DtF

Developing the Future

2007

A report on the challenges and opportunities facing the UK software development industry

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Imagine it is 2015 and the trends outlined in this report have come to fruition.

The City of London will have overtaken New York as the world's financial hub, also rivalling Silicon Valley in the number of internet-based start-ups being launched. The revolution in information technology will have transformed the world of entertainment. London's Soho will have the biggest movie digital effects industry outside Hollywood and the convergence of television and the internet will bring about a renaissance in visual entertainment. The UK will lead the world in the production of video games.

"I HOPE THAT THIS DOCUMENT WILL NOT ONLY SPARK DEBATE BUT ALSO IGNITE ACTION TO ENSURE THAT THE UK TAKES FULL ADVANTAGE OF THE FANTASTIC OPPORTUNITIES THAT ARE NOW IN OUR GRASP."

But the boom will not be confined to London or even to clusters of excellence such as Cambridge or Scotland's Silicon Glen. The industrial wastelands of the north will now be transformed by the information industries as the phenomenon described in this report as 'knowledge services' sweeps across the whole of Britain. Well over half the UK's gross domestic product (GDP) will be accounted for by knowledge services, a category which includes financial services, creative services and IT.

The process of off-shoring will have also breathed new life into the regions. Globalisation has long since migrated the old manufacturing industries abroad. But the second wave of off-shoring will involve locating routine back office functions to developing countries such as India and China, enabling UK companies to concentrate on the research and development needed to bring world-beating new products and services to market first. Cities like Liverpool and Newcastle will win international reputations as a result of their thriving multimedia industries.

In order to attract the cream of the IT graduates starting to stream out of Britain's universities, these regional cities will be working overtime to improve their quality of life. This is proving to be even more important than ever before as technology will enable professionals to work from wherever they wish.

In the summer, many people will prefer to work from home, running their global office from a laptop on the garden table.

But for those who do make the journey into work, the surroundings will be need to be equally convivial. Anxious to attract the best minds and give them the most productive environments in which to collaborate with one another, companies will increasingly occupy Silicon Valley style campus locations. Abandoned or run-down industrial estates on the edges of provincial cities will rapidly be transformed into green landscaped Californian-style campuses.

If the trends highlighted in this, the second edition of the Developing the Future report, are allowed to blossom, then this attractive vision of the Britain of tomorrow can then be the new reality. But what needs to be done to make this change?

This report outlines the challenges that lie ahead if Britain is to make this happen.

Chief amongst these is ensuring that the UK's skills match the speed of technological change now taking place. The supply of IT graduates must increase to reflect the UK's shift to a Knowledge Economy. Schools must also ensure that crucial computing skills are made available to all at GCSE level as well as at A-level and beyond. Industry must also work in concert with academia and government to ensure that UK citizens can constantly refresh their skills throughout their working lives.

The second edition of Developing the Future not only comprises original research commissioned by Microsoft on these fascinating themes, it also includes independent articles from luminaries such as Will Hutton, outlining unique perspectives on the massive change now taking place in Britain.

I hope that this document will not only spark debate but also ignite action to ensure that the UK takes full advantage of the fantastic opportunities that are now in our grasp.

Microsoft®

DR ANDREW TUSON

CITY UNIVERSITY, LONDON

London is at the hub of the UK's Knowledge Economy, key to our prosperity. Such activity is by its very nature IT-intensive. IT professionals are not only engaging in developing the underlying technology, but in using it to make UK businesses more effective in a globally competitive marketplace.

Underpinning this is the talent of the UK's IT professionals. This is an important challenge for the UK. IT professionals are at the forefront of change and are charged not only with understanding the technology but also the business environment as the IT industry moves from being a provider of technical services to a provider of business services; the demands on them have never been greater.

This has implications for Higher Education. The drop in applications to computing degrees is of concern. The changing nature of the industry requires us to look hard at what we are teaching at schools and universities, and how. We need to work with our stakeholders to provide graduates with the qualities to succeed, both for themselves and for society. We also need to produce the high-quality research that underpins innovation.

The rewards for getting this right are great: greater prosperity for all, a dynamic, inclusive IT profession that offers real challenge and job satisfaction, interesting and stimulating school and university curricula, and a university sector that can provide world-class research and education in computing.

MIKE RODD

THE BRITISH COMPUTER SOCIETY

This second DtF report has moved our understanding forward on the challenges and opportunities we collectively face. The UK is well positioned, but there are changes to the global economic environment that demand adaptation. Globalisation in IT is not the death-knell that received wisdom portrays. In fact, the potential global opportunities that are open to us are tremendous. However that does not mean success is assured, or that the road will be easy.

For business, the challenge is two-fold. Firstly, to take advantage of new models for IT services and software, making knowledge services an integral part of their overall strategy and mission. The second challenge is to help staff transition as job roles change by supporting continued education and skills development. For that to take place, our industry needs to collectively lift its eyes from short-term problems and act together for the long term.

For government, the challenge is to create the right frameworks for an agile workforce. Without structures and support in place, businesses will simply be unable to make these transitions; they will be left without the right skills, and our citizens will be adrift in the international job market. This will require real delivery on the promise of lifelong learning and support, and at this point the route to that delivery is uncertain. There is much to be done!

There are also challenges in education. There is a misunderstanding at all levels about the difference between ICT user skills and the discipline of computing that fuels the Knowledge Economy. We fear this misunderstanding is turning off students and teachers, and may be behind some of the educational pipeline problems. Students need to be inspired and informed of the opportunities and excitement that a career in computing offers, and yet collectively we have convinced them neither exists.

Fundamentally, the issue is the pace of change. Today's 16 year-olds were born at the same time as the web. They are the first generation of natives in our digital, web-enabled world. Providing a competitive education for them and those that follow will require us to adapt quickly to this new environment. This report sheds light on how we can make that transition, and confirms that the benefits are there for us to reap if we succeed.

TOM WILLS-SANDFORD

INTELLECT

Intellect is pleased to contribute to the second edition of Developing the Future, a report we hope will stimulate the debate and action needed to drive innovation in the UK.

There is currently a trans-Atlantic innovation divide. The UK does not spawn start-ups and fast-growth new companies in the same way as Silicon Valley solely because of a difference in business philosophy, as is often supposed. It is as much to do with public sector attitudes to encouraging growth and innovation. In the US, for example, a large part of public procurement expenditure is ring-fenced for small and medium sized enterprises (SMEs). In the US, 23% of prime federal government contracts and 40% of subcontracts must go to SMEs. It has been estimated that if the UK Government were to adopt a similar strategy, it would inject almost £8 billion into British SMEs. This could be combined with research and development tax credits to encourage SMEs to develop innovative new products and services.

Were the UK Government to support British innovation in this way, it is not only the SMEs which would benefit. The public sector would also find itself repaid with the kind of solutions needed to support a 21st century democracy.

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Introduction:

DEVELOPING THE FUTURE 2007

This is the second report in the 'Developing the Future' (DtF 2007) series commissioned by Microsoft® that researches the UK software development sector in the UK. The report reveals that the UK economy is fast approaching a point where the Knowledge Economy will contribute 50% of UK Gross Domestic Product (GDP). The report also reveals that the software sector is the most significant contributor to growth and prosperity for the creative industries and shows the greatest contribution to the UK National Accounts for the creative sectors.

There are several key recommendations within DtF 2007 that must be acted on now to address the widening skills gap (breadth and depth of skills), stimulate excitement and interest in ICT/computing education from age 11 and actively support innovation and growth within the SME software development sector.

KEY FINDINGS FROM DEVELOPING THE FUTURE 2007:

1. The UK economy is fast approaching a point where the Knowledge Economy will soon contribute 50% of UK Gross Domestic Product (GDP).

The 'Knowledge Economy' includes sectors such as financial services, IT, business services and creative services and today employs 41% of all workers by occupational classification and 40% of GDP by industry classification – expected to rise to 50% by 2010. The fastest growing component of the UK economy, it is predicted to have a 40% graduate workforce by 2020.

This report also reveals that the software sector is the most significant contributor to the growth and prosperity for the creative industries, and shows the greatest contribution to the UK National Accounts for the creative sectors.

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2. London's growing role as an innovation hub and the emergence of new global markets will drive economic growth in the UK.

With its unique overlap of financial services, technology, media, venture capital, and government interests, London is rapidly becoming a global hub for a new class of entrepreneur as well as being an international capital for creative industries such as digital effects for the film industry and video games.

The emergence of rapidly expanding economies in developing countries such as China and India are simultaneously creating new business opportunities for UK-based enterprises.

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3. Private sector investment of £127 billion a year on intangible assets now equals that in tangible assets.

According to the most recent available figures, investment from the private sector in intangibles, such as software, research and development and brand value, is approximately £127 billion. Comparing the USA with the UK, recent expenditure on intangibles is 11% of UK GDP versus 13% of US GDP. This contribution is about the same contribution that investment in tangible assets has on GDP.

The importance of this to the IT sector is significant. Of the £127 billion, 15% is spent on software (£19 billion); 10% on scientific R&D (£12.7 billion) and 20% (£25.4 billion) on non-scientific R&D.

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4. IT industry faces potential skills shortage.

In 2005/6 the number of graduates from IT related degrees that chose to enter careers in the IT professions was only 30%. This is set against the UK IT workforce averaging 156,000 – 179,000 per annum that covers both new jobs created from growth and replacement demand. Put another way, 70% of IT graduates chose or found alternative activities or jobs outside of the IT profession in 2005/6, with 10.1% going on to study for higher degrees or other qualifications, 10.3% are unemployed, 4.3% are engaged in other activities and 3.8% are not available for employment, study or training. Of those finding employment 6 months after graduation a proportion may be classified as IT workers within other industry sectors based on the current government careers taxonomy and some may be in interim jobs.

The question facing the UK is whether there will be enough people working in the primary IT sector to develop the tools, applications and technologies that will be needed in other sectors that are heavily IT dependent such as financial services.

Despite numerous industry initiatives, currently only around 20% of the UK's IT workforce is female. If it is to fill its skills gap, the IT industry needs to recruit from the entire talent, not merely the masculine half. Currently, only 17% of those undertaking IT-related courses are women.

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5. There is growing pressure on the UK Government to reform the National Curriculum to allow students to study computing at GCSE level.

There is a call from several bodies (including academia) for the Government to begin to reform the National Curriculum in a way that will provide an opportunity for students to study computing at GCSE in an innovative and exciting way. This is coupled with a call from many agencies including e-skills to put excitement for Computing and science back into the curriculum. GCSE ICT is not currently about providing the specific skills for Computing but offers a means by which students gain skills in computer and software use.

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6. There is a loud clear call for the UK Government to develop appropriate Intellectual Property Rights (IPR) for the 'digital age' to support innovation.

By adopting the pragmatic recommendations from the Gowers Review, the Government has an opportunity to stimulate the growth in the information and communication technology (ICT) sector that is now required to support UK's future wealth and prosperity.

There is also a specific call for the UK Government to examine how it might emulate the USA small-to-medium sized enterprise (SME) development strategy that earmarks 25% of public expenditure for innovation and growth in the SME sector. Growth in wealth and prosperity will come from growth in the SME sector.

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globalisation

Why Globalisation is Good For Us

BY WILL HUTTON AND IAN BRINKLEY

There is a growing perception that the process of globalisation in general, and the practice of off-shoring in particular, represent a massive threat not only to jobs in the UK but also to the British economy as a whole.

It is not only manufacturing jobs that are now disappearing to China, the argument goes, but increasingly also white-collar jobs in innovative sectors such as technological research and development. The prophets of doom say that unless the tide of off-shoring can be somehow stopped, Britain will soon be overtaken by the developing economies of Asia and the Far East.

This widely-held view could not be more wrong. Globalisation offers Britain its best chance of sustained economic growth since the start of the industrial revolution over 200 years ago. The practice of off-shoring and the rapid growth of developing economies such as India and China will help drive this growth.

Underpinning Britain's future success is its leadership in what have come to be broadly referred to as 'knowledge services'. These include financial services, IT, business services and creative and cultural services. In these rapidly growing markets, Britain is the undisputed European leader. The Eurostat European Union International Trade in Services 2006 edition reports that Britain is currently the biggest European exporter of services, providing over 25% of the total, easily outstripping its closest rival, Germany. Knowledge-based services increasingly underpin the domestic UK economy, currently accounting for 40% of Britain's GDP.

According to the Office for National Statistics, the past decade has also seen a massive boom in the UK exports of services associated with the Knowledge Economy: financial services, computing services, business services, royalties and licence fees. In the ten years to 2005, exports of these services grew by over 100% compared with just over 50% for more traditional services such as transport and travel.

The critics of globalisation say that Britain has paid a heavy price for this growth with jobs disappearing to the Far East as companies strive to cut costs by reducing wages. The evidence does not bear this out.

Far from globalisation being a threat to the UK, it is its saviour. Globalisation is the chief reason why the UK is not in the throes of a balance of payments crisis. Globalisation can also take much of the credit for the fact that unemployment is at its lowest level for anytime since the 1970s and that Britain is not seeing the kind of inflation that caused the crash at the end of the 1980s.

It is also widely but inaccurately argued that the flip side of the globalisation coin is the way in which the developed countries are now being flooded by cheap goods from emerging economies such as China. But it is difficult to see how Britain has been disadvantaged by having its competitiveness bolstered by globalisation.

In the bad old days before the global markets of the 21st century, British firms faced with rising salaries would simply raise the price of their products, resulting in the inevitable inflationary spiral. In the current era, competition from overseas manufacturers makes it impossible for UK companies to raise prices arbitrarily. Even the huge rise in energy costs has done little to increase prices in the era of globalisation.

In any case, there is little foundation to claims that the UK is being flooded with cheap imports from China and that this is resulting in low wages and unemployment. The big exporters to the UK by a considerable margin are Germany and Japan. China accounts for roughly the same level of exports into the UK as Belgium and there is no cry that Britain is being flooded with imports from Belgium.

But there is now a growing danger that the blizzard of negative press surrounding globalisation could blind Britain to the incredible opportunity now facing it. The UK is in a strong position to become a world leader in knowledge services. Today's global economy has already created a robust international market in sectors such as IT and financial services. But the scale of today's knowledge-based industries is likely to be dwarfed by their future growth.

According to the World Bank, the growth of the world's middle class, the market for knowledge services, will become exponential over the next two decades. In its report, Global Economic Prospects, the World Bank has forecast the emergence of what it terms a global middle class within the developing world that will number around 1.2 billion by 2030. The World Bank believes that this rapidly growing group will participate actively in the global marketplace, demand world-class products and aspire to international standards of education.

This development of a worldwide middle class will provide a ready market for the knowledge-based products and services now being developed in the UK. For example, the UK now has the biggest video games industry in the world. Video games conceived and developed in the UK are played on consoles and computers everywhere from Beijing to Birmingham, Alabama.

As the 21st Century progresses, the growth of overseas markets in countries like India and China will provide massive growth for sectors such as the video games industry. The off-shoring of key skills in IT and financial services will only drive the growth of the new middle class in these rapidly developing regions.

The real danger is not that China will overtake the West, as many doom merchants warn, but that it will lag too far behind. Without a sustained influx of Western skills, China could start to retreat away from its increasingly democratic business model and revert to its more traditional and totalitarian state. Over $800 million has already been spent on screening the internet and blocking websites that include the word 'democracy'.

Another potential brake on the rapid acceleration of Britain's knowledge management services could be a skills shortage. The UK already has to import many of its IT workers and this situation is likely to worsen as the population continues to age. In developed countries like the US, around 40% of PhDs in the US are awarded to people from outside the US, as companies are finding it harder and harder to recruit from their own country. As other markets develop, it is likely that many of these bright people will either return to their own rapidly developing economies or never leave them in the first place.

But, in the medium term, it is likely that bright young professionals with the appropriate skills will continue to be drawn to clusters of excellence such as the City of London or Cambridge and that Britain will increase its leadership in knowledge services. The real test may be if the UK can accomplish this transformation without the kind of social disruption that accompanies the industrial revolution.

The other side of the skills coin is the question of how to handle people who find their skills becoming redundant in the switch from traditional manufacturing to knowledge services. This time around, it is the factory workers who rapidly shed their value in the labour market of the 21st Century. For example, after Rover closed it was found that many of the people who had been employed in the factory were unable to find new employment at anything like their former salary levels.

If the UK is to meet the challenge of globalisation fully, it must ensure that the workforce is helped to re-equip itself with the IT and communications skills needed to make the transition from 20th Century factory hands to 21st Century knowledge workers.

Will Hutton is the former editor of *The Observer* and author of *The Writing on The Wall*. Ian Brinkley is Knowledge Economy Programme Director at the Work Foundation.

Meeting the Challenge: Professional Education and the HE Perspective

BY PROFESSOR DAVID BOLTON,
DEAN, SCHOOL OF INFORMATICS, THE CITY UNIVERSITY

Computing in Higher Education (HE) plays a key role in the IT industry, both in workforce education and in providing an underpinning science base. The changes in the IT industry described in Developing the Future come at a time when HE in the UK faces its own challenges. This is fuelling a healthy debate about the extent to which market forces should determine the nature of computing HE provision in the UK.

Universities are competing in a global education and research market and recognise that gaining funds from additional sources is essential. Government policy is moving firmly to a skills and knowledge exploitation agenda (e.g. the Lambert and Leitch reports) at a time when other pressures such as the Research Assessment Exercise have to be addressed.

Furthermore, funding changes three years ago from the Higher Education Funding Council in England resulted in computing being assigned to a lower price group, lowering per-student funding, and increasing the squeeze on already hard-pressed university computing departments. With economies of scale favouring fewer, larger departments, and a falling computing undergraduate intake nationwide, the end result has been downsizing or closure for some departments.

In contrast, the City University's School of Informatics has risen to these challenges. The numbers and quality of the computing undergraduate intake has been retained since 2001 and postgraduate numbers have risen by over one-third in just two years. Research productivity and funding have also increased strongly. A focus on dependable socio-technical systems and active links with industry underpin a vibrant research culture, enabling research-led teaching.

We believe that fundamental to our success is the way in which we view and engage with IT as a profession, aligning ourselves with the University's mission to provide rigorous research and education for the world of work.

We have forged strong IT industry links over the past 20 years, enabling us to deliver integrated in-depth placement experience and in-demand professional skills to both undergraduate and masters students, making them highly employable. Moreover, this focus is central to the marketing of the courses, positioning us as a professionally-led University and securing high quality students attracted by courses which reflect their career aspirations.

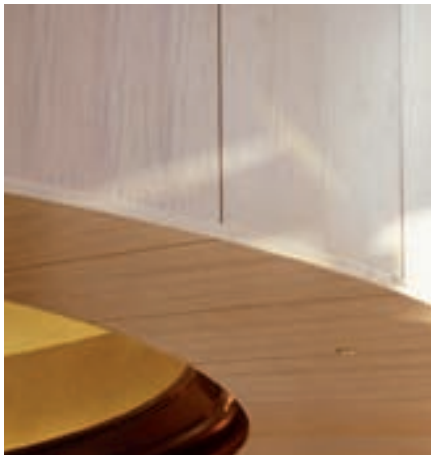
Our experience points to the need for HE computing departments to engage more closely with the demands of the IT profession if they wish to flourish. We are moving to a post-disciplinary world where traditional knowledge boundaries are being supplanted by a career and industry-led HE market, and where teaching and research become ever more linked to the needs of external stakeholders.

In short, we are seeing a reinvention of professional identity that will transform computing in HE. Long term, the most effective outcomes will be delivered by engagement in a two-way process. While HE must develop a more professional focus, the IT profession and industry also need to work in partnership with HE to develop a better understanding of their roles. The British Computer Society as well as other national professional and industry organisations will play an increasingly important part in this process.

"Our experience points to the need for HE computing departments to engage more closely with the demands of the IT profession if they wish to flourish."

PROFESSOR DAVID BOLTON,
DEAN, SCHOOL OF INFORMATICS,
THE CITY UNIVERSITY

Globalisation



THE CREATION OF OPPORTUNITY

For many, globalisation means 'off-shoring' and the threat of large numbers of jobs moving overseas. Although this is the view implicit in many newspaper headlines about jobs leaving Britain never to return, the reality is far more complex.

The economic benefits of globalisation may be felt in different ways across society. Some economists state: "In the rich world, labour's share of GDP has fallen to historic lows, while profits are soaring."[1]

The issue of protectionism is not just talked about in the UK, The German Marshall Fund found last year that, although most people still say they favour trade, more than half of Americans want to protect companies from foreign competition even if that slows growth.[1]

But protectionist policies could potentially jeopardise the benefits of off-shoring.[2] In the absence of real data about the long-term effects of off-shoring and outsourcing, the negative public perception is partly a reaction to the perceived threat of globalisation rather than a considered rational response. The danger is that the perception is seen as the reality, and policies are developed on the basis of received wisdom and not hard evidence.

