and the commercialisation unit.

In Australia, the largest public research organisation, CSIRO, which produces many spinouts, lags behind the US research universities in total numbers, but performs better in terms of royalty revenues.

There is no doubt, however, that the recent expansion in the number of spinout companies started in the UK will increase even further the sizeable gap with our international rivals.

Leadership in the most unlikely technologies

Absorbing interest... Donald Eagland (right), joint developer of Bradford's unique hydrogel (far right)



Ground-breaking science is by no means the sole province of the UK's ancient universities.

At Bradford University, a company specialising in patented supercritical fluid technology for controlled particle formation was formed in 1994 by Professor Peter York, Dr Mazen Hanna and Dr Gwyn Humphreys at the university's School of Pharmacy.

The firm, Bradford Particle Design, was sold to the US pharmaceutical company Inhale in January 2001 for £200million.

Since then, the company has maintained its status as a world leader in the methodology of how particles can be turned into medicines, and it now employs 40 staff at the Listerhills Science Park, adjacent to the Bradford University campus.

A second Bradford spinout, Advanced Gel Technology, has cleverly formulated a water-based gel capable of absorbing almost any liquid, and is even capable of supporting living cells and bacteria. Sealing the cracks in oil wells is just one current application being pursued.

Go with the flow... Fluid technology specialists (left to right) Professor Peter York, Dr Mazen Hanna and Dr Gwyn Humphreys of the School of Pharmacy



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