Research has shown that in reality, the process of global economic integration, of which off-shore outsourcing is a highly visible component, diffuses the best business ideas and management tools, intensifies competition, and sparks innovation. It therefore ultimately leads to lower prices and higher wages as well as bigger profits that companies can reinvest in new business opportunities.[2] This is explored further in the section on Innovation within this report.

THE IMPACT OF OFF-SHORING

Little research has been carried out to date regarding the productivity benefits of off-shoring, and this seems surprising given how great a perceived impact the phenomenon of off-shoring is as a threat to jobs and opportunities in this country.

There is also currently no accurate and objective measure of the impact of off-shoring on jobs in the UK or the extent to which this affects IT and software employment. The UK Government does not monitor what is happening and has no up-to-date evidence. At the very least, there is a need for the Government and the Department of Trade and Industry (DTI) to monitor the impact of off-shoring on employment and the economy. With accurate indicators it might be simpler to plan meaningful policies and strategies for the future.

In order to try and gain some insight as to the potential for off-shoring and the possible implications on labour markets, we have looked at research begun in 2005. This is a contentious area and one which generates considerable anxiety and disagreement. The available research analyses the potential availability of off-shore talent in 28 low-wage nations and the likely demand for it in service jobs across eight of the developed world's sectors; automotive, financial services, healthcare, insurance, IT services, packaged software, pharmaceuticals and retailing.[3]

This analysis offers two conclusions:

- Off-shoring will probably continue to create a relatively small global labour market without sudden discontinuities in overall levels of employment and wages in developed countries.
- Demand for off-shore labour by companies in the developed world will increasingly push up wage rates for some occupations in countries with developing economies, but not as high as current wage levels for those occupations in developed ones.

1 The Economist (January 20th 2007)
2 McKinsey Governing Globalisation Diana Farrell 2004 Number 3
3 McKinsey Sizing The Emerging Global Labor Market Diana Farrell, Martha A. Laboissière and Jaeson Rosenfeld

These conclusions suggest that the threat of loss of jobs and lower wages due to off-shoring in developed countries may not, over the longer term, be as catastrophic as currently perceived.

This is an area which is continually evolving and requires further accurate monitoring. Without accurate information, the 'perceived' threat or 'fear factor' has the potential to drive the development of protectionist policies which could ultimately damage the competitiveness of the economy. This makes it vital that up-to-date data is collected and analysed so that informed policies can be developed.

WHAT ARE THE REAL IMPLICATIONS OF OFF-SHORING?

The research that has been undertaken suggests that the productivity benefits of off-shoring are most evident in the service sector.[4]

But it is difficult to paint a true and accurate picture within any given industry as productivity gains from off-shoring are not fully recorded across industry sectors. This makes press stories of the impact of off-shoring more stressful for employees than they would be if a more realistic picture were available.

According to the Organisation for Economic Co-Operation and Development (OECD), information and communications technology (ICT) industry growth is forecast to increase[5] and the technically more complex tasks such as design and testing and research and development (R&D) are increasingly being shifted to China. But most Chinese ICT firms are small compared to their US and EU competitors.

RESEARCH, SKILLS AND TECHNOLOGY INVESTMENT – INNOVATION DRIVES COMPETITIVE ADVANTAGE

Today, off-shoring is occurring primarily to reduce costs and to boost productivity. But how will it develop in the future?

Automation and innovation are driving growth, with technology taking over more responsibility for undemanding human tasks. Off-shoring mundane work is just a transitional step to reduce the cost base when a business process moves from innovative to mainstream before becoming automated. With Moore's Law (the observation that the power of computers doubles every 18-24 months) delivering increasing computer power, computers are taking more and more routine functions, as well as many advanced knowledge functions from people. Therefore, the place to invest is in the creation of new tools and technologies that fuel this process.

There is an argument that organisations going overseas and off-shoring many of their services including software development, see an initial productivity gain. But as other firms within the industry which off-shore accrue the same gains, the original competitive advantage inevitably reduces. The pressure is then on to find the next competitive advantage so more firms will look to innovation, either in product or business processes. Demand to innovate will therefore be firmly at the forefront of most firms' agendas. The Government commissioned Cox Review[6] published in 2005 looks at the threat posed by emerging economies and highlights the need for innovation and creativity in developing UK industry so that we remain competitive in the face of growing overseas competition.

Automation and innovation are driving growth, with technology taking over more responsibility for undemanding human tasks. Off-shoring mundane work is just a transitional step to reduce the cost base when a business process moves from innovative to mainstream before becoming automated.

4 Olsen, K. B. (2006), "Productivity Impacts of Off-shoring and Outsourcing: A Review", OECD Science, Technology and Industry Working Papers, 2006/1, OECD Publishing

5 OECD – article – ICT Industry growth set to increase by 6% in 2006 can be found at http://www.oecd.org/document/34/0,2340,en_2649_33723_37487522_1_1_1_1,00.html

6 Cox Review of Creativity in Business: building on the UK's strengths, 2005 can be found at http://www.hm-treasury.gov.uk/independent_reviews/cox_review/coxreview_index.cfm

The emerging economies' investment in new technology-based industries is already resulting in impressive capabilities in scientific research and they are investing massively in education, technical skills and creative capabilities. As a consequence, it is now the high-skilled jobs in the hitherto leading economies that are coming under threat.[6]

The OECD says: "What is impressive, and worrying about the emerging economies is not where they stand today but how they are positioning themselves for the future."[6]

In the early 1990s, companies in North America and Europe started commissioning software from Indian sources, mainly for routine applications, on the grounds of cost. Today, it is for advanced applications on the grounds of capability. In the first half of 2005, Indian exports of software and IT-related services are estimated to be worth over $5.5 billion.[6]

But the rapid growth of China as an off-shoring rival to India has led the Chinese to conclude that, as its economy grows, the cost advantage it currently has will go to the next emergent economy. It therefore needs to develop new skills and services. Over the last two years, it is China which has had the fastest global rate of increase in R&D, now estimated to have reached 1.5% of GDP. As a result of this, the capability that is being built-up is one of high investment, high-level skills and a low cost base.[6]

Initial analysis shows that it is currently more difficult for smaller small-to-medium sized enterprises (SMEs) to take advantage of cost reduction strategies from globalisation than it is for larger companies. Larger businesses have established operational centres in emerging economies such as Asia, lowering the cost of production of goods and services. But this may begin to change as more SMEs become aware of how off-shoring can improve their speed to market (see Sally Ernst's article on page 19).

The growth of the Knowledge Economy and the efficient deployment of off-shoring is dependent upon the success of the IT and software development industries within this country.[7] Much of the future prosperity of the UK therefore depends upon the health and growth of the IT sector.

THE SOCIAL IMPLICATIONS OF OFF-SHORING

Although many organisations are continuing to experience huge financial gains from their current off-shoring policies, there are concerns over its wider social impact.

A recent speech given by Joseph Stiglitz, Professor at Columbia University, New York and winner of the Nobel Prize for Economics, highlights both the difficulties and opportunities of globalisation.

Stiglitz recognises that globalisation offers tremendous financial rewards that benefit the overall economy. But if we do not manage the negative impacts of globalisation then we could see a backlash. What we are seeing at present, he believes, are reduced wages for unskilled workers in the developed countries which exacerbate the trends which already exist from the changes in technology and computerisation of many unskilled jobs.

"In the North, global competition has helped drive down wages of unskilled workers, exacerbating similar trends coming from changes in technology and the weakening of labour unions."[8]

He believes what we are actually seeing is that globalisation is in some cases being used as an excuse to take away social protections for individuals.

"When last spring, young workers in France went on protest concerning their low wages and weakening job protections they were told globalisation demands it."[8]

"What is impressive, and worrying about the emerging economies is not where they stand today but how they are positioning themselves for the future."

OECD

6 Cox Review of Creativity in Business: building on the UK strengths Nov 2005

7 Interim report on the 2007 green paper on the creative and Knowledge Economy

8 Making Globalisation Work – J Stiglitz. The Times Feb 18 2007

RECOMMENDATIONS

- Increased investment in skills, education and knowledge by the Government and employers is vital over the long term. A highly skilled workforce is essential for the Knowledge Economy and all employees need to have access to opportunities and incentives to develop their skills.
- Actions: UK Government should put in place some robust incentives for implementation of the skills agenda[7] with particular emphasis on SMEs. An action-oriented pilot with the DTI and others that would determine a best practice model for incentives for up-skill/cross-skill development within this sector is crucial; this should be considered firstly as a consultative report and secondly as a plan for policy change should the research point to the need for change in policy direction.
- Actions: for academia and industry facilitated by Government to provide a debate and working paper on skills development and industry liaison where UK Higher Education Institutes (HEI) can begin to meet the needs for short/medium term education objectives for industry.
- IT and technological skills are required across the whole economy. All industry sectors, not just the IT industry in isolation, need to collaborate to ensure that the transferable skills required are developed within our education system.
  Actions: for academia and industry facilitated by Government to provide a debate and working paper on skills development and industry liaison where UK HEIs can begin to meet the needs for short/medium term education objectives for industry.
- We need to understand the 'social' and 'cultural' requirements of society in order to understand how to motivate individuals to continue to learn and develop new skills.
  Action: for a key company in the UK IT sector to analyse and report on initiatives that have (and could) be developed to support an integrated skills agenda framework across all sub-sectors. The report could then be used to help inform policy or Government decision making that could further provide incentives for a collaborative approach to ensuring that CPD/life-long learning becomes the responsibility of the citizen but with full support and guidance from Government and industry supported wholly by UK HEIs.
- Communicating the benefits of learning and education is vital to changing behaviours and creating the will of individuals to commit to their own personal development.
  Action: from UK Government and industry consortium to provide a communications programme to drive incremental changes in behaviour.

- Strategies and policies to foster growth and economic development can only be based on accurate data. It is a priority to understand the real drivers for off-shoring and the potential gains both to corporations and to society.
  Action: for Government agencies, academia and industry to initiate research that will provide the initial scorecard and statistics for the economic drivers behind globalisation strategies adopted by business.
- It is also important to monitor the investment and development strategies of other countries, in order to understand how they benefit and to forecast how they may affect our economic performance and ability to compete in the future.
  Action: for industry and Government agencies to collaborate on an analysis of strategies and outcomes from modern globalisation initiatives to provide a mechanism to begin to forecast the impact on UK economic performance.

7 Interim report on the 2007 green paper on the creative and Knowledge Economy

The challenges facing the IT sector will affect the UK economy substantially, and this makes it vital that those challenges are understood and addressed effectively as the success of the IT sector affects the entire country.

SUMMARY

Contrary to press reports that off-shoring is creating unemployment in the UK, it is enabling UK companies to grow and take on more staff.

At the same time, globalisation means that low-wage economies are benefiting from companies in developed economies such as the UK and the US off-shoring back-office operations. Globalisation offers companies in the UK the prospect of fantastic financial rewards as markets such as China and India increasingly hunger for goods and services from developed countries.

The fastest growing part of the UK economy is the Knowledge Economy. This is also true for many other countries. Currently, depending upon the definition used, the Knowledge Economy in the UK makes up around 40% of GDP. Its contribution to UK prosperity is essential and profound. It is included here because the growth of the UK Knowledge Economy is underpinned by the software development and IT industries. The challenges facing the IT sector will affect the UK economy substantially, and this makes it vital that those challenges are understood and addressed effectively as the success of the IT sector affects the entire country.

In this section we have examined the hard facts; what it will take to succeed. Skills and education are vital to the Knowledge Economy, and without continual investment in these sectors there are real social dangers, both in terms of social unrest and a polarised society.

Additionally this section examines the areas of investment which have a major impact upon economic growth of the Knowledge Economy. It shows that the UK lags many other nations in terms of its investment in research and development, education and information technology. This is important because there is a high correlation between economic growth and investment in these areas.

Both China and India have invested heavily in these areas and as a result are enjoying considerable growth in their knowledge based economies. Levels of skills are growing in these economies and it is possible, even likely, that they will compete with the UK for research, innovation and highly skilled work. The report suggests that if Britain looks at the investment strategies of these countries it will begin to see how they are positioning themselves for the future. This makes it vital that the UK increases its investment in these areas. Whilst the report acknowledges the need for Government investment, it states that employers also need to recognise that they too should invest in their workforce skills and in research and innovation if they are to continue to prosper.

The UK must remain aware of the social implications of globalisation. The benefits of increased profits and prosperity must be across society, and both the Government and employers must invest in our workforce so they too can ensure they have a future role in the developing economy, otherwise there is huge potential for social unrest and inequality.

Off-shoring is examined both from the point of view of industry but also the individual. There is evidence to suggest that 'ordinary workers' may not be benefiting from global trade. The implications of this are considered. If workers feel threatened and perceive no benefits then there is the possibility of a backlash against global competition, in terms of a call for 'protectionist' policies and a dis-incentive to re-skill and compete, both of which would be harmful for the UK economy.

Off-shoring may give economic benefits currently, but there is a question as to whether they can be sustained over the long term. Therefore UK organisations must look to other ways to maintain their competitive advantage, such as innovation and new developments either in products and services or in business processes and the creative application of new knowledge and skills.[9]

Globalisation may have the benefit of stimulating innovation as the UK seeks to remain competitive.

The report argues that we need to invest and develop strategies to ensure our future competitive role in the global economy. However, it is important, that these are based on accurate information, and not perceived threats and 'headline' stories which do not give the full picture. The data on which we need to plan is not available and the collection and analysis of this needs to be made a priority.

Finally, the report looks at some of the actions, labour policies and investment strategies which would increase our ability to compete and offer possible solutions for many individuals confronted by the threat of the loss of their livelihoods through globalisation.

Globalisation may have the benefit of stimulating innovation as the UK seeks to remain competitive.

9 The Relationship Between Publicly Funded Basic Research And Economic Performance a SPRU Review Ben Martin and Ammon Salter With Diana Hicks, Keith Pavitt, Jacky Senker, Margaret Sharp and Nick von Tunzelmann Science Policy Research Unit University of Sussex Falmer, Brighton BN1 9RF, UK

Innovation and Globalisation

DR JEREMY BEALE, CBI

Traditionally, innovation in the IT services and enterprise software sectors (and much of the packaged software sector too) has been driven by large companies who, with significant purchasing power, have forced the globalisation of the supply side as they themselves have faced increasing international competition across the board. Suppliers have off-shored to develop and maintain competitive advantages based largely on costs. The economic benefits of off-shoring and economies of scale have, however, while accessible by multi-nationals, been less appreciated by and available to SMEs.

While large users have driven the off-shoring agenda, suppliers' competitive advantages of doing so are now tending towards equilibrium as the cost advantages of doing so are becoming eroded over time.

The UK SME segment is therefore vital; it is where margins still exist and where innovation will help ensure competitive advantage. Many large companies engage with SME's in their supply chains, and the application or use of ICT within SMEs are key generators of overall economic growth and employment. SME's are often the fastest growing part of most developed and developing countries, and where significant value-adding occurs. This of course depends upon the type of SME. But smaller companies are often more dynamic than large ones because they're driven by entrepreneurs to whom large corporations can't offer sufficient reward or flexibility. Smaller companies are also often able to connect with local customers better than large corporations – an important attribute in high wealthy economies where personalisation of products and services is important.

Some of the most dynamic SMEs may now even be able to operate on something of a global scale, offering products to niche global customer segments using the internet. But the cost reductions of doing so are generally less important if you're able to provide highly customised or innovative products to high value customers, as markets are less competitive and economies of scale less vital to margin maintenance.

However, barriers currently exist to widespread and deep adoption of IT services by SMEs. First, they are often concerned about having suppliers and their products close at hand and designed according to the requirements of their business operations. Being designed initially for large companies, many applications and systems need to be re-configured for the needs of smaller ones. This can be costly for suppliers, but SMEs are very wary of being sold a technology rather than a solution and are loathe to make investments unless they are vital for business success. To grab the opportunities for economic prosperity, inward investment and continued support is required from suppliers.

Second, the skills required in computing or IT change more rapidly than in other science-based subjects, and this makes it particularly difficult for SMEs to exploit the advantages of technological innovation. This makes professional development and updating skills vitally important to SMEs. Only by collaborative development can we ensure that the sector can access relevant programmes in ways which benefit them.

A new approach to accommodate flexible learning is needed. The acquisition of higher level skills and access to these skills is vital to all sectors of the economy and they can only be developed through the continued collaboration between industry and academia/educational organisations. One way to accelerate innovation is to radically re-think HE/industry engagement and collaboration so that the SME sector can benefit fully from knowledge transfer programmes and access government support and other initiatives. This should be developed in consultation with all business sectors and academia, to promote the formation of HEI and private sector hybrids to develop Continuing Professional Development (CPD)/life-long learning and other professional development and skilling initiatives

Harnessing the innovative potential of SME suppliers is not beyond the reach of large suppliers. Large users are increasingly outsourcing supply to consortia usually led by large prime contractors who augment in-house skills by buying in specialist SME technical competence or niche market customer relationships. The design skills adopted in such consortia can be adopted and refined for more general service migration from large to small users.

"A new approach to accommodate flexible learning is needed. The acquisition of higher level skills and access to these skills is vital to all sectors of the economy…"

DR JEREMY BEALE, CBI

China to Catch Up with UK in Five Years

BY SALLY ERNST, CHIEF EXECUTIVE, SINOCODE

When developed nations first began off-shoring software development to India, the IT industry had a 15-20 year window in which to create rapidly growing, highly competitive companies through right-shoring.

Unfortunately for the laggards, the 15-20 year window has now closed, and many missed the boat. India has developed a powerful rival software industry of its own, competing very effectively with UK firms both on-shore and in its own market.

However, UK technology firms can learn from this experience and find new markets with which to right-shore such as the new off-shore destination of choice, China. The challenge for UK firms today is the acceleration of affordable travel, ease of immigration, free trade agreements, and robust enabling technology. These phenomena have shrunk the window of opportunity for UK firms to realise the benefits of right-shoring their skills base to 3-8 years.

Laggards won't just miss the boat this time around, they'll be dead in the water as the large commodity skills base in developing nations becomes quickly saturated by innovative technology companies who are then empowered through their right-shoring strategy to lock out competitors in local and foreign markets.

"Laggards won't just miss the boat this time around, they'll be dead in the water as the large commodity skills base in developing nations becomes quickly saturated by innovative technology companies who are then empowered through their right-shoring strategy to lock out competitors in local and foreign markets."

SALLY ERNST,
CHIEF EXECUTIVE, SINOCODE

Much of the work that would have, until recently, been off-shored to India is already coming to China. The cost of off-shoring software development to India has been rising by 15-20% a year and has now reached a point where most Indian software development companies now have large hubs in China or plans to develop them. China is growing as a destination of choice, with off-shoring increasing at an annual growth rate of 8% in 2003 to 11% in 2006. By contrast, India as a destination is in decline, falling from 42% to 39%.

All the evidence points to China developing its own national software industry even faster than was the case in India. The Chinese literacy rate is over 90% contrasted with India's, which is less than 65%. China currently has 35 national training schools and aims to train 800,000 software engineers versus India's 600,000. Crucially, China has enforceable intellectual property (IP) protection laws as part of its agreement with the World Trade Organisation (WTO).

The situation is particularly urgent for smaller players which have far slimmer resources than larger organisations. Small and medium sized enterprises (SMEs) do not have the cash to pay teams of London programmers £100 an hour, support non-productive staff or cope with rapid staff turnover.

Developers who ignore the opportunity to off-shore in China not only face higher costs than they need but also risk cutting themselves off from the world's fastest growing and potentially largest market.

innovation

Emerging Trends and Technologies

BY DR. SHIRLEY WILLIAMS, HEAD OF INFORMATION SYSTEMS;
THE UNIVERSITY OF READING

I have just attended a meeting with educational colleagues from around the world (from Hong Kong to Argentina), on an idyllic island. Unfortunately for me, the island was not real; the meeting was in a Multi User Virtual Environment (MUVE). The meeting happened because someone I know, through a Community of Practice, was online at the same time as a colleague and I were trying out a new product. My acquaintance invited us to join him and some others he knew and we were able to learn about the product together.

The experience reflects a number of emerging trends and technologies. It could be classed as informal learning. There was no schedule or agenda; we wanted to learn and so we did. There were examples of what can be called presumption; all of us were producing some of the learning material we used and sharing that provided by others. No one took the role of the teacher. The technologies that supported the experience included: a grid of computers providing the MUVE, our internet connections, the provision of internet voice (VoIP) for telephone conversations, and online text translation between our different languages.

This is just one example of what emerging trends and technologies can offer. There are many other things that are now possible, that were not only five years ago, and there are many more changes to come. From the point of view of the educationalist there are a number of challenges:

- Having an awareness of emerging trends and technologies;
- Ensuring that these new things feature in the syllabus;
- Exploiting new opportunities for developing educational material;
- Recognising the competition between different technologies and trends. For example the conflicts between discussion forums and blogs.

From the point of view of the researcher, there are the obvious challenges of developing the technologies and recognising the trends, but there is also the need to develop: standards, interoperability frameworks, tools for interactions, understanding the semantics, automating processes.

For industry the challenges exist in recognising what to adopt and when; but perhaps the biggest challenge comes with the students:

- Some of the trends and technologies that middle aged academics see as new and exciting are everyday and mundane to the younger students.
- Students (certainly from the UK) are very motivated by marks, and they expect to participate in formal learning; anything less formal can cause them to be worried.
- Some people believe when students graduate they should know everything that they need to know.

NECESSITY IS THE MOTHER OF INNOVATION

INTERVIEW WITH BT'S ANDY GREEN

Sometimes, it is only when a company has its back against the wall that it really starts to innovate. After BT span off its mobile business BT Cellnet, now known as O2, in 2000, it found itself the only former national incumbent telecoms operator in Europe without a mobile arm at a time when mobile phones were seen as the cash cows of telecoms. The former state-owned operator was also struggling under a £30 billion burden of debt.

Sheer necessity forced BT to innovate and to focus on the global potential offered by the internet, particularly the way in which voice calls that were once sent across traditional telephone networks are now being routed via the internet using internet protocol (IP) software.

At a time when many traditional operators were in denial over the price revolution wrought by new internet-based virtual telecoms operators such as Skype and Vonage, BT decided to embrace innovation.

According to Andy Green, BT chief executive of group strategy and operations: "BT was very early to realise that IP would revolutionise the communications industry. We launched the first widely available commercial voice over IP (VoIP) service for business about six years ago. But our IP vision was based on the importance of more than just voice over IP. It's about any media that needs to be in real time – voice, video and data."

BT has also benefited from the fact its head office is based in the City of London at a time when the UK capital is fast becoming the world's leading financial centre. BT now connects nearly 45 of the leading global stock exchanges, including New York, London and Tokyo. As the service continues to grow the UK operator is opening up new markets such as the recent additions of the Mexican Derivatives Exchange and Taiwan Stock Exchange.

The Bard of Whitehall

INTERVIEW WITH MARK O'NEILL, CIO DEPARTMENT FOR CULTURE, MEDIA AND SPORT

On Mark O'Neill's desk sits a copy of the complete works of William Shakespeare. But it is not for reading.

O'Neill keeps the hefty tome handy in order to remind himself and his staff of a frightening bureaucratic statistic. Two years ago, O'Neill's department used to generate the equivalent of the complete works of Shakespeare in terms of paperwork every 1.5 days. Today, it generates the same colossal number of words every 1.5 hours. O'Neill predicts that, at current rates of growth, by next year it will generate the same number of words as Shakespeare every 15 minutes.

This gives his department a deadline of less than 12 months to develop an information management system capable of handling this potentially overwhelming volume of data. But O'Neill wants to do more than merely manage the data, he wants to be able to control it in a way that would allow his department's staff to mine it from wherever they happen to be.

For the last year and a half, O'Neill has been trying to develop an IT project called the Information Management Programme. This would comprise an information management system that will handle the huge volume of data being generated while delivering the IT industry's Holy Grail, commonly referred to as Any3, the ability to deliver any data anywhere anytime. This would enable his department's staff to work flexibly, either from home or anywhere outside the office. O'Neill also believes another pillar of the new system must be ease of use and flexibility, backed up by a robust virtual management scheme.

But so far, O'Neill says that the IT industry has failed to meet his department's requirements: "No part of our plan struck us as being particularly revolutionary. But we went to the marketplace eight months ago and found it a disappointing experience."

"I have been out to the market with well-defined requirements, but have repeatedly been told by IT suppliers that they cannot match our needs," said O'Neill. "I find it incredible that this should be the case at a time when the public sector is moving away from office-based systems towards community-based communications."

O'Neill has little doubt that the IT industry has the technology to deliver the applications the public sector needs but that, for a number of reasons, it is failing large areas of the public sector.

"The technology needed to deliver precisely what we want is doubtless sitting on someone's desk in Silicon Valley but it has not been brought to market," said O'Neill.

He believes that many public bodies are being forced to exist in a world where cutting edge technology is being offered to consumers, but where organisations such as his are in danger of being left behind.

"The technology being provided to private consumers is becoming far more powerful and effective than that offered to organisations such as mine. For example, the internet voice services (VoIP) services offered by Skype or even Tesco are far more powerful than 99% of corporate communications products on the market.

"We live in a rapidly moving agile environment in which innovation in IT is increasingly being driven by entrepreneurship. One of the problems from the public sector viewpoint is that our sheer size as opposed to average small-to-medium sized enterprise (SME) means it can be hard to partner with small agile companies."

But, according to O'Neill, large IT corporations are also failing to deliver as a result of not being attuned to the specialised needs of large public sector clients.

"The industry fails to grasp that an organisation like ours has an absolutely vast customer base which comprises virtually everybody on the planet. We are trying to sell tourism to the UK as a concept," said O'Neill. "That means trying to reach anybody on the globe who might one day consider coming to London."

He added that instead of trying to work with clients such as his department to develop focused solutions to their problems, the IT industry too frequently simply tries to sell them its latest stock products and applications.

"The real challenge for the IT industry is that it has developed a number of bad habits. It is, for instance, the most fashion conscious industry there is. It is even worse than the fashion industry itself. The whole industry tends to focus on selling one specific technology or buzz word at a given time, often to the detriment of both itself and its clients," said O'Neill.

He quotes the example of the way in which the industry furiously peddled solutions to the predicted software problems that would result from the switchover to the year 2000, commonly referred to as Y2K. At the time, the prophets of doom were predicting that old computer programmes failing to account for the switch over to the year 2000 would be responsible for all manner of disasters, including planes literally falling from the sky.

O'Neill says that Y2K was not an isolated aberration but an example of the way the IT industry all too often likes to do business. Rather than building solutions for organisations such as his, it likes to create new technology and then market it in its own time and on its own terms.

According to O'Neill, a term like knowledge management can be used to sell anything from software to tape drives.

O'Neill is concerned that, unless public bodies like his can establish a two-way dialogue with suppliers, there is a real danger that government will become increasingly distanced from a public that is increasingly more technically literate and expects the same from all its service providers, regardless of sector.

"It may not be a big thing at the moment, it is far easier to buy books on Amazon than it is to do your taxes online. But if the rate of change increases, how are we to ensure that people still regard the structure of public service as having value," he said.

He admits that, in an era where teenagers spend much of their leisure time communicating via the internet using social networking and messaging services rich in digital photography and video, public sector communications are in danger of becoming outmoded. But he added that the public sector does have some isolated examples of it trying to drag itself into the 21st Century.

"At last we are starting to move forward, but it is incredibly slow. If things do not change, we will be forced to end up developing our own technology. This is not really a path we want to go down," said O'Neill.

But he acknowledges that the public sector presents a real challenge to the IT industry simply because it inevitably moves far slower than the pace of technological change.

"One major problem for large public sector bodies is that, by the time a feasibility study has been done, the technology under consideration is often obsolete," he said.

But he believes that, if the public and private sectors can work together they will be able to use IT to transform the way government bodies communicate with the public.

"It is not about technology and buzz words but about constructing environments that people want to be part of. That is the fundamental challenge," said O'Neill.

LESSONS LEARNED:

There are several key issues arising from this interview with the chief information officer (CIO) of the Department for Culture, Media and Sport experiences:

- Niche suppliers need access to the latest research in order to service public bodies more effectively.
- Government bodies should alter its approach to IT procurement so that it is more of a partnership rather than merely a project model.
- The IT industry as a whole should start to offer public bodies the same level of innovation currently directed at the consumer market.

Innovation

INTRODUCTION

The process of innovation and creativity is under the spotlight, particularly in the technology industries and the developing Knowledge Economy (KE). As technological changes make new products and services possible, organisations that are able to innovate quickest will gain a commercial advantage if they launch their products effectively into a demanding and technology-hungry world.

Research into innovative and successful organisations shows that there are a number of factors which enable success. Those organisations which offer their products or services in a way that is faster, cheaper and better than their competitors will prosper over those which are slower.

"In today's changing economy, the key to faster, cheaper, and better is to bring the full force of a company's knowledge to bear on the effort. Knowledge – not land, labour and capital – is now the lifeblood of a corporation."[10]

INNOVATION RAPID AMONG SMEs

Innovation in the UK is increasing more rapidly in the small-to-medium sized enterprise (SME) sector than any other. Additionally, we see that the proportion of 'innovation active enterprises' is around 62% (2005), which is an increase of 14% from 2001 data. This includes a 15% rise for enterprises with fewer than 250 employees and an eight percentage point increase to 75% for larger enterprises.

With knowledge services soon accounting for half the UK's gross domestic product (GDP), innovation in IT will drive growth in financial services, technology and telecoms, travel, retailing, creative industries including the media and entertainment. All these sectors increasing rely on internet-based communications and IT to develop new products and services.

The Government has identified that computing/IT/software constitutes the fastest growing section of the UK Creative Economy (CE). Not only is software or computing at the interface of all sections of the CE as the key enabler for growth, in its own right it also constitutes the largest component of the CE. The CE contributes around 7.3% of GDP with a growth rate predicted to raise this to 10%, probably by 2010. The contribution that software and services makes is the largest of all sub-sections of the CE, showing a 2.7% contribution to GDP.

The CE, which overlaps the KE, has around 41% of the UK workforce by occupational classification.[11] Analysis shows that the KE is the fastest growing component of the economy in the United Kingdom and that it is expected to have approximately a 40% graduate workforce by 2020. In practical terms, this means that as we increase productivity, per capita income will increase, which will have an impact on demand. There will be a cultural shift from 'desire to demand' as increased wealth and status place greater pressures for new products and services. In essence, the predicted growth rates will shape the demand for business innovation over the next 20 years and beyond.

10 McKinsey Quarterly Review Creating A Knowledge Culture S Hauschild T Licht and W Stein 2001 No 1

11 Work Foundation & preliminary report for the Green Paper on the Creative Economy/Industries 2007

Although there is still much debate over the exact definition of the Knowledge Economy, we need some measure of how the UK is performing in comparison to overseas competitors. The Work Foundation takes a wide definition as it includes the 'creative' and 'cultural' industries. Using this extended definition of the Knowledge Economy we are able to make cross country comparisons of how important this is to different economies. Using the Organisation for Economic Co-operation and Development (OECD)/ Work Foundation definition and applying it to the UK economy, it shows that about 40% of GDP is accounted for by knowledge-based industries.

Ireland is the most knowledge based economy in the OECD, with these industries accounting for 48% of GDP followed by the US, Germany, and Sweden, with around 43% and 40% of GDP in the UK and France. We see therefore the contribution of knowledge based industries to OECD countries is significant and set to increase. This section provides greater detail into how this is broken down and considers the impact that computing/software and services on the rapidly growing creative economy.

INTANGIBLE ASSETS

Private sector investment of £127 billion a year on intangible assets now equals that in tangible assets.

According to the most recent available figures, investment from the private sector in intangibles, such as software, research and development and brand value, is approximately £127 billion. Comparing the USA with the UK, recent expenditure on intangibles is 11% of UK GDP versus 13% of US GDP. This contribution is about the same contribution that investment in tangible assets has on GDP.

The importance of this to the IT sector is significant. Of the £127 billion, 15% is spent on software (£19 billion); 10% on scientific R&D (£12.7 billion) and 20% (£25.4 billion) on non-scientific R&D.

INTELLECTUAL PROPERTY

Investment in intellectual property (IP) is a core part of software development and protecting this investment is vital to business success.

New initiatives and legal frameworks are evolving which should protect new businesses and stimulate the spread of commercial ventures. The report suggests recommendations that could expand innovation in the SME sector by additions to the current set of Government policies and compares the benefits this would bring with similar initiatives in the USA.

But while having robust IP networks is important, it is essential that IP is underpinned by creative research and development and a true culture of innovation.

CURRENT INNOVATIVE ACTIVITY

Research undertaken by the UK Department of Trade and Industry (DTI)[12] shows the number and type of organisations in the UK which are involved in innovative activity. Data from 2002-04 shows that, 57% of enterprises were classed as being innovation active during this period (see figure 1) and that large enterprises with more than 250 employees were more likely to engage in some sort of innovation activity (72%) than smaller enterprises (57%).

	Size of Enterprise: Employees		
	10-250	**250+**	**All 10+**
Innovation Active	57	72	57
Product Innovator (share with new to market products)	25 (56)	39 (59)	25 (56)
Process Innovator (share with new to industry processes)	15 (30)	31 (31)	16 (30)
Ongoing or abandoned activities	10	21	10
Innovation related expenditure	54	68	54
Both product and process innovators	10	22	11
Either product or process innovators	30	48	30

Figure 1:
Enterprises who were innovation 'active', by type of activity, 2002-04 Source Economic Trends 628 DTi/ONS

12 First findings from the UK Innovation Survey, 2005 S Robson and L Ortman DTi Initial analysis of the UK 2005

Comparing these findings with similar data from the innovation survey in 2001 (1998-2000) shows that the overall proportion of innovation-active organisations had increased.[12]

The proportion of innovation-active enterprises in the 2005 survey is around 62%, an increase of 14% on the previous survey. This includes a 15% increase for enterprises with fewer than 250 employees and an 8% increase to 75% for larger enterprises. The proportion of enterprises reporting product innovation increased by 11% and the proportion reporting process innovation increased by 4% (see figure 2 below).

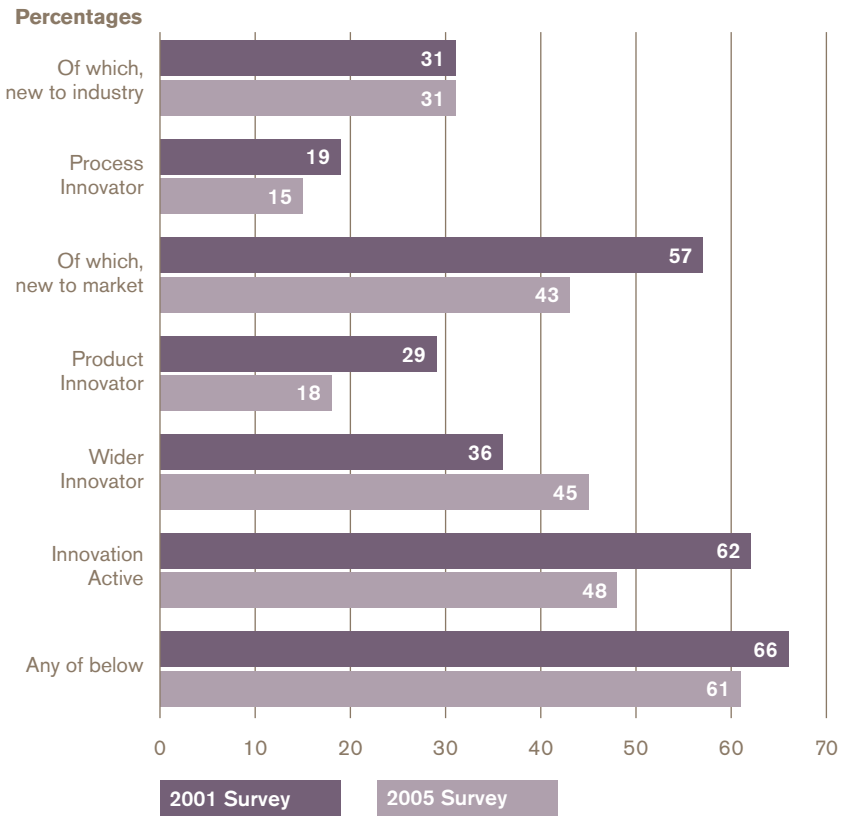


Figure 2:
Comparisons of 2001 & 2005 UK Innovation Surveys: Proportions of innovation Enterprises
Source: Source Economic Trends 628 DTi/ONS

It is interesting here to note that the smaller enterprises have shown a greater proportional increase in innovation activities over the larger organisations.

There are many factors influencing innovation within the UK:[13]

- Past macro-economic instability has generated cautious investment strategies
- Willingness to invest in 'intangible assets'
- Organisations should generate a culture to support innovation
- Organisations must monitor and react to external factors
- Appropriate intellectual property rights (IPR) for the 'digital age'
- Competition drives innovation
- Skills and knowledge underpin innovation
- Networking, partnerships and collaboration

PAST PERFORMANCE AFFECTS THE PRESENT

Past UK macro-economic instability has created a level of economic uncertainty, making organisations averse to high risk and thereby taking a cautious view on investment in new product development and research and development.

Past research has concluded that there is a very definite, positive, relationship between economic performance and productivity and investment in research and development (R&D).[9] Research also shows[12] that the cost of investment in innovative activities is commonly regarded as one of the most significant barriers to innovation. While there is a continuing requirement for publicly-funded research there is also a need for the IT industry to invest in new research and development as this underpins innovation which is essential to creating competitive advantage and sustainable prosperity.[14]

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12 First findings from the UK Innovation Survey, 2005 S Robson and L Ortman DTi Initial analysis of the UK 2005

13 OECD report 'Innovation Policy and Performance' published in 2005

14 'Why British University Computing Research Deserves Better Funding and Recognition' BCS, UKCRC

While investment of this kind could be financed by larger corporations, it is increasingly difficult for smaller organisations within the SME sector to fund this sort of investment. Research has shown that smaller businesses find the lack of qualified personnel one of the more important constraining factors on their ability to innovate.[12] However, collaboration and networking with academia also allows the SMEs within the IT sector to influence the future and to support its own innovation through initiatives such as Knowledge Transfer Partnerships (KTP),[15,16] and student internships.

As Silicon Valley in the US has shown, clusters are also important to developing innovation. This why innovation in IT in the UK is frequently focused around locations such as Cambridge, the Thames Valley and Scotland's Silicon Glen.

CREATING A CULTURE OF INNOVATION

There are a whole range of cultural factors which also help determine organisational tolerance for risk, employee empowerment, innovation, and a willingness to design new and flexible organisational structures and work processes.

There is also a relationship between organisations that are seen to be responsive to the needs of their customers and their staff, and their attractiveness as a place to work. Recent research has shown that 'e-enabling' employees (implementing electronic processes within an organisation) has multiple benefits, ranging from better communications to increasing IT skill levels amongst existing staff.[17] This empowerment is a known factor in stimulating creativity and innovation within an organisation.

EXTERNAL FACTORS AFFECTING INNOVATION

Organisations do not operate within a vacuum, they respond to the legal and regulatory framework surrounding them and to their customers and competitors, and to their suppliers and employees. Research suggests that the lack of restrictive and complex trade regulations within the UK is an active encouragement to innovation, and a lure to inward investment, although other surveys[12] find that the impact of UK and European Union (EU) regulations are a barrier to innovation for smaller enterprises.

The Confederation of British Industry (CBI) concludes that the Government should focus its strategic thinking on minimal regulation principles, and on encouraging a best practice culture to support e-business.[17]

DEVELOPING INTELLECTUAL PROPERTY PROTECTION

Other incentives which currently exist to spur new innovations, however, do not seem to be fully understood. Intellectual property rights (IPR) for example were designed to provide incentives for innovators and inventors, as they provide a time period where new inventors can recoup costs without the worry of being challenged by competitors.

However, formal IPR methods, such as patents, can only be used if the knowledge is able to be easily documented. Therefore, new innovative business processes, even if they are bespoke and fundamental to the success of an organisation, cannot be easily patented. Many firms therefore need to find ways to protect their competitive advantage but this cannot be done through any formal method such as patents.

"Generally data for the UK indicates that most firms do not place a great deal of emphasis on formal methods protecting intellectual property. They prefer to use informal methods because they are more cost effective."[13]

Research has also indicated that universities tend to use more informal methods of protecting their intellectual property. As the incentives for academics to exploit become stronger, they are becoming more sophisticated about protecting exploitable IP while still publishing the basic research for peer review. It would be much easier if the patent system on this side of Atlantic was like the US system where academics have up to 12 months after first disclosure to file a patent so academic publication (which has to be timely and competitive) can be done before patent filing.

As Silicon Valley in the US has shown, clusters are also important to developing innovation. This why innovation in IT in the UK is frequently focused around locations such as Cambridge, the Thames Valley and Scotland's Silicon Glen.

12 First findings from the UK Innovation Survey, 2005 S Robson and L Ortman DTi Initial analysis of the UK 2005

13 OECD 'Innovation Policy and Performance' published in 2005

15 KTP's proven scheme for encouraging tech' transfer partnerships between universities and industry managed by the DTi

16 KTP detail found at www.ktponline.org.uk

17 e-value matters October 2005 ISBN 0-85201-614-X sponsored by the DTi

While protecting intellectual property is considered vital for innovation and business economic competitiveness, research shows[12] that there is a difference in perception between larger and smaller companies. Initial investigations indicate that IPR protection costs are more easily carried by larger organisations and that SMEs find the costs harder to meet and therefore justify, although venture capitalists (VCs) look for a start up to have a patent on the core IP as a way of protecting their investment.

The UK Government recognises the need for IPR and commissioned the Gowers Review, which was published in December 2006.[18] The review recognises the need for a modern IP scheme to support the 'digital age' and ensure the UK can stimulate creativity and innovation. This would enable Britain to compete in the global, knowledge-based economy, recognising that IP acts as an incentive to both individuals and firms to innovate and create, knowing their investment is protected. The review makes a number of recommendations in terms of strengthening the existing systems and making these cost effective. However, it recommends, "greater balance and flexibility of IP rights to allow individuals, businesses and institutions to use information and ideas in ways consistent with the digital age."[19]

The lack of intellectual property protection for algorithms, software or enhanced business processes are barriers to innovation. While the Gower Review recognises some of these issues, the UK Government could do more to assist small companies in protecting their IP. Initiatives such as extending the tax credit system to cover the costs registering a patent, or other forms of IP, would assist many SMEs, as owning a strong IP portfolio can be an incentive to financial investment.[20]

But, since the US is still the largest single market for software, the intelligent entrepreneur would generally file a US patent first to protect the high ground and think about a UK or European patent second.

Companies also need to understand that there are alternative methods to support innovation protection other than obtaining legal protection. The Gowers Review survey into alternative protection measures shows how companies of varying sizes view differing practices.

Within the IT sector, the restrictions on legally protecting software algorithms and programs has led to the concept of the 'fast innovator'; a company that protects its trade secrets and uses an accelerated product to market business strategy.

There are often many different ways to solve a software problem, so even if an algorithm is patented another company may be able to invent a completely different solution and bypass the IP. At the end of the day, out engineering and out selling is really what matters.

	Percentage of respondents		
	Size of enterprise: employees		
	10-250	250+	All 10+
Formal			
Confidentiality agreements	11	22	11
Trade marks	6	16	6
Copyright	6	10	6
Patents	5	13	5
Registration of design	4	11	4
Strategic			
Lead-time advantage on competitors	9	17	10
Secrecy	8	19	9
Complexity of design	5	9	5

Figure 3:
"Rating different methods for protecting innovation" Source: First findings from the UK Innovation Survey 2005 ONS

12 First findings from the UK Innovation Survey, 2005 S Robson and L Ortman DTi Initial analysis of the UK 2005

18 Gower review can be found at www.hm-treasury.gov.uk/independent_reviews/gowers_review_intellectual_property/gowersreview_index.cfm

19 Gowers Review of Intellectual Property, December 2006, HMSO, ISBN: 978-0-11-84083-9

20 Information Age Partnership 2007 i2010 Working Group Ensuring the right conditions for an innovative, inclusive and competitive UK Knowledge Economy

Initial investigations for this report show that some innovators are using USA IPR protection for software systems and algorithms; even though they may not be able to fully fund the costs of pursuing breaches of infringement in the courts. The motivation behind the initial protection of their innovations has more to do with the potential for financial exit strategies than anything else. It is suggested that an organisation that wishes to exit via a trade sale arrangement to a larger USA company will gain more by having this protection in place than if it ignored it.

COMPETITION SPURS CREATIVITY AND INNOVATION

The cycle of innovation continues[21] at an ever increasing pace. Research has shown that there is a very positive link between increased competition and increased innovation. A review of the international empirical evidence suggests that the link between innovation and competition is positive.[13]

According to research by PricewaterhouseCoopers' 'Innovation Survey', top innovators generate over 75% of revenue from products not in existence five years ago.[6]

The need to innovate, to create new products, goods, services and innovative and effective new processes and operations is critical to the UK's future, so nurturing an innovative culture within the IT sector is essential.

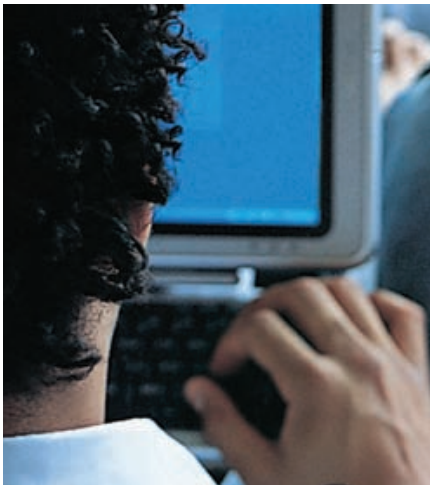
KNOWLEDGE AND INNOVATION

Innovation depends heavily on knowledge, with science and technology being key areas in the information technology (IT) industry. The UK has, despite lower levels of funding when compared to other nations, a very successful and high-quality science base. "The UK leads the G7 (an international forum for the governments of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States) in terms of citations relative to both population and gross expenditure on R&D."[13]

The OECD research shows that the benefits from knowledge transfer are directly proportional to a firm's own investment in innovation. It quotes "Relatively low levels of innovation investment therefore probably mean that UK businesses are, compared to their major competitors, less well placed to exploit research carried out in the UK science base. Weaknesses in skills are another barrier to successful knowledge transfer."[13]

SUPPORTING NETWORKING AND COLLABORATION – SCALE-UP COLLABORATION WITH ASIA

Networking and collaboration have a profoundly positive impact on innovation. This is because organisations rarely innovate alone but rely on others for additional knowledge and expertise as well as access to additional resources and shared risk. According to OECD research[13] the UK performs well in this area, although too often this networking pattern was seen as intermittent and patchy.



6 Cox Review of Creativity in Business: building on the UK's strengths, 2005 can be found at http://www.hm-treasury.gov.uk/independent_reviews/cox_review/coxreview_index.cfm

13 OECD report 'Innovation Policy and Performance' published 2005

21 Research on global competition and innovation, Dialogic Consulting 2007, www.dialogic.co.uk

It has been recommended that the UK must scale-up its collaboration with Asia's innovation hotspots if it wishes to exploit its science and technology industry within the global market. According to recent press commentary in the Financial Times (FT)[22], it is vital that the UK increases its collaboration in Asia. The article states that "Top priority is for Britain to 'unleash mass collaboration' now while Chinese and Indian innovation is still developing, rather than in 10 years time when it will be too late". It says: "The centrepiece should be a £100 million global research and development collaboration to help fund programmes with target countries on particular themes."

DEMAND LED INNOVATION

Customer demand also affects innovation. It seems that customer demand for 'high tech' innovative products in the UK is strong. "UK imports of 'high tech' goods account for roughly one third of all imports."[13]

It has been suggested that one way of promoting innovation could be to amend the procurement processes and criteria of major purchasers of high tech supplies such as the UK Government, "Solely relying on cost as a criteria for evaluation in technology intensive areas is not good practice."[13] It has been further suggested that the SME sector could benefit substantially if Government procurement systems could be modified. A recent report estimated that, if the UK Government were to purchase goods and services from the UK SME sector, it would inject something approaching £8 billion into stimulating growth in this sector.[23]

A recent 2006 report by Intellect[24] on potential changes to public procurement policy highlights some interesting observations. Some commentators reason that the level of public procurement expenditure, ring-fenced for SMEs in the USA, drives innovation in a very significant way.

	US	EU/UK measure	Comments
Eligibility	Small and medium sized enterprises (SMEs), Several minority groups, women owned, HUBzones	SME only	Much simpler and less prone to the exploitation of loopholes
Overall % set aside goal	23% primes		
40% sub contracts	10% – no distinction between primes and subs	It might de facto result in sub-contracts only	
Dept goals	Set by Small Business Administration (SBA)	Set by Small Business Service (SBS) or Office of Government Commerce (OGC)	
Individual contract goals	Set by agencies	Set by departments or OGC	
Size eligibility criteria	100s and depending on sector and sub-sector	EU SME definition only	Much simpler
Industry sectors	All		Would it be possible to restrict it to hi-tech or possibly to start there?
Legal basis	Opt out for US only in World Trade Organisation (WTO).	Not permitted today – according to some. Do we need EU law change?	There have been suggestions that SME set aside may not be allowed under current EU law
Innovation grants	Small Business Innovation Research Programme (SBIR) $2 billion each year to small businesses for innovation	Research and development (R&D) grants	Small Business Innovation Research Programme (SBIR) has some similarities to the R&D Grant program, but orders of magnitude larger
Small Business-University Collaboration	Small Business Technology Transfer Program (STTR) $200 million	Collaborative R&D program	Some similarities to the DTI's Collaborative R&D program. UK program is of comparable size
SME Mentoring	The SBA Mentor-Protege Program	1. Princes Trust 2. Business Link	Not the same scale

HUBzones – Historically Underused Business Zones
SBA – Small Business Administration
OGC – Office of Government Commerce
WTO – World Trade Organisation
GPA – Government Procurement Agreement
SBIR – Small Business Innovation Research

Figure 4:
Comparison of US SME 'set aside program' and a possible UK/EU program – Source: Intellect

The French have been leading advocates of an SME set-aside programme in Europe. Tom Wills-Sandford commented that he is surprised that the UK Government is not also supporting the French initiative. In his view, the establishment of an SME set-aside programme would do as much for innovation in UK as any other government programme being considered. It would also make the UK Government much more innovative.

The table (figure 4, left) provides a comparison between the USA and what the UK could do in a proposed 'set-aside' programme of investment to support innovation by public sector procurement policy changes as detailed in the report by Tom Wills-Sandford.

The Deputy Director of Intellect, Tom Wills-Sandford believes that the UK could consider methods by which it provided similar support to SMEs and has some pragmatic suggestions of how this would be achieved. He says "I believe an EU/UK programme could be based on the US model but with the following characteristics, many of which streamline the process:

- Only oriented at SMEs (measured by size) – no special cases
- A goal/target set by a strengthened Small Business Service of 10% of central government procurement £s going to SMEs
- No distinction between primes and subs and no separate targets. (In the US 23% prime contracts must go the SMEs and 40% of sub contracts to SMEs)
- Establish one definition for an SME rather than several
- Small Business Service to agree with each Whitehall Department their target for the FY but the targets must balance out to 10% across Whitehall
- Each department decides for each contract the relevant percentage set aside for that contract, but the total set aside must add up to their agreed department target
- In the procurement process large businesses bidding for prime contracts must provide a plan to use SMEs and then the plan will be subject to audit after the contract has been awarded. Incentives (and penalties) should be considered
- A Mentor-Protégé programme would have a very useful role to play. Consideration should be given to how this might be introduced."

The ideas are quite streamlined and there are tangible benefits that could be derived from employing this as part of a strategy for supporting innovation in the SME sector. The UK Government needs to re-examine its current policies.

ENCOURAGING NEW ENTREPRENEURS

As innovation and creativity become more significant within the economy, it is interesting to note that more and more Master of Business Administration (MBA) students are keen to learn the secrets of becoming a successful entrepreneur. Nowadays, there are a number of MBA programmes that include an 'entrepreneurship elective' where students can learn skills such as economics management, operations systems, venture capital finance and, most importantly, spend some time working with entrepreneurs.

The University of Oxford, Saïd Business School, is operating a new 'Enternship'.[25] Within the Oxford programme new students often choose to work with the SME sector rather than the larger multi-nationals.

This enables the students to gain an understanding of all aspects of running a business, and to be at the edge of day-to-day business decision-making. The Cambridge Centre for Entrepreneurial Learning at the Judge School of Management is another good example of the way in which some institutes of higher education are adapting to the needs of the UK's increasingly entrepreneurial culture.

Innovation depends heavily on knowledge, with science and technology being key areas in the information technology industry.

13 OECD report 'Innovation Policy and Performance' published in 2005
22 FT.com 'Scientists urged to work with innovation hotspots' Clive Cookson January 17 2007
23 i2010 Information Age Partnership Ensuring the Right Conditions for an Innovative Inclusive & Competitive UK Knowledge Economy 2007
24 A UK Perspective on US Procurement Preference Programs – Small Business Set Aside; Tom Wills-Sandford, February 24 2006, Intellect www.intellect.org
25 "Work placements with a difference" MBA supplement – The Times, London, 18th January 2007, p12

There is an enormous need for science and industry to connect and to work together to commercialise the emerging research.

OPTIMISING PRODUCTIVITY LEADS TO INNOVATIVE CULTURE – PROVIDE TIME TO INNOVATE

Competitive pressures mean organisations are constantly finding new ways to optimise their employees' productivity and many new ideas are being adopted by UK firms. Giving staff 'innovation time' away from their normal work duties is an idea conceived in the US that is gradually spreading to the UK.

"There is a growing belief that by de-cluttering employee minds of the minutiae of everyday working life, creativity and innovation must surely blossom."[26]

Initiatives such as 'staff suggestion schemes' are being introduced in many large organisations. In some cases these have led to new products and services. Google's policy of allowing its engineers the freedom to spend 20% of their time to pursue products they are passionate about[26] has created new products and services such as Google News and Google Suggest.

Other interesting examples of where these concepts make a difference are Microsoft's 'Think Week', where Bill Gates Founder and Chairman spends time considering the future of the technology company based on his own ideas together with a set of high profile 'papers' that are submitted by employees. This can also be illustrated by Live Labs 'Think Tank Incubator' for Web 2.0 with Microsoft Research (MSR) and MSN.[27]

Microsoft also has a 750-person world-wide research organisation that competes and collaborates with the best universities worldwide to ensure it is abreast of and contributing towards developing the state of the art.

Over its 15 year history, MSR has made major contributions to every MS product and indeed incubated several of them, e.g. Digital media, Web Services (Indigo).

FLEXIBLE WORKING, EMPOWERMENT AND INNOVATION

Given the changing demographics in the UK and the pressure to recruit and retain highly skilled employees, organisations must find ways to keep and reward the workforce which they have. Flexible working, performance related pay and stock options are proven methods of achieving this. Another alternative to flexible working is to provide good workplace services to busy professionals. These can include laundry pick-up, childcare, grocery delivery, lunch and dinner services and a concierge service.

Recent government figures[28] reveal:

- 92% of employers provide paid leave for fathers
- 75% of workplaces provide parental leave (additional leave to either father or mother)
- A quarter of workplaces allow some (non-managerial) employees to work flexitime
- In terms of flexible working arrangements, 64% of employers accept that employees can switch from full-time to part-time employment (64%, up from 46% in 1998), 41% use job-sharing, 28% term-time only contracts and 28% home working

Given the pressing need for organisations to become more creative and innovative, workplace policies which improve staff motivation and morale seem to be a vital step forward.

26 Personnel Today January 16th 2007
27 Live labs information can be found at http://labs.live.com/
28 5th Workplace Employment Relations Survey (WERS), July 2006

RECOMMENDATIONS

- To reconsider the options for support for SME innovation and growth and examine if and how the UK could adopt a similar strategy for public procurement within this sector in a similar manner to the USA.
- Consider options for financial support for innovation within the software sector as a means for stimulating SME growth, a re-appraisal of the R&D classification that places software development outside of accepted R&D should be thought through more fully to ensure that we encourage rather than discourage innovation.
- Develop the pragmatic recommendations from the Gowers Review to develop an appropriate IPR for the 'digital age'.
- To re-examine how the UK can work towards a solution with the French National Assembly to ratify the London Agreement on IPR for the sector. DtF 2006 highlighted this as an issue: essentially this proposed an effort to simplify the language and regime to reduce the costs of obtaining patents in Europe.
- If the London Agreement looks irretrievable then the Government should examine the recommendations in the Gowers Review and provide alternative economic measures that might enable SMEs to either copyright or protect innovations via a formal or semi-formal set of affordable procedures.
- Industry should recognise that innovation can be born from supportive, non-restrictive work practices and develop new strategies that provide employees with the time to think in order to contribute to innovation.

SUMMARY

Those organisations that innovate quickest will gain a competitive edge. There is a well established link between innovation, increases in productivity and economic growth. Creativity drives the development of new ideas, creating new products and new markets. Innovative business processes improve efficiency, benefiting individuals, customers and society.

Although the UK has a history of success in research and development, it is not exploiting this in terms of translating research success into new innovative, commercially successful opportunities. There is an enormous need for science and industry to connect and to work together to commercialise the emerging research.

At a recent Royal Society meeting, a senior R&D manager from Unilever admitted, "he would be relaxed if more of their synthetic chemistry moved to Shanghai, because the unique strengths of their British labs were in combining hard science with a sophisticated understanding of what makes consumers tick, drawn from social and behavioural sciences. A growing number of scientists and R&D-intensive businesses recognise these opportunities and are reorientating themselves to meet them. Now policy needs to catch up."[29]

29 The science lobby is getting it wrong on innovation' http://www.ft.com/cms/s/9044734e-6ae0-11db-83d9-0000779e2340.html Financial Times November 3,2006 By James Wilsdon

The State of Entrepreneurship in the UK in 2007: Lead, Follow or Get Out of the Way

BY JULIE MEYER, CEO, ARIADNE CAPITAL

With its unique overlap of financial services, technology, media, venture capital, and government interests, London is rapidly becoming a global hub for a new class of entrepreneur.

One typical example is Eric Baker, the founder of online ticket exchanges ViaGoGo and StubHub, which was sold to eBay earlier this year for $310 million. He is planning his next venture in London, having found funding from one of the top venture capitalists. Baker is far from unique; there is a wave of newcomers from the English-speaking world and beyond currently streaming into London. The simple fact is that some of the best people in the world are here.

Niklas Zennström, founder of two of the most disruptive start-ups in the internet's history, KaZaA and Skype, now also bases himself in London. KaZaA was the peer-to-peer file swapping that sounded the death knell for the music industry's traditional distribution channel; Skype let the internet voice (VoIP) genie out of the bottle, providing free telephone calls over the internet and forcing the traditional phone companies into a downward price spiral.

No sooner had Zennström sold Skype to eBay in September 2005 for nearly $4 billion that the rumours started about Joost, an interactive software for distributing TV shows and other forms of video over the Web using peer-to-peer TV technology. This time around, Zennström is taking greater care with copyright issues than was the case with KaZaA, which ended up fighting an international legal battle with the music labels. The Joost software developers are currently in negotiations with TV networks and have signed up with Warner Music, Indianapolis Motor Speedway Productions (Indianapolis 500, IndyCar Series) and production company Endemol for the beta. In February 2007, Viacom entered into a deal with the company to distribute content from its media properties, including MTV Networks, BET and film studio Paramount Pictures.

But it is not only new entrepreneurs who are being drawn to London. Leading entrepreneurs from Web 1.0, the first dotcom boom which ended seven years ago, are back, having dusted themselves down from the dotcom crash and learned some crucial lessons about the harsh reality of business.

Witness Brent Hoberman, the co-founder of lastminute.com, who is helping launch a website designed to streamline the process of moving home for the 6 million people who change address in the UK every year. Moveme.com has raised seed funding from investors including Advent Venture Partners and Accelerator, an investment fund managed by father-and-son entrepreneurs Robin and Saul Klein. The web-based service creates a personalised checklist of all the things needed to arrange a move, ranging from notifying utility companies of a change of address to hoisting a grand piano through the first-floor windows. The site automatically generates the relevant documents as and when they are needed. It can also be used to book removal and insurance services.

When asked what was driving him to set something up again, Brent replied: "What? Sit this wave out? No way."

But there are key differences between this dotcom boom and the previous one. Something new is happening not only in the way that the internet is shaping our lives this time round or in Web 2.0 as the industry loves to call it, but also in how new technology innovations are becoming bedded down in the industry. Briefly put, venture-capital-backed start-ups are being acquired much earlier by corporate enterprises which can offer scale to these entrepreneurs and which are looking to expand the way they grow new products and services. Through their corporate development units, most larger companies operate a mixed economy where they balance the greater certainty of organic growth and its longer time horizon with the benefits of inorganic growth, namely an earlier starter position and greater innovation.

Entrepreneurs have the greatest insight into how a particular market is developing – if they are good – as they are in the 'eye of the tornado' and are dealing with how the markets are dynamically evolving in real-time. Entrepreneurs think differently; they see things that others don't. They feel compelled to make things happen because something doesn't exist which they believe should. Sometimes that can take the form of blind faith which leads to catastrophe. But, more frequently, it represents a sharp insight which is harnessed into a step change in how an industry operates.

If a company acquires that asset of the entrepreneur's insight and innovation, then it can lead in that industry breakthrough. Time and time again, we see that the benefits of market disruption and dislocation accrue to the numbers one and two players who embrace it. Said another way, the disrupter will be acquired by the entity they most disrupt, and embracing the disruption can be very value-enhancing.

One reason why corporates buy start-ups is to add new DNA to the corporate gene pool and introduce a new way of thinking into how they operate. Sometimes there is massive organ rejection by the body, but there have been hugely successful acquisitions. In the best of these, the start-up culture has had a positive effect on the corporate culture. The EMAP acquisition of WGSN is one example. WGSN is a Bloomberg service for the fashion and style business which was acquired by EMAP in October 2004 for £140 million. Since then, WGSN's business has doubled.

"Entrepreneurship is not for the faint-hearted; it is about persisting and taking total accountability."

JULIE MEYER, CEO, ARIADNE CAPITAL

But there is still a large black cloud hovering over London's future as a global hub for entrepreneurial innovations. The UK is still feudal in many ways. A large segment of society wants to argue for the master/slave relationship, the employer/employee relationship despite the fact that the individual revolution brought about by the internet is busting wide open these outmoded relationships. The UK has the richest poor people of any other region in the world, but you can count on one hand the £1 billion companies that have started from scratch over the past 30 years. Some of the finest entrepreneurs have gone elsewhere to build their dreams.

It sometimes appears almost as if there has been something pre-meditated about the Government's penchant for squashing the ambitions of the UK's homegrown entrepreneurs. Over the past ten years, the role of Government in British people's lives has increased dramatically. It is not difficult at all to connect the dots between government, their lack of accountability and a diminished entrepreneurial sector. A massive tug of war is happening between the surge of entrepreneurship in London, and the unnecessary difficulties of setting up a business in the UK.

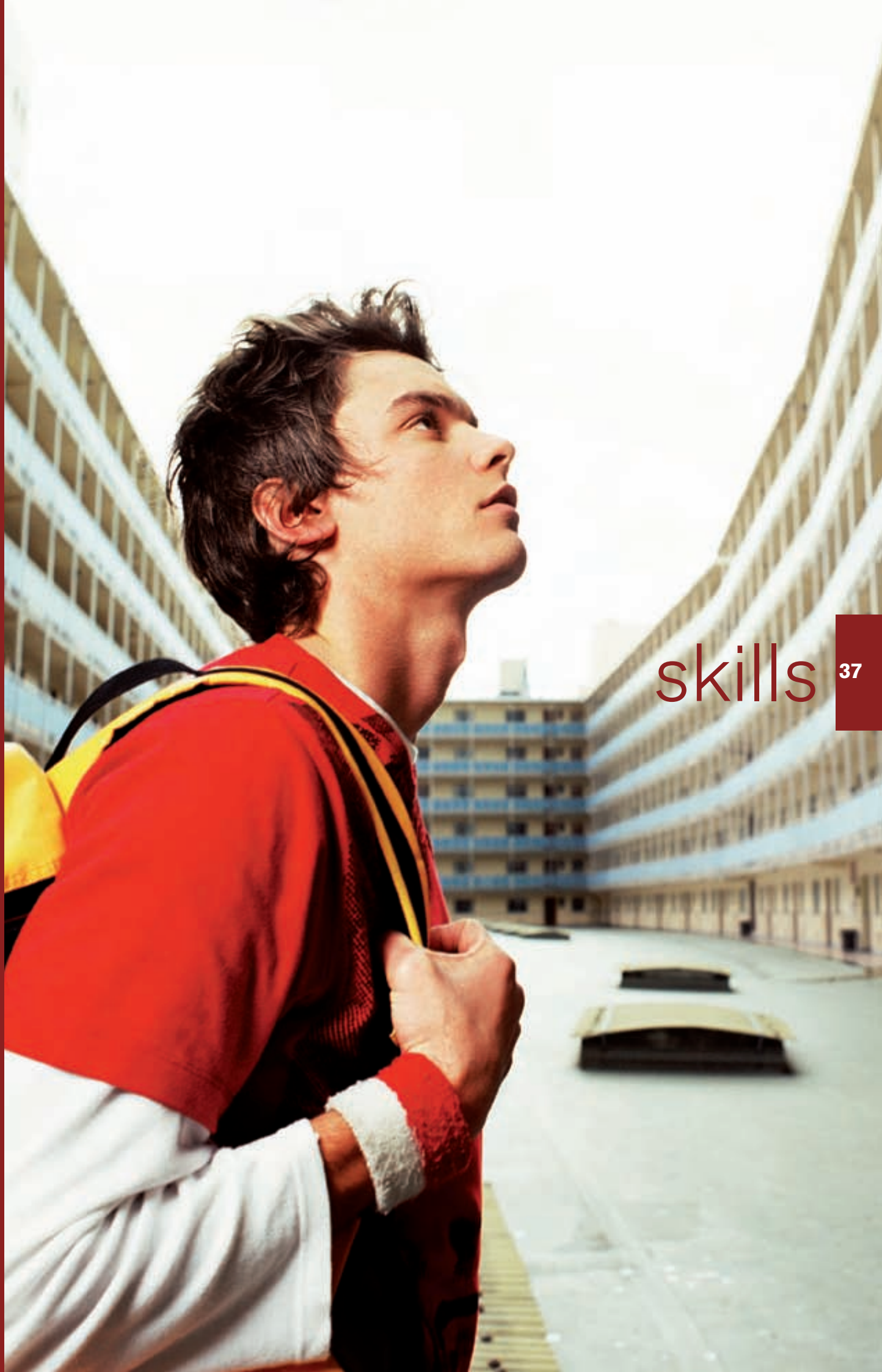
The good news is that, in 2007, economics is trumping politics around the globe. The triple play of the internet, entrepreneurship and individual capitalism is encouraging people of all walks of life to dream big dreams. Previously people were given aid and told to stay in their ghetto. That is changing fast. Leading British entrepreneur Paul Barry-Walsh has, for example, founded the Fredericks Foundation to give micro-loans to disadvantaged people who want to bootstrap themselves up.

Iqbal Quadir, one of the founders of the Grameen Phone, the mobile phone operator start-up that has taken Bangladesh by storm over the past 10 years, said: "Capitalism was about empowered authority which didn't necessarily activate the citizenry; the internet stands that on its head, and shifts the power to the Individual – making Individual Capitalism the force of the 21st Century."

Nick Ogden, is the founder of internet payment provider WorldPay, has recently founded VoicePay, a new service which uses voice biometrics to verify purchasers' identities when making an online transaction. When asked what he was most proud of, Ogden replied: "Never missing payroll". Entrepreneurs know where the buck stops. It stops with them and sometimes hits them smack in their forehead.

Entrepreneurship is not for the faint-hearted; it is about persisting and taking total accountability for a company and your life: the good, the bad and the ugly. Accountability is a good credo for any society. The UK needs radical forces and mobilised people who intend to take back their rightful ownership of their society by reducing the role of government in their lives, and letting entrepreneurs drive growth.

Venture capital has often been a catalyst for this growth. But venture capital should have as its aim not only making a return for its investors but also creating the leading businesses. Sadly, there are few new European businesses that have become world leaders which were founded less than 30 years ago; the group includes Vodafone, Sage, and ARM. Far fewer were backed by venture capitalists.



skills

Shoring Up the Foundations

BY SIR DIGBY JONES

The foundations of Britain's future skills base are in urgent need of support. The level of literacy and numeracy in England's green and pleasant land is well below that in many so-called 'third world' regions.

Official research suggests that there are around seven million adults in the UK who cannot read and write properly and 11 million who cannot add two three figure numbers. According to the latest available government research, around a third of people of working age in the UK do not have a level 2 qualification, five or more O-levels or GCSEs. This summer, around half the teenagers taking GCSEs will fail to achieve a grade C or above in English and maths. Only about 19% of Germans and 15% of those in the US have such low skills. Even other European countries which have traditionally had high numbers of unskilled workers approaching the UK level are managing to retrain people. For example, in the 10 years to 2001, France has reduced its proportion of low-skilled workers dramatically, from 26% to 15%.

There is nothing new in this sorry state of affairs. Britain has historically had a far poorer skills base than many other countries, with higher education traditionally the preserve of a privileged few. In the 1960s, only one in 18 young people went to university with many people not even bothering to complete formal schooling. As late 1979, only 40% of the workforce held any qualification and a relatively low proportion of young people stayed in education after the age of 16. Although there have been considerable advances in attracting people to the higher levels of education, there has been almost no progress made at the lower end of the skills scale.

The lack of basic literacy and numeracy amongst a disturbingly large proportion of the workforce has little to do with the linguistic shortfall associated with immigrants from non-English-speaking cultures. The worst area of Britain in this respect is Northern Scotland, where there is very little immigration.

It is more than a national disgrace that there has been no substantial improvement in literacy and numeracy among the adult population of Britain in the last 30 years. It is a potential time bomb. Three decades ago, in the middle years of the 1970s, Britain was still rich in those industries that once relied on a vast pool of unskilled labour. Mines, docks, shipyards, factories and the merchant navy were all big employers of the unskilled. Today, there are only 2.5 million jobs in the UK. A large proportion of these are provided by big public sector employers such as the Ministry of Defence, the National Health Service and local authorities.

But even these employers are discovering that they need increasingly modern skills for even the lowest-level jobs. Basic IT skills have joined the traditional 'three Rs' of reading, writing and arithmetic as the minimum skillset needed to perform any but the most unskilled work.

According to Government research, the advance of information and communication technology and its rapid adoption in the workplace has fundamentally altered the way businesses operate. The development of other technologies such as bio-technology are expected to have similarly far-reaching effects on the way in which society operates. These developments provide opportunities for the UK economy as it has been shown that countries that play a central role in developing new technologies stand to gain most from their diffusion. Skilled workers will be better placed to adapt to the new business and production techniques brought about by technological change. Those unskilled jobs which still remain are disappearing quickly as knowledge services fast replace the old economy and even the most basic tasks require some degree of digital input. It is estimated that, by 2012, there will be no more than 50,000 unskilled jobs in the whole of the UK.

This low-end skills gap has become so wide that people with literacy problems are desperate to have something done to remedy the situation. When the Government ran its national ads using the concept of 'gremlins' to bring home the point that help with re-skilling is there for those who want it, they received around 1.5 million phone calls requesting help with roughly 300,000 signing up for training courses.

All the indications are that people who are in need of basic re-skilling at this level are fully aware that they need training and will take advantage of it when offered. The government's Train to Gain scheme is designed to give them the help they need by releasing them from their full-time employment for two or three hours a week.

Many of the people with basic literacy problems who are in full-time employment work for small business employing only a handful of people. A typical example would be a small delivery or haulage company employing young men to lift and carry. It is often hard to convince the owner of such a business that it is in his direct interest to participate in the Train to Gain scheme. But without this co-operation, those employees with skills in reading and writing and basic computer literacy are likely to face a jobless future further down the line.

Such is the need for this basic re-skilling to take place that, unless companies start participating on what is still a Government-funded scheme on a voluntary basis, the Government may consider making a similar scheme compulsory, in which case the employee would be forced to pay. If this did happen, then many employees would do the absolute minimum to comply and some might even discriminate against hiring those in need of this kind of re-skilling.

The picture in this case of larger organisations is much more encouraging. Companies like Compass and McDonald's employ large numbers of people who lack basic literacy, numeracy and computing skills. And they do an excellent job of co-operating with any initiative aimed at improving their skills base. But the support and co-operation of companies in IT is also essential if those at the bottom of the skills ladder are to be given a helping hand.

Sir Digby Jones is the former Director-General of the Confederation of British Industry (CBI).

Imminent Demise of Computer Science is Greatly Exaggerated

BY PROFESSOR KEITH MANDER: CHAIR, COUNCIL OF PROFESSORS AND HEADS OF COMPUTING; PROFESSOR OF COMPUTER SCIENCE AND DEPUTY VICE-CHANCELLOR, UNIVERSITY OF KENT

Suggestions that the teaching of Computer Science in universities is about to fade away are premature. While it is true that applications for undergraduate courses in Computer Science have fallen by about 50% since 2001, the subject's value to the graduate remains as strong as ever, and will be so for the foreseeable future. Computer Science is concerned with the understanding, design and exploitation of computation and computer technology, combining theory with the solution of immediate practical problems, combining scholarly and professional activities, underpinning the development of both small scale and large scale organisational systems, as well as with helping individuals in their everyday lives.

The pervasive nature of Computing, and its wide application, produces a complex employment market for Computing graduates. This ranges from industrial sectors concerned with the production of foundational hardware and software technology, through stand-alone hardware and software products, industrial applications (particularly, for example, in the financial services, media and telecommunications sectors) and finally to the business solutions deployed in the majority of entrepreneurial businesses serving real human needs throughout the developed world.

While Computer Science courses produce graduates that are able to enter any of these employment sectors, demand for such graduates is likely to be concentrated in those parts of the industry for which the deep technical knowledge of hardware and software is a pre-requisite (i.e. that part of the industry concerned with the production of foundational components) and in parts of the industry where analytical and logical skills are at a premium. This section of the industry will have a requirement for fewer graduates than those parts of the industry concerned with business solutions (which will recruit no less satisfactorily from a broader range of disciplines, including Computing, Information Technology, often combined with other subjects such as Business and Management, as well as many other degree subjects outside the Computing discipline).

Throughout the 1980s and 1990s there was a strong economic advantage to studying for a degree in Computing. This advantage was eroded in the public's perception from around 2001 when the 'dotcom' bubble burst, but is now returning to its former levels as reported in the recent UUK/PWC report (*The economic benefits of a degree*, February 2007), and as evidenced by salary levels, employment levels and international competitiveness.

The economic advantage of studying for a degree in Computing also remains very strong in countries like China and India, which are at different levels of their economic development from the UK, and these countries are producing many thousands of graduates per year, fuelling a strong off-shoring business in the development of computing applications.

The perceived erosion of the economic advantage of studying Computing in the UK has been brought into sharper focus by the introduction of variable fees into the higher education system. While UCAS data shows that since 2001 the number of students applying to read Computing in UK universities has dropped by about 50%, graduate employment data shows that the number of Computing graduates entering employment within the UK has risen. Many reports claim that the demand for Computing graduates will increase, perhaps dramatically, in the next few years. If the current trends continued into the future, by about 2009 the number of Computing graduates produced will be wholly insufficient to meet demand. This is an unfortunate fact, since the Computing graduates of 2009 were recruited in the Autumn of 2006.

The UK derives significant competitive advantage from its Computing industry. For this to continue, it is important that this industry remains strong, and that universities produce graduates – particularly those with the high-level design skills from which the UK derives much of its prosperity – in sufficient numbers to meet the national need. University Computing is therefore a subject of major strategic importance to the UK. Fortunately, the Engineering and Physical Sciences Research Council (EPSRC)'s recent International Review of Information and Communication Technology (ICT) Research (February 2007) shows that Computing research remains strong – second only to the USA on many academic metrics. But it also notes the worrying decline in the supply of future researchers as undergraduate numbers fall. Despite the relatively large numbers of students still studying the subject, Computing may be vulnerable as universities downsize their computing departments as demand from undergraduate applicants declines.

Although academic computing feels vulnerable at the moment, it is not out-of-touch, it is not dying, and it will not die while it continues to innovate. Over the next few years, we shall see new alliances emerging, particularly for the funding of higher education, insofar as it relates to the more vocational subjects like Computing.

Public funding will continue, but private funding (through students paying variable fees), funding from industry (in the form of bursaries, salaries for industrial placements, golden hellos, and the write-off of student debt) and funding from higher education institutions (HEIs) themselves (in the form of bursaries to facilitate participation) will feature much more in the higher education landscape.

The emerging market in higher education, and the simple laws of supply and demand, would, for many subjects, see graduate salaries influencing application trends, with HEIs adjusting staffing levels to cope with increased demand. But Computing is not quite like other subjects. It evolves quickly and the industry is truly global, with the capacity to move its operation from one country to another at the press of a button. Its *lingua franca*, English, has become increasingly widely spoken throughout the world, reducing the competitive advantage of highly-salaried native speakers.

Market forces will regulate this in the long-term. But in the short to medium-term, the academic computing community needs an alliance not seen in the UK since the earliest days of the subject. This would involve HEIs, the wide spectrum of the computing industry, the professional bodies, the Government and the funding/research councils, all working together to safeguard the fundamental contribution that computing occupies in the UK economy and in the wider society, with particular emphasis on inspiring young people to recognise that role and to want to be a part of it. Although many are already engaged in this activity through varied links between universities and industry, through professional accreditation of courses, and through the active promotion of the subject in schools, the scale of the problem should not be underestimated.

There are no silver bullets, no magic paradigms and insufficient 'guru lectures' to sustain a whole degree programme. But the shared enthusiasm, commitment and sense of adventure that still characterise that computing will be a good starting point.

Lessons in Learning

BY PAUL SMITH, GLOBAL MANAGING DIRECTOR,
OFF-SHORE SOFTWARE DEVELOPMENT, HARVEY NASH

UK companies are becoming increasingly reliant on the IT superpowers of South Asia. As our skills resource dwindles, theirs grows. Modern business flounders without world-class technological innovation and maintenance, so we have no choice but to look abroad in pursuit of global competitiveness. Strategic outsourcing and the inward immigration of knowledge workers is now intrinsic to the UK IT environment.

But our distant goal must be to learn to compete again, to become a force in training and development, to excel in IT research and enhancement. Our foreign outsourcing allies have just the educational model upon which we should base our skills recovery – and we must start learning from them immediately.

Borders are no longer barriers. The net effect of migrant workers on the UK is clearly positive, According to the Centre for Economics and Business Research commissioned by Harvey Nash, £54.3 billion was the uplift of GDP in 2005.

Unsurprisingly, the spread of online technology has increased the demand for information technology specialists – in particular software developers. According to the Office of National Statistics, in 1995 just 2,142 software specialists came into the UK. In 2005, 20,900 were welcomed. More difficult to measure is just how many overseas developers are currently employed by UK firms. The number is in the tens of thousands – costing UK business hundreds of millions of pounds each year. Although the word 'costing' can be badly misconstrued – there is nothing necessarily uneconomical or damaging about outsourcing. On the contrary, constructive and strategic use of overseas suppliers can form part of a sound platform upon which to run a business. Moreover, many of the UK's biggest and best businesses have no choice but to outsource, as there is simply insufficient local resource to satisfy current needs.

But cultural disinterest in technology and science has become an endemic affliction among those born in the UK. "I'm hopeless at maths" is heard with alarming frequency in offices up and down the country. Unfortunately, it is often said with resignation – even pride – as if it were an irreversible flaw in our ethnic make-up. Elsewhere in the world, such educational poverty might only be announced when earned by unfortunate economic circumstance and where rudimentary scientific instruction lies beyond reach. In the UK it is at least available for all, but its detail is out of sight and unwelcome for most. By contrast, our population does at least recognise the value of science – even if only passively. According to a recent nationwide MORI poll, 86% of adults think science makes a good contribution to society.

Six thousand miles away, Vietnam has wrapped its economy around a scientific future – churning out some of the world's leading IT thinkers. More than 80% of the country's students are scientists. And Vietnam is not alone; China, Japan, Taiwan, India… Each is looking to transmute in the West's eyes from exploited off-shore commodity to innovation powerhouse.

Worryingly for our IT future, the UK population is ageing. Over the last three decades, the median age of the UK population rose from 34.1 years in mid-1971 to 38.8 in mid-2005. This is primarily the result of past trends in fertility, although recently declines in mortality rates especially at older ages have been playing a major role, according to the Office of National Statistics.

Looking ahead, there will not and should not be an end to outsourcing abroad, as foreign workers in so many markets carry a cost advantage we could not possibly equal. Yet a science and technology polarity in the world is an unwelcome prospect. There is not a single valid reason to suggest the UK cannot rediscover its ability to excel in IT – and to start to operate and innovate at the rate of the world's IT superpowers. But we must be robust and immediate in our approach to reparation.

More and more of our IT needs could be outsourced or supplied by migrants. But do we really want to sacrifice our digital innovation for ever? Do we want to become dependent in our use of IT and in the development of new technologies? An ideal outsourcing model would be one where the UK innovates and manages and the foreign supplier, with its cost advantages, activates and produces on our behalf.

There needs to be a radical change of attitude amongst the pillars of responsibility. As the trend is towards increased trade in IT between here and the Far East – we could do worse than learn from those cultures. In many Asian countries which lead in IT, children look up to scientists with awe. In South Korea, for example, technology giants such as LG and Samsung are part of society's fabric, and a prestigious career target from school-age upwards. Maths and science is taught with rigour and discipline until 18 in many countries and the per capita achievement of students in science far outstrips what we manage in the UK.

According to the CBI's 2006 statistics, China alone is producing upwards of 300,000 science graduates each year. India produced a staggering 450,000 engineering graduates in the last academic year. While in the UK, figures reveal a decline in all science subjects, from GCSE through to A-level and tertiary education.

In all, we have a skills gap in UK IT professionals. Combine that with an ageing population, net drops in scientific education and a glut of affordable, willing resources in foreign destinations and it is clear that drastic action is needed.

If we look again to Vietnam, the model is simple: large businesses form their own universities with governmental endorsement. This is having a marvellous effect on the schools below and the working world above. It is like a throwback to apprenticeship, but with the rigour of academic tuition applied. The result, of course, is that the modules provided by this new breed of university are precisely suited to the world of work which enthusiastically embraces the students upon their graduation.

Conservatively, it will take fifteen years to fill the skills gap. If each decent-sized company were to commit to providing excellent on-the-job training today, sponsoring students next year and working with a partner university on designing and funding a vocational course, the UK would be back on track in five years time.

Professional Education: The Role of Work-based Learning

BY VIRGINIA WILLIAMS, PROFESSIONAL LIAISON DIRECTOR, SCHOOL OF INFORMATICS, CITY UNIVERSITY

An element of practical experience is necessary to develop competence in any profession, and higher education institutions are now offering courses with substantial practice-based elements in order to meet the expectations of students, employers, and professional bodies. Research suggests that 70% of learning comes from experiences, either planned or unplanned, thus emphasising the need to 'learn from real work'.

Employers regard the higher level intellectual abilities associated with university study as necessary for competitiveness in the IT industry of the future. However, analysts agree that the higher education (HE) sector has a very low market share of the employee learning market, however defined, and this is seen as an opportunity by some in the HE sector.

City University arranges role-based, project-based and usually paid work experience for students, with a wide range of employers, lasting between six months and three years. The most common model is the one-year undergraduate sandwich placement, but City has innovated by introducing new models for its IT students.

On the Professional Pathway, City undergraduates take work-placement IT roles alongside their studies. For three years of a four-year degree programme, the only fixed elements are tuition at City one day per week and a substantial software development project done in the workplace. Employers often choose to employ Professional Pathway students for the whole three years of the programme, although shorter periods are also acceptable.

In addition, City postgraduate students can undertake a client-based project for an organisation and use the work as the basis for their dissertation. Help from City is available to the employer and student in formulating these internship projects.

Work-based Learning Advisors are key to the success of City's schemes. They visit employers and students during placements/internships to ensure that expectations are being met on both sides. City offers flexible arrangements that fit with employer needs, while supporting students in ways that maximise the benefit they derive from the opportunities.

City encourages students to develop the skills they will need to gain successful entry into the workplace. Starting with an initial skills self-assessment, students work with personal tutors to identify their own development needs and interests. Employers work with City to develop students' communication skills through workshops on presentations, interviews or CVs. Industry knowledge is developed by means of expert lectures.

City students use the British Computer Society's Professional Development Scheme to document placements and internships. Students are assessed for a Certificate in Graduate Professional Development, which can include Key Skills and National Occupational Standards, using a framework developed in conjunction with e-skills UK.

There is a great deal of workforce development activity underway in the HE sector, with substantial employer engagement with HE to provide work-based development opportunities.

There are, however, issues that need to be addressed if work-based learning is to expand.

First, work-based learning is a contested area, not least because it challenges the very essence of universities as the primary source of knowledge. We cannot afford to let debates about the value of different types of learning or where learning is best situated to divert attention from the more important issue of how higher education institutions (HEIs) and employers can best 'co-develop' the workforce.

Finally, this co-development requires a new model of 'co-financing' with employers paying for the development that will bring added value to their businesses, staff contributing through the time they give and the state paying to accredit the learning.

The China Syndrome

BY PROFESSOR DYLAN JONES-EVANS,
DIRECTOR, NATIONAL ENTREPRENEURSHIP OBSERVATORY FOR WALES

"Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime".

Given China's pre-eminence as one of the most important economies of the 21st century, it is worth examining this ancient Chinese proverb in the context of skills and learning within business organisations, as it may well hold the key to where the West can take on the might of this new Asian superpower in terms of global competitiveness during the next 10 years.

The UK Government recently published the Leitch Report, which examined the UK's long-term skills needs and set out ambitious goals for 2020. If achieved, these would make the UK a world leader in skills. It clearly indicated that skills are the key to unlocking potential within the population and that without increased skills, we would condemn ourselves to a lingering decline in competitiveness, diminishing economic growth and a bleaker future for all.

However, if we are to compete with the growing pre-eminence of countries such as China and India, the issue is not about the skills of individuals alone. Businesses must also adapt to the changing competitive global environment, usually by becoming skilled at creating, acquiring, and transferring knowledge. Within such 'learning organisations', the generation and acquisition of new ideas is essential if learning is to take place, and whatever the sources of these ideas, they are the trigger for improvements that will lead to greater profitability which, in turn, will increase the competitiveness of the UK as a whole.

For UK businesses, one of the major barriers to learning is that of organisational inertia as many businesses find change a difficult process and often resist change, even when they are threatened with extinction because previous actions have 'worked well in the past'. As a result, even successful firms can become complacent, learn too little, and eventually fail.

There is a role for large firms to work more closely alongside small firms to ensure that business can access the right type of information about their technology or market cheaply and quickly. Many large businesses, especially within knowledge-based sectors such as biotechnology and IT, have developed strategic partnerships, or have acquired small high technology firms to enable them to gain access to a specialist type of knowledge which is not currently available within their organisations.

There is evidence that small firms can, through both formal and informal arrangements with large companies, gain access to knowledge that, in turn, will lead to increased efficiency and competitive advantage to both partners. For example, research indicates that not only did the inward investors into Wales create high value jobs but, through their skills development initiatives, raised the quality of learning amongst smaller companies involved in their supply chains.

The dissemination of such best practice throughout different industrial sectors can create an effective 'learning loop' between small and large firms which could be the answer to many of the questions being asked in terms of how we compete with the growing economies of China and India.

Skills are the key to unlocking potential within the population.

To Succeed in the Global Economy the UK must Commit to Technology Skills

BY KAREN PRICE, OBE, CEO E-SKILLS UK

The UK is facing a potentially critical shortage of technology skills. The UK's IT industry is growing at five to eight times the national average, and around 150,000 entrants to the IT workforce are required each year. At the same time, every year, fewer young people choose to study technology-related subjects at school and university; and every year fewer technology graduates choose to embark on a career in IT. This mismatch urgently needs to be addressed.

In the first instance, we must improve the attractiveness of technology careers and the quality and relevance of IT-related education. Drawing new talent into the IT workforce is vital to its renewal and growth.

Between 2001 and 2006 there was a drop of 43% in the number of students taking A-levels in Computing (from 10,913 in 2001 to 6,233 in 2006). The uptake of IT-related degrees almost halved between 2001 and 2005 (from 27,000 in 2001 to 14,700 in 2005). Of these IT-related graduates only around three in ten choose to enter IT occupations upon graduation.

There is also a growing chasm between technology-related education at school and university and employer needs. At school level, most IT courses focus on IT user skills, which have little relevance to today's IT careers. We need courses that bring out the excitement and relevance of IT to modern day lives and that transform the attitudes of young people, particularly women, towards careers in IT.

At university level, many IT courses focus on computer science, with little business content. There is an urgent need for more university-level courses to combine IT and business, with creative and stimulating programmes of study that enable students to develop the full range of skills required for a modern career in IT.

This should be complemented by a sector-wide commitment to the development of the existing IT professional workforce. Over 70% of the UK's workforce in 2020 has already left compulsory education. The development of IT professionals to meet changing business, technological and global needs is a primary challenge for the UK if we are to remain successful ten years from now.

Over the next decade, UK employers will need increasing numbers of business-oriented IT professionals who can function in customer-facing roles and are prepared for ongoing change. This requires a sophisticated set of skills and understanding, one that encompasses business, communication, team working and project management skills as well as in-depth and up-to-date technical knowledge. IT professionals need to be encouraged and able to develop their skills throughout their careers, with access to recognised qualifications that meet consistent standards and employer and individual needs.

The global landscape for IT professionals and the IT industry is undergoing constant evolution and this will only accelerate with time. It is vital that we continue to understand and address the skills and development implications of these changes so that the UK has the IT professionals it needs to succeed in every sector of the economy.

"IT professionals need to be encouraged and able to develop their skills throughout their careers."

KAREN PRICE, OBE, CEO E-SKILLS UK

Knowledge Transfer: Linking HE with the IT Industry

BY PROFESSOR ROBIN BLOOMFIELD, PROFESSOR OF SYSTEM AND SOFTWARE DEPENDABILITY, SCHOOL OF INFORMATICS, CITY UNIVERSITY

Knowledge transfer is not a one-way process where the wisdom of academia is somehow transferred into the minds of students and clients in the IT industry. If this arrogant attitude was ever appropriate, it is no longer. Research and teaching need to be informed by current practice, responsive to its challenges and to learn from it.

The research focus at City is on dependable socio-technical systems and this requires a close cooperation between HE and industry. The systems we depend on are pervasive and we need to work closely with those responsible for them in areas outside the IT industry such as financial services, air traffic management and energy.

At City we have a number of ways in which we achieve this close coupling between HE and industry. In our research, we work on real systems and real problems with partners that own and address systems critical to the UK economy. We have an approach that de-risks these interactions with industry but allows us access to real systems. To do this we have spent years building up confidence and trust in how we work. For example, we exploit the good links we have with the City of London in developing a research partnership with the City of London Police on High Tech Crime. Of course, we have the usual mechanisms available to us of Knowledge Transfer partnerships (KTP), case studies, spin outs etc and we use these as and when we can. But two-way working on real systems and real problems means we also need the resources to provide what our partners need. This requires flexibility and perhaps a broader interaction than is customary (the 'Knowledge Transfer' product can be quite broad and in our field sometimes requires engaging with solved problems previously solved but unknown to the community).

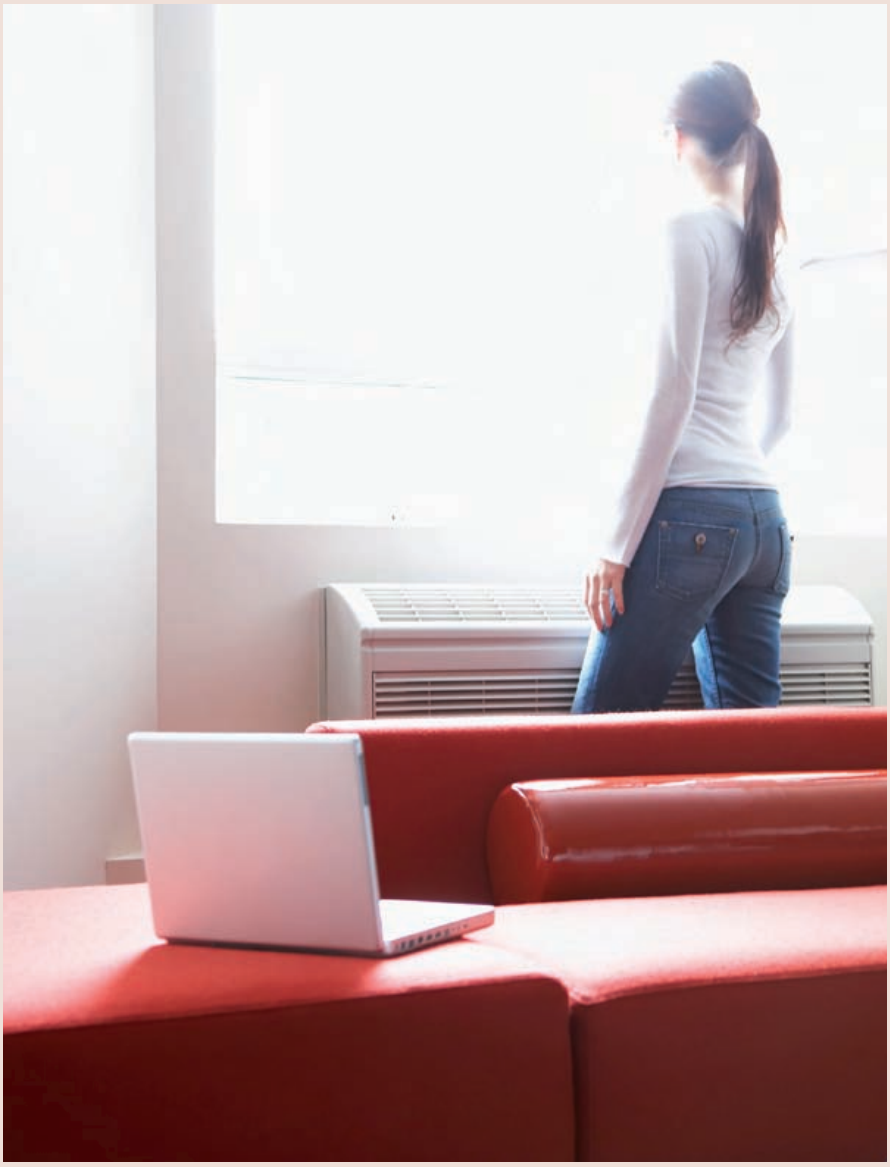
We are also active at a policy and regulation level. Again, this is a two-way process where we can both shape the agenda within Government, EU and corporate bodies but at the same time understand their needs and priorities. This can be a very efficient mechanism if we work at a senior enough level, as we do.

Finally we have experimented with spinning in a high-tech company (Adelard) so that it is co-located with our Centre for Software Reliability. This proves a direct 'water cooler' synergy with low interaction costs. It has provided staff to teach who are also practitioners plus a route for collaboration and contact with a wide client base.

In our area of socio-technical systems, as in so many others, Knowledge Transfer is about developing and being able to sustain trusted relationships. This involves specific skills and opportunities and is something that can be facilitated at an institutional as well as a personal level. It involves investment, commitment and patience from all concerned.

"Knowledge Transfer is about developing and being able to sustain trusted relationships."

PROFESSOR ROBIN BLOOMFIELD, CITY UNIVERSITY



"We need courses that bring out the excitement and relevance of IT to modern day lives and that transform the attitudes of young people, particularly women, towards careers in IT."

KAREN PRICE, OBE, CEO E-SKILLS UK

Skills

INTRODUCTION

Research for this section of DtF 2007 develops the themes from DtF 2006 from commentary and challenge into analysis and action. The education and skills agenda for IT in the UK is the linchpin for the success and growth of the UK knowledge and creative economy. Skills and education develop the knowledge and flexibility to adapt and respond to market trends, competitive pressures (e.g. globalisation) and provide the means by which the UK can become a lead innovator in IT.

The section deals with three main areas:

1. Skills: providing insight into UK skills agenda from within the education system through to the work-place. It examines current strategies such as the IT Management for Business (ITMB) degree and goes on to provide action-oriented solutions for the implementation of a unified skills agenda within the work-place.
2. Secondary Education: analyses the fracture points in the current system, explains what impact these have on the overall education and skills agenda for the UK and provides solutions and recommendations for action.
3. Higher Education: examines the trends in undergraduate and postgraduate applications for both full and part-time modes of study. It provides a developed insight into the output from university to industry and provides examples of successful strategies that some universities are employing.

The section shows the problems that the UK will face if it cannot develop a cohesive action oriented strategy between industry, academia and Government.

POTENTIAL SHORTAGE OF QUALIFIED IT PROFESSIONALS IN THE UK

In 2005 the number of graduates from IT related degrees totalled 15,930.[30] Six months after graduation 71.5%, 11,390, were in employment or employed and studying; but only 42.4%, 4,829, were employed in the IT sector.[30] Research shows that unemployment among IT graduates is higher, at 10.3%, than the average for all subjects, 6.2%.

In 2005/6 the proportion of graduates from IT related degrees that chose to enter careers in the IT software professions was only 30% (rounded).[31] This is set against the UK IT workforce requirement that averages 156,000 – 179,000 per annum that covers both new jobs created from growth and replacement demand.

Put another way, 70% of IT graduates chose or found alternative activities or jobs outside of the IT profession in 2005/6, with 10.1% going on to study for higher degrees or other qualifications, 10.3% are unemployed, 4.3% are engaged in other activities and 3.8% are not available for employment, study or training. Of those finding employment 6 months after graduation a proportion may be classified as IT workers within other industry sectors based on the current government careers taxonomy and some may be in interim jobs.

There is an increasing demand for alternative graduate level skills that are only being met in part by graduate qualifications in computing. Research for this report indicates that there is indeed a 'pipeline' problem with fewer students electing to study computing at higher education institutions (HEIs) since the high point in 2001.

30 Data source: prospects.ac.uk & HESA
31 HESA, Destinations of Leavers of Higher Education, 200, cited by prospects.ac.uk, survey carried out 6 months after graduation

The number of advertisements monitored for permanent and contract IT staff appears stable at 150,000 since 2005.[32] The acknowledged number of entrants required for the IT workforce averages between 156,000 and 179,000 a year. This figure covers new jobs created from growth as well as replacement demand.

The sector may, therefore, be heading for a crisis that could have a substantial impact on the growth of the UK Knowledge Economy. But there are immediate interventions that can be taken to begin to turn the problem around and accelerate the growth of this important sector of the UK economy.

DEVELOPING SKILLS TO UNDERPIN THE GROWING KNOWLEDGE ECONOMY

There is a close correlation between successfully developing the Knowledge Economy and the need for a highly educated workforce. The Leitch Report (December 2006) examines the skills requirements within the UK. It states that the UK should aim to become a world leader and focus on economically valuable skills. The Leitch Report recognises that although considerable progress has been made with regard to education and skills in the UK, it is still behind other countries.

"The UK's skills base remains weak by international standards, holding back productivity, growth and social justice," said the report.

Even if current targets to improve skills are met, the UK's skills base will still lag behind that of many comparator countries in 2020. "The UK will run to stand still,"[33] warns the review.

Research by several agencies, including e-skills UK, CBI and McKinsey, shows that companies are hiring more workers for complex rather than less complex jobs.

Research shows that 70% of all US jobs created since 1998, 4.5 million, require judgement and experience. These jobs now make up 41% of the labour market in the United States. Most developed nations are experiencing a similar trend.[34]

Britain is experiencing a huge need for highly skilled employees across all industry sectors, in particular those industries which demand knowledge of technology and IT. Individuals with IT knowledge are finding their skills in demand not just within the IT industry itself but across other industry sectors.

The IT sector can no longer assume that all IT graduates will work within the IT industry. Many will use their skills within other sectors where rewards are the highest, working in sectors such as financial services. The universal demand for skilled IT people is great news for new graduates, but a challenge for the software development and IT industry sector itself.

ECONOMICALLY VALUABLE SKILLS

Evidence of the types of skills required by the industry is provided by the survey on the ICT labour market produced by e-skills UK.[35] The survey undertaken in the third quarter of 2006 indicates that there is still a skills shortage and that there are particular areas which are more problematic than others. The greatest problems are in those areas where applicants with high-level technical skills are required, such as computing and software engineering. Around one in ten businesses reported suffering recruitment difficulties during the period. A similar proportion of ICT recruiters were having problems finding suitably skilled applicants for jobs.

The sector skills council (e-skills UK) reports that when employers are asked for more detail about recruitment difficulties, they state that software engineers are considered to be the most difficult to recruit.

"The UK's skills base remains weak by international standards, holding back productivity, growth and social justice."

LEITCH REPORT

32 Computer Weekly/Salary Services Ltd. As reported by e-skills UK

33 Towards 2020 Science – Microsoft Research UK 2006 http://research.microsoft.com/towards2020science/background_overview.htm

34 Competitive advantage from better interactions; Beardsley, Johnson and Manyika, McKinsey, 2 2006

35 e-skills UK ICT Inquiry, Quarter 3, 2006

Government statistics[36] are likely to point to a growth in the software sector over the coming years (to 2010 – forthcoming Green Paper on the Creative Economy) and the UK could face a worse crisis in the near future if this issue is not addressed now.

The data that is available at present makes it difficult to separate out the key skills for sub-sectors of the ICT industry. The definition of ICT not only includes computing but other areas such as telecommunications. The data does not, therefore, give us a conclusive picture of the skills shortage as related to the software sectors. Some planned work with the ONS, industry and academia (Summer 2007) will aim at providing a more robust jobs/roles taxonomy that reflects the changing face of the IT industry that could be used to derive more robust statistics in order to differentiate more clearly between the IT industry itself and the more generalised use of technology in other industries.

PREDICTING SKILLS REQUIREMENTS

Organisations increasingly outsource the routine tasks and concentrate on developing the tasks which require judgement, experience and knowledge in order to develop a competitive advantage. Using technology to develop new processes, products and improve current work operations is vital in many organisations, not only within the IT sector.

The novel application of technology across other industry sectors in this way not only requires technical skills but also business knowledge, communication skills, specialist knowledge combined with knowledge of IT practice and project management skills. Combining knowledge of technology with other skills and applying these integrated higher skills gives organisations the ability to develop new innovation which in turn will drive a sustainable competitive advantage.

Organisations cannot afford to lose highly skilled staff with years of knowledge and experience and rely on trying to hire younger employees with an exact skills match for the projects they wish to complete. There are not enough new entrants into the IT profession to make this a sustainable strategy; organisations will have to commit to supporting lifelong learning. The process of understanding technology and its potential is continual, and the supporting knowledge and skills required also require continual updating.

Assuming that technology and IT has a refresh time of around 18 months, then it is fair to assume that the knowledge required to support this technology will also have a finite 'lifetime'. We have moved into a time when 'lifelong learning' is no longer an aspiration but a necessity.

We have moved into a time when 'lifelong learning' is no longer an aspiration but a necessity.

HIGHER EDUCATION

BRIDGING THE WORLDS OF ACADEMIA AND COMMERCE

The education sector does not necessarily respond in the same way as the private sector to emerging economic trends. It is simplistic to assume that all the requirements of a skilled workforce can be met by the education sector alone. It is also naive to assume that academia is motivated solely by the needs and requirements of industry. However, academic institutions are more exposed to market forces now that students pay for part of their own tuition.

KEEPING PACE – EDUCATION AND INDUSTRY REQUIREMENTS

New technology is being deployed swiftly where it can offer benefits that are both social and economic. Where there is demand for new technology there is a demand for the people to deploy it. The industry needs more people skilled in computing.

Demand for ICT workers has been quoted as being in the region of 150,000[37, 38, 39] workers per year. This is a huge figure and has provoked much alarm in some sectors of the economy. The UK Government is examining this issue in greater detail,[40] with work that is looking at not only the numerical or statistical figures but the distribution and mix of skills required for the industry.

WHAT DO THE FIGURES SAY?

Dr. Andrew Tuson of City University says: "The use of the term 'ICT' in Government statistics is telling. It confuses and combines two distinct though related industries: Information Technology and Telecommunications. Does this figure include telecoms installation technicians? If so, are we in danger of providing provision for which there is no real demand?"

36 IT Investment, ICT Use and UK Firm Productivity – summary of ICT effects, and measurement conclusions, T Clayton, Oct 2005, vol169kb, no 625; ISSN: 0013-0400

37 Microsoft UK, Developing the Future, 5th June 2006

38 The Office of National Statistics

39 UK Government Creative Economy Programme: Software Summit 21st March 2007

40 Ongoing work towards the UK Government Green Paper on the Creative Economy

The skills issue is not a simple one of numbers of graduates. Neither is it a case of 'predict and provide', a strategy that has consistently failed in previous government skills interventions.[41]

But there are some clear trends emerging:

- A move to 'higher-level' skills and roles[42] such as business analysis, IT service management and high-quality, high-value technology and software development. A salaries report by Hudson[43] notes that although IT salaries are increasing overall, the increase is going to the quality end: highly skilled managers and technologists. IT professionals without such skills and expertise are having difficulty maintaining their earnings and some are seeing their roles disappear.
- The increasing need for IT professionals to be 'lifelong learners' and update their skills, and the need for the IT industry to actively support their employees in making the transition to the changing skills profile.
- The balance of soft and hard skills is becoming more critical, with soft skills for IT graduates being of more importance than other STEM[44] disciplines. Prospects[45] quotes research by the analyst group Gartner, revealing that sound business acumen is just as essential to IT roles as technical ability.
- The 'traditional' Computer Science degree with its emphasis on purely technical skills will not be enough on its own to meet the needs of the IT industry; its valuable focus on technological and software development roles covers only a part of a diverse IT industry that increasingly is focused on supporting businesses in achieving its aims, rather than solely being a provider of technical services.
- Diversity of provision is therefore essential to providing a balanced IT graduate mix. The complementary skill-sets offered by 'Business Computing' and 'Information Systems' degrees – long-standing offerings by some universities such as City and Brunel – will play a larger role in satisfying employer's needs. Niche offerings such as Games Technology degrees will also play their part.

UCAS COMPUTING RECRUITMENT

The number of students joining UK universities to study computing using Universities and Colleges Admissions Service (UCAS) shows a sharp decline in numbers of full-time undergraduates accepted on computing courses, from 29,014 in 2001 to 18,341 in 2005. Figures for 2007 are considerably more encouraging and recruitment is up on previous years, despite the introduction of top up fees.

Developing the Future 2006 was concerned about the falling numbers of students enrolling on undergraduate computing degrees in the UK and in other developed economies. City University's Dr Andrew Tuson explains "It is worth noting that there have been boom/bust cycles in computing recruitment before,[46] usually around key technological transitions such as the introduction of the PC in the early 1980's or the internet boom at the turn of the century.

The recent recruitment expansion occurred when there was a stock-market bubble based on telecoms and internet start-ups, a time when the market was in clear disequilibrium and sending strong and very unrealistic employment signals to potential students."

Tuson said: "To put current recruitment in context, in October 2006 G4 (Computer Science) was the 6th largest JACS[47] group by acceptances[48] (9,987). Combining the total acceptances for G4-G7 groups[49] that cover all types of computing degree, gives a total of 14,313 acceptances. If this were a single JACS group, computing acceptances would be the second largest after law."

The latest UCAS statistics[50] for 2007 entry indicate that the large falls in applications of recent years are levelling off. Tuson concludes that "This tells a very different story to that of a discipline in trouble."[51]

The importance of computing at University is also emphasised by Professor Keith Mander, Chair, Council of Professors and Heads of Computing, Professor of Computer Science and Deputy Vice-Chancellor, University of Kent. "The Engineering and Physical Sciences Research Council (EPSRC)'s recent International Review of ICT Research (February 2007) shows that computing research remains strong – second only to the USA on many academic metrics, but notes the worrying decline in the supply of future researchers as undergraduate numbers fall. Despite the relatively large numbers of students still studying the subject, computing may be vulnerable as universities down-size their computing departments as demand from undergraduate applicants declines."

41 Alison Wolf, 'Does Education Matter? Myths about education and economic growth. Penguin Books, 2002, ISBN-13: 978-0140286601.
42 'Insights – Trends and UK Skills Implications', e-skills UK with Gartner Consulting, 1 Nov 2004.
43 Hudson, IT Salary Survey 2006, at: uk.hudson.com/documents/jobs_uk_ITSalarySurvey.pdf
44 Science, Technology, Engineering and Mathematics
45 'What do graduates do? 2007' at www.prospects.ac.uk
46 David A. Patterson, 'Restoring the Popularity of Computer Science'. Communications of the ACM, 48(9), 25-28.
47 Joint Academic Coding System
48 Source: Universities and Colleges Admissions Service (UCAS). See Table 9 on: http://www.ucas.com/new/press/news180107.html
49 Computer Science (G4), Information Systems (G5), Software Engineering (G6), and Artificial Intelligence (G7).
50 Source: Universities and Colleges Admissions Service (UCAS). See Table 8 on: http://www.ucas.com/new/press/news140207.html
51 For example: Neil McBride, 'Erase old programme and launch new version'. Times Higher Education Supplement, 9th February, 2007.

However, looking further into the UCAS data we can see that there are still a number of areas of continuing concern:

- Low levels of female applicants on computing courses
- Lower entry qualifications to computing courses compared to other subjects
- A decline of 8% in STEM subjects, an area which the IT industry is likely to recruit from

Dr Jeremy Wyatt from Birmingham University said: "Given that the industry has a history of drawing candidates from a range of mathematically focussed science and engineering degrees it is also important to consider the total applications to all these subjects. Between 1996 and 2006, applicants to the hard sciences and engineering declined by about 8%, showing that there is a continuing and long term decline in graduates of disciplines which have traditionally supplied the IT industry with its technical leadership."

The drop in students studying science, technology, engineering and mathematics (STEM) subjects therefore has an impact on the total pool of resources which the IT industry has traditionally recruited from.

The recruitment level during the dotcom boom should not be considered a desired or realistic baseline. It is becoming clear that we are returning to a state of normality with application levels around those of the late 1990's. Computing is still recruiting more undergraduates than most professions. Advertised vacancies are buoyant[52] and around 1999 levels – 150% higher than the nadir in 2003 – with salaries increasing. It is also clear that the research output of UK computing departments is world-class with excellent examples of knowledge transfer to industry.[53]

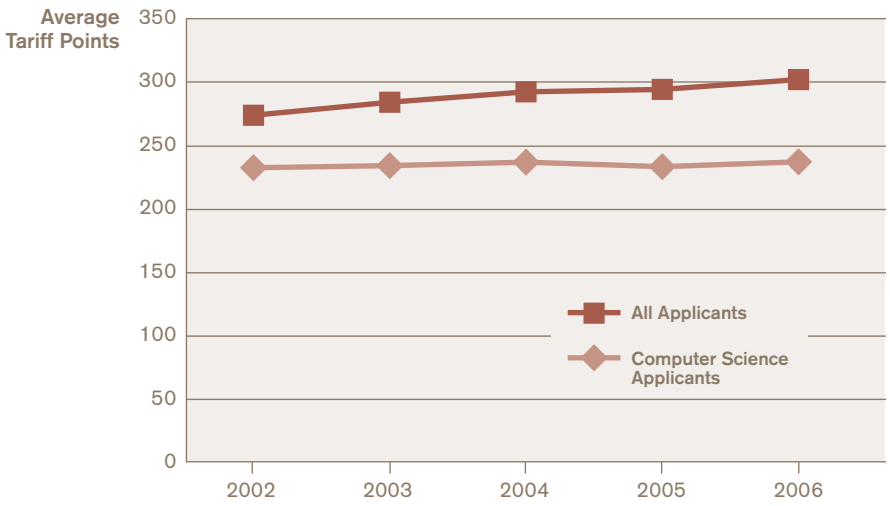


Figure 5:
Rise in Average Tariff Points 2002-2006

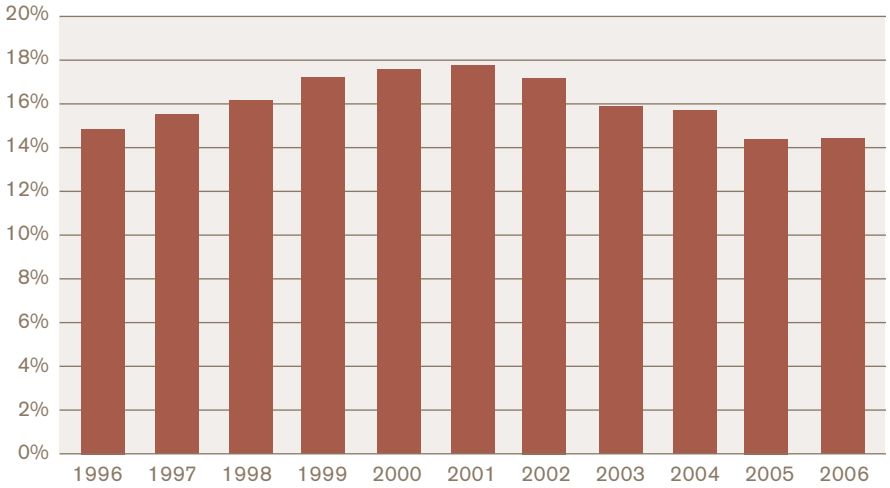


Figure 6:
Female Applicants as Percentage of Home Apps

52 Source: www.jobstats.co.uk

53 EPSRC, 'International Perceptions of the UK Research Base in Information and Communications Technologies'. December 2006, EPSRC.

LOOKING BEYOND UCAS DATA

Many analysts and the media look only at the UCAS statistics – unfortunately these show an incomplete picture.

The research for this report shows that the nominal 'decline' in full-time undergraduate acceptances (all courses) is being reversed. In early 2007[54] UCAS released a report that showed the number of people applying to full-time undergraduate courses at UK universities and colleges has increased by 6.4%. The rise represents 395,307 applicants applying to enter HE in 2007 compared to 371,683 in 2006. The snapshot of data is taken at UCAS' 15th January advisory closing date for UK and EU applicants.

Anthony McClaran, UCAS Chief Executive, said: "These figures are encouraging for all who believe the expansion of higher education is good for individuals and good for our society. Not only has last year's dip in applications been reversed, but application levels are now higher than in 2005 which had previously broken all records. The increase is particularly marked in England".

However, the picture for computing still shows a recent continued decline from the high levels of 2003 (across JACS G4-G7) for full-time applications. In contrast, research for this report[55] shows that there is a small but potentially significant growth in part-time undergraduates from a moderate baseline in the years from 1996 – 2000. This increase, or change of emphasis on study modes, might also be related to the introduction of top-up fees.[55]

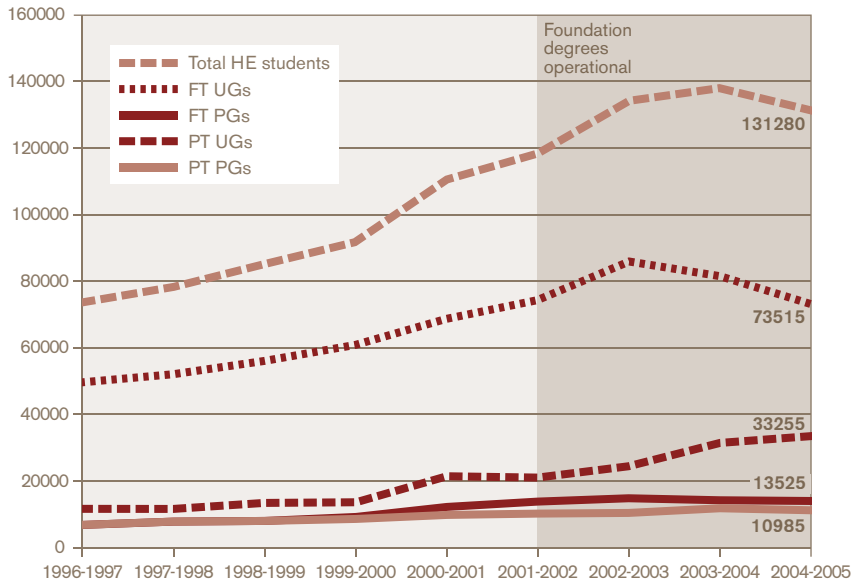


Figure 7:
Computing Students in HE with breakdown between FT/PT as well as UG/PG 1996/97 – 2005/06 DTAHESA-Dialogic

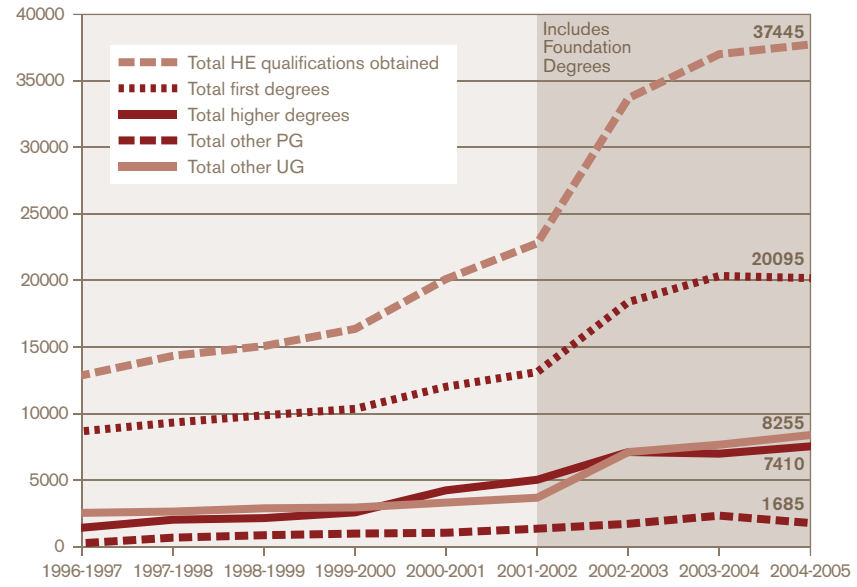


Figure 8:
HE Computing Qualifications obtained with breakdown between UG/PG & other UG/PG 1996/97 – 2005/06 DTAHESA-Dialogic

54 UCAS, 14th February 2007
55 Dialogic Consulting for City University London, February 2007
www.dialogic.co.uk with baseline data from UCAS

HE outputs are currently showing a significant improvement and this is largely in response to the increases seen in undergraduate recruitment in 2003, as these graduates feed through the system. However, in the short term these outputs will decline in response to the lower undergraduate recruitment thereafter.

Although initial research into the undergraduate UCAS recruitment figures for 2007 are showing that for the moment the picture is healthier than some commentators would have the media believe, it will take three years before these students graduate and take up employment.

While the output from HE looks encouraging today, in the short term this picture will change in response to lower undergraduate recruitment in the recent past. Any recovery in undergraduate recruitment will also take some time to feed through the system, so will not solve the immediate skills dilemma.

DEMOGRAPHIC CHANGES – THE ISSUES AND OPTIONS

The data shows that there is a smaller pool of potential young undergraduates from which to train and to recruit.

According to Government data,[56] under any plausible scenario this country is faced with a rapidly ageing population, in common with most other developed countries. Analysis shows that the age structure of the UK population has become older in the last 30 years. Predictions show that it is likely to age further in the next 30 years. The median age has risen from 34.1 in 1971 to 38.6 in 2004, and its projected to rise to 42.9 in 2031. Not only is the population ageing, but the proportion of the population under 16 is declining. In 1971 over 25% of the population were aged under 16, in 2004 this fell to 19% and is projected to fall to 17% by 2031.

IT GRADUATES – HIGHEST UNEMPLOYMENT – CHOOSING CAREERS OUTSIDE OF IT SECTOR

The data for 2006 suggests that the labour market for information technology is growing and there is demand for new graduates with these skills. Official labour market statistics have shown that the labour market in information technology is rising and recent studies have predicted strong growth in the numbers of vacancies in computing/IT of up to 20% for 2006.[57]

Examination of data from 2005 shows that six months following graduation, 71.5% of IT graduates (from the 2005 cohort) were in employment (including working and studying), compared with 71.7% for all subjects. IT graduates, however, were still less likely to be in further study (as a sole activity) and more likely to be unemployed. At 10.3%, the unemployment rate fell slightly from 2004 (10.7%), but was still substantially higher than the average for all subjects (6.2%).

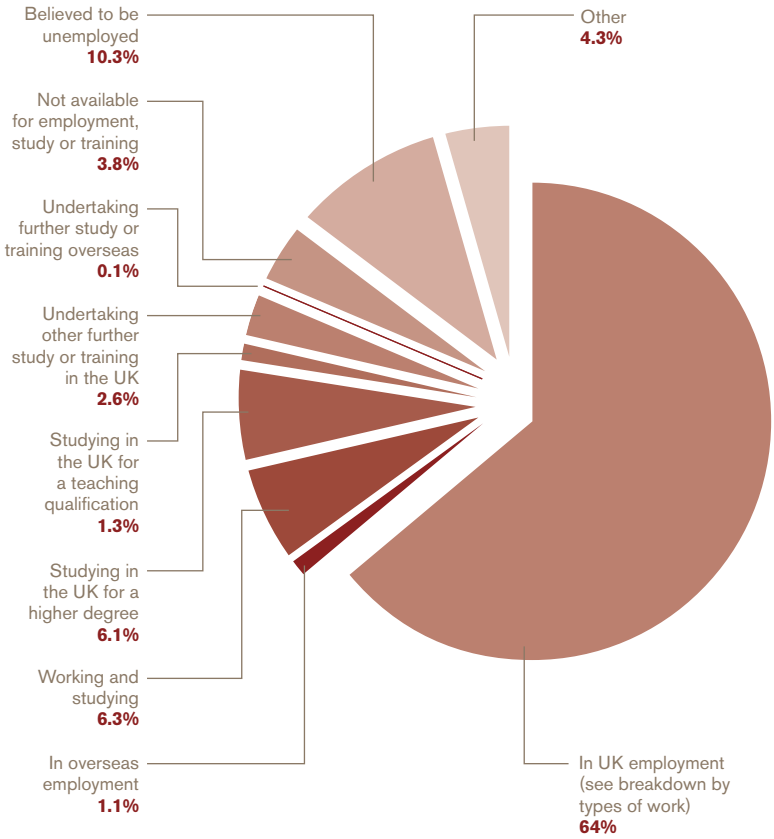


Figure 9:
Destinations of UK IT 2005 Graduates
Source: Prospects

56 DNS, People and Migration, www.statistics.gov.uk
57 Prospects 2004-2007

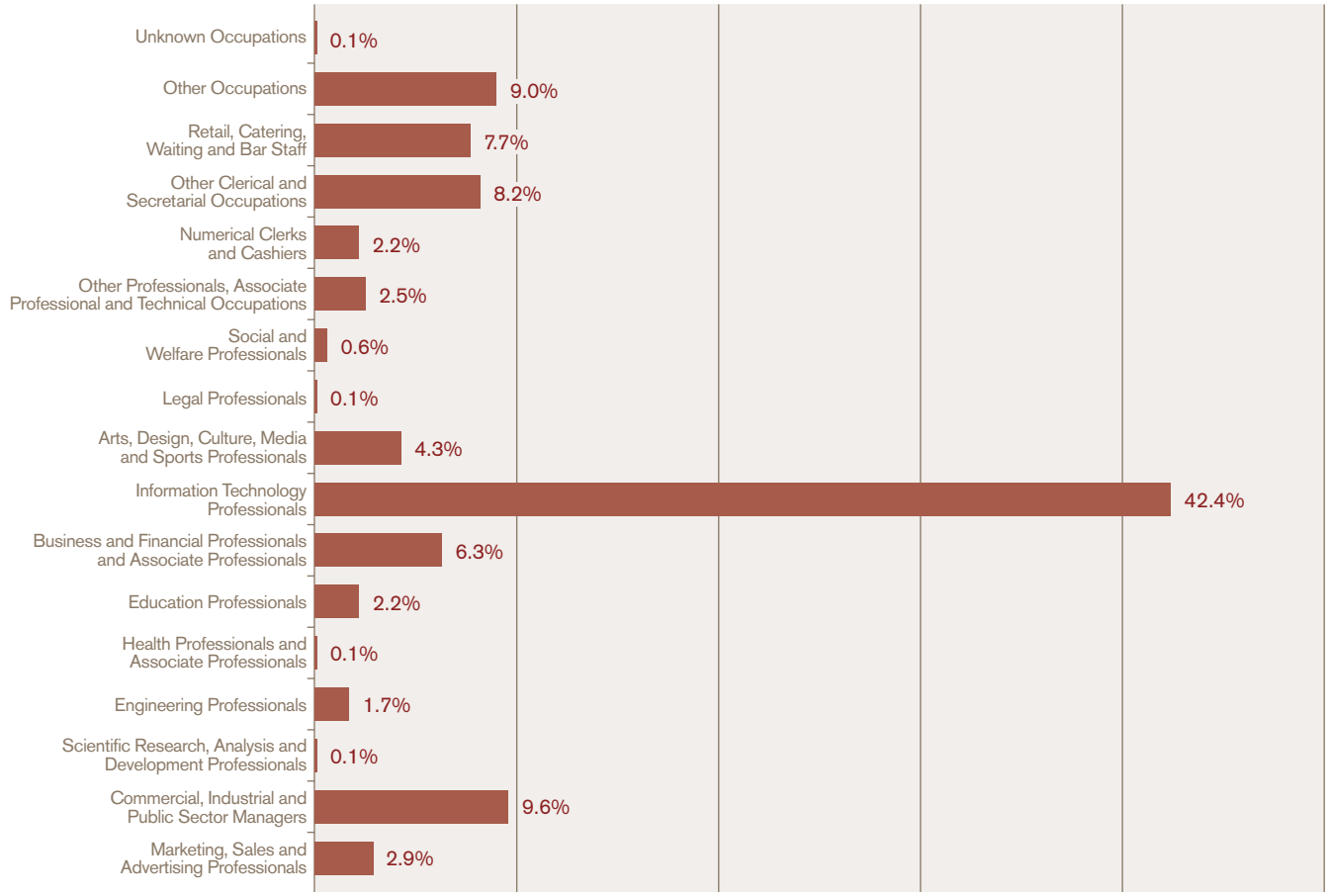


Figure 10:
Types of Work Graduates in UK Employment
Source: Prospects

Year on year the picture is not improving and research for 2006 shows that six months after graduation, 58% of computing/IT graduates were in full-time work, 7% were in part-time work and 6% combined work and study.

However, the research also shows that 11% were assumed to be unemployed. Of those in full-time employment, only 45% were working in the information technology sector and 11% were working in commercial, industrial, engineering or public sector organisations.

One aspect highlighted for this report shows that, of the 58% of IT graduates finding employment in 2006, only 42% (rounded) enter the IT profession.

ALL THIS DURING A TIME WHEN THE IT INDUSTRY IS IN ECONOMIC RECOVERY

A press report[58] that referenced the Prospects research revealed that the level of students applying to study computer science has halved in five years, leaving the sector short of the 150,000 new entries needed by businesses.

This data reveals a paradox, why is employment amongst IT graduates comparatively low at a time when demand for IT graduates is rising, and their skills are apparently in huge demand? In order to try to understand the employment statistics it is necessary to look at some further research.

Research by FDM[59] Group revealed the disparity that exists in the minds of graduates that the skills taught to them by university courses were outdated.

WHERE THE REMUNERATION IS HIGH – BUT THE ENTRANTS TO IT CAREERS LOW

The subject areas of Mathematics & Computing and Medicine and related subjects have two of the highest average annual earnings for both men and women.[59] This finding is corroborated by research undertaken by PricewaterhouseCoopers which show that a graduate in Maths or Computer Science can expect to earn, over his/her lifetime, £241,749 more than someone with two A-levels. So those graduates who go into the IT industry can expect to receive higher than average earnings throughout their careers.[60]

58 Computer Weekly (17 July 2006) citing research – Prospects final destination survey
59 DfES The Supply and Demand for Science,Technology, Engineering and Mathematics Skills in the UK Economy Department for Education and Skills Research Report RR775
60 The Times Feb 7th 2007

	Science and Technology Professionals (SOC code 21)	Health Professionals (SOC code 22)	Science and Technology Associate Professionals (SOC code 31)	Health Associate Professionals (SOC code 32)	All other occupations (All other SOC)
2004 (baseline)	947,000	277,000	593,000	1,045,000	26,449,000
2014 (forecast)	1,121,000	360,000	666,000	1,122,000	27,314,000
Change (%)	18%	12%	30%	7%	4%

Figure 11:
Projected employment in STEM occupations in 2014
Source: Science, Engineering and Technology Skills in the UK (DTI March 2006) based on SSDA Working Futures

UPDATING COMPUTING EDUCATION

The nature of IT has changed in recent times with significant numbers of graduates entering roles such as business analysis, consultancy and project management. Research by the analyst group Gartner, reported in the Sunday Times and referenced by Prospects, has revealed that sound business acumen is just as essential to such roles as technical ability.

Research related to the production of this report[61] has begun to examine some of the deeper issues and is raising some questions including:

- How much do key influencers, such as parents and teachers, affect the choices students make?
- Is it the case that those influencers have a different opinion of the career prospects in the IT sector?
- Did the dotcom boom-bust create a negative perception of the stability of a career in the software/IT sectors for key influencers?

The pre-university student is very well informed and is in essence a sophisticated consumer, one who is able to determine a good opportunity from a bad opportunity.[62] This is view borne out by e-skills UK, which is an employer-led, not for profit organisation, licensed by Government as the Sector Skills Council for IT and Telecoms.

Tilly Travers from the e-skills UK organisation said: "In a global knowledge-driven economy, IT professionals need to be numerate, literate, business and customer-oriented people who understand how to make the most of technology to transform the way we work and live. This requires a deep and sophisticated blend of business, technical, project management and personal skills – developed through a varied and balanced education."

Research shows that employers are looking for business-oriented technology graduates with the ability to demonstrate problem solving, project management, team-working and communications skills.[63]

THE ITMB DEGREE AND THE WORKPLACE

The need for these combined skills has led to the development of the information technology management for business (ITMB)[64] degree by e-skills UK which has had some limited success in recruiting students or licensing the course itself. Initial indications in March 2007 show that more universities are considering the ITMB degree as an option to aid with recruitment or indeed to offer as a benefit to their students.

61 Research – City University – M. Bowkis 2007; www.dialogic.co.uk
62 Dialogic Consulting, September 2006; interim report for Anglia Ruskin University, School of Applied Sciences on the changes to undergraduate recruitment markets in the Eastern Region.
63 e-skills UK – T. Travers, 2007
64 e-skills UK, ITMB degree: http://www.e-skills.com/cgi-bin/go.pl/itmb/itmb.html

The ITMB degree and courses from higher education institutions (HEIs) such as City, Brunel and other universities give business skills, project management and personal skills as much prominence as technical skills.

The ITMB degree includes some interesting concepts and, in addition to traditional lectures and tutorials, the degree course includes a programme of employer involvement that keeps students up-to-date with topical issues in IT. For example, representatives from business regularly share their experiences and vision in the form of 'guru' or 'leading-light' lectures.

The courses also feature 'real life' group projects during which students work with IT professionals on authentic business challenges. ITMB students are expected to undertake at least one extended business placement, and these are often hosted by one of the supporting companies.

PROFESSIONAL PERSONAL SKILLS DEVELOPMENT

As the population ages and new talent becomes less available, employers and employees will need to re-skill or up-skill existing talent. The need for continual professional development was highlighted in the Government's recent report on skills and education.[33] The Leitch Report argued that in order for people to progress in the modern labour market, it is critical that they are able to update their skills.

This report goes on to recommend that the UK should aim to have 40% of its adult population educated to a high level (level 4 or 5 – degree and postgraduate). By changing educational targets and offering incentives to HEIs to work closely with industry, the aim is to enable adults to continually invest in updating and developing their skills.

The report argues for "a culture of learning to be fully embedded across society." This cultural change will take time but the forecast is one of huge economic benefits for the country as a whole "The prize means more economic prosperity and increased social justice. It would deliver a possible net benefit of at least £80 billion over 30 years, an annual average of £2.5 billion."[33]

The discussion so far neglects an important source of HE provision for the IT industry: masters graduates. UK universities in 2004/5 admitted 7,070 full-time and 1,460 part-time taught masters students in computing.[65] In recent years this has remained broadly stable.

Postgraduate provision plays two important roles. First, it allows established IT professionals to upgrade their knowledge and skills, which given the move to higher-level skills will be essential if we are not to lose existing talent. Second, it provides a route for non-IT graduates to enter the profession; these graduates often have complementary skills that enrich the IT profession. It may be the case that these students are more responsive to recruitment efforts. The lead-time is also shorter for masters study – one year – allowing a faster response to skills shortages in the industry.

WHAT WILL FORCE A HIGHER UPTAKE FOR PROFESSIONAL DEVELOPMENT?

There is already recognition of the problems facing the industry and a willingness on the part of many university departments to work more closely with industry. Examples include the Cisco Development programme and the Microsoft university programmes. These allow students to learn the IT fundamentals using state of the art equipment and software in a practical way at the same time as working towards their academic qualification.

Mike Smith, Principal Lecturer and Cisco co-ordinator at Anglia Ruskin University, said: "Anglia Ruskin's main educational collaboration with Cisco Systems is through the Cisco Networking Academy Program (CNAP). The CNAP is a comprehensive e-learning program that provides students with the internet technology skills essential in a global economy."

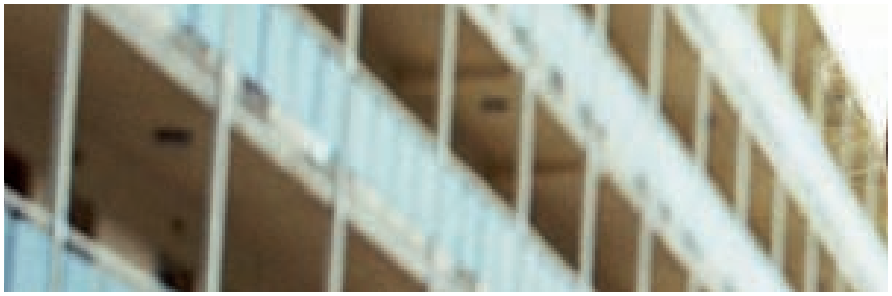
According to Smith, the benefits to Anglia are numerous, but the key benefits are: curriculum enhancement, external profile industry certification, external income and research.

"In a global knowledge-driven economy, IT professionals need to be numerate, literate, business and customer-oriented people who understand how to make the most of technology to transform the way we work and live."

TILLY TRAVERS, E-SKILLS UK

33 Towards 2020 Science – Microsoft Research UK 2006 http://research.microsoft.com/towards2020science/background_overview.htm

65 Source: Higher Education Statistics Agency (HESA)



There is a gender gap in the IT industry as a whole and in the software development industry in particular. Currently, only one in five of the UK's IT workforce is female and only 17% of those undertaking IT-related degree courses are women. In Scotland, only 15% of the IT workforce is female. Given the industry's need for high level skills it cannot afford to overlook large sectors of the workforce and so it is essential to do more to encourage women into the industry.

Young women from all walks of life are now, more than ever before, engaging with the use of computer technology as a means of communication. The assertion that women are not as good at Computer Science is untrue.[66]

In the USA, the Carnegie Mellon Women@SCS Action Plan[67] has had some success in increasing the entry and retention numbers from 7% to 38% between 1995 and 1999. It would be appropriate for a similar initiative to be established in the UK, so that the small number of women currently recruited to CS degree programmes can gain the support of a larger group across the country.

The CC4G programme, has more than 70,000 girls in over 2,400 schools, has been developed for girls in response to the gender imbalance within the IT industry. The programme has been developed as a response to an e-skills UK strategic objective in order to improve the attractiveness of technology careers, so that they appeal to the quality, quantity and diversity of recruits the industry needs.

IMMIGRATION

One method of alleviating the skills shortage in the software development and IT industry as a whole is to encourage skilled workers from overseas to work in the UK. Net migration to the UK was 185,000 in 2005.[68] The latest estimates show that around 510,000 people from the A8 accession countries have registered to work in the UK since May 2004. Migration generally has a positive effect, helping to mitigate skills shortages and fill jobs.

Between 2001 and 2004, some 110,000 work permits were issued in total for IT occupations, representing no less than 20% of the total work permits issued for all occupations, despite the fact that IT occupations represent only 3.5% of the workforce.

Although immigration alleviates the problem, it treats the symptoms not the illness. Britain needs to invest in developing the skills of the UK to ensure the future ability to compete across the IT sector and the whole economy.

SECONDARY EDUCATION

COMPUTING – THE IMAGE IN SCHOOLS

There is evidence to suggest that the problems relating to the shortage of people entering the IT industry starts at or during Key Stage 2 in the education system.

The current schools ICT curriculum is out of step with the 'New Media World', where content blurred across TV, internet and mobile communications. This is compounded by the fact that ICT teaching to 16 years of age is all about gaining skills in computer software use.

Peter McOwan from Queen Mary, University of London said: "Young people are fighting hard to create the content for TV, but what about the content for PCs, software? Software engineers have fulfilling well-paid and successful careers and their work can really change society. But students see this world as filled with problematic stereotypes, career dead ends and dull office work. Changing the perception of the industry is a fundamental requirement to attracting more individuals into an IT career."

There is an economic justification for supporting this effort. The creative economy, which relies on software, has been predicted to grow to 10% of GDP per annum by 2010.[40]

THE ICT CURRICULUM NEEDS RADICAL REFORM

Within state secondary schools, ICT is taught as part of the National Curriculum but has not kept up with the technological developments within the industry. Therefore, many students see it as increasingly irrelevant and unattractive.

40 Ongoing work towards the UK Government Green Paper on the Creative Economy

66 Fisher A, Margolis J, and Miller E. "Undergraduate Women in Computer Science: Experience, motivation and culture" ACM SIDCSE Technical Symposium

67 Carol Frieze, "Building an Effective Computer Science Organisation: The Carnegie Mellon Women @SCS Action Plan", Inroads SIGCSE Bulletin Women in Computing: vol34. No2. 2002, June P74-78

68 Leitch Review of Skills . "Prosperity for all in the global economy – world class skills" December 2006. HMSO, ISBN-13: 978-0-11-840486-0

The National Curriculum forces teachers into prescriptive teaching. Many now find themselves in a situation where they are forced to teach many areas of ICT which are increasingly irrelevant, and yet neglect new emerging areas such as digital video production, animation, music sequencing and digital image editing.

Many analysts and education specialists have concluded that the teaching of ICT from Key Stage 2 onwards is in need of a thorough overhaul and some recognition is given to the belief that the national Key Stage 3 online test would only have exacerbated the problems faced within schools.

The ICT test was designed at an estimated cost of around £25 million to measure attainment in practical ICT skills at 14 years. It has been piloted annually since 2004, and was due to be statutory from 2008. Some analysts say that the recent announcement that the test will not be run and withdrawn signified a u-turn in policy.

This report has made it is clear that the issues facing the lead into HE from STEM subjects and Computing within schools are felt in the HE sector; the direct result has been the decline in applications from the high point in 2003/4.

ICT IN THE NATIONAL CURRICULUM IS NOT COMPUTING

The significant issue regarding teaching Computing in schools is the skewed focus within the curriculum on computer and 'software use'. With no GCSE in Computing or Computer Science as part of the National Curriculum (only the GCSE in ICT; which is not about the subject of computing) learning to use a computer and learning Computer Science become indistinguishable as far as students are concerned. The skew in emphasis has a direct bearing on a students' view of the IT industry; one that results in many negative perceptions.

With many families having greater access to computing technology, children are obtaining computing and 'software use' skills far earlier and often at home. In addition many Primary schools are providing good ICT use skills, often delivered in quite interesting ways.

The problems start to manifest themselves at Key Stage 2, here the ICT curriculum is outdated and in some instances the delivery is a repetition of previous work.

Whilst it is recognised that gaining computer and 'software use' skills is essential for entry into the work-place there is also a need to provide an education option for Computing or Computer Science at GCSE within the National Curriculum. The current policy and thinking is only serving to de-motivate children that see ICT teaching as outdated and boring and their tendency is to extrapolate this to further study in Computing and indeed Computing as a career option.

More emphasis needs to be given to the contribution that technology makes in creating and sustaining the modern economy.[69] To enter higher education, students need to understand something about ICT in the same way as they need to be able understand some mathematics or to write an essay.

"Young women from all walks of life are now, more than ever before, engaging with the use of computer technology as a means of communication. The assertion that women are not as good at Computer Science is untrue."

FISHER A, MARGOLIS J, AND MILLER E.
UNDERGRADUATE WOMEN IN COMPUTER SCIENCE:
EXPERIENCE, MOTIVATION AND CULTURE.
ACM SIDCSE TECHNICAL SYMPOSIUM

69 "Ensuring the right conditions for an innovative, inclusive and competitive UK Knowledge Economy", DTI, Information Age Partnership, i2010 Working Group report, 9th May 2007

RECOMMENDATIONS:

- More research needs to be undertaken into verification of the detail regarding the break points in the skills and education agenda for the UK with regard to IT and the software industry. This should be action oriented, with measurable outcomes.
- Large software companies should be encouraged to develop and enhance their existing education programmes for individuals, schools and HEIs with the support and backing from Central Government.
- Initial pilot studies must be conducted to devise the best support networks and strategies that bring together industry and academia with the support of the Government for a radical reform of ICT teaching across the Key Stages 2 and 3 through GCSE and A-level to university entry.
- Industry and academia should develop a system of mentoring and supporting a continued education programme for school teachers for the subject of Computing.
- Implementation policies for taking the recommendations of the Leitch Report forward for Computing should be devised in concert with industry and academia and not in isolation from Central Government.
- Innovative programmes of continual professional development from industry need to be further developed and integrated into the workplace to facilitate the notion of 'cradle to grave' education.
- Government needs to examine and provide the incentives that might be required for the SME sector to ensure that businesses can afford to provide the skills and education packages required to develop staff capability and productivity.
- Industry should work proactively with the HEIs to develop suitable education and training packages for SMEs that would provide relevant education whilst simultaneously offering a means for connecting industry and academia together in a meaningful way.
- e-skills UK should re-evaluate the business licensing model for the ITMB degree so that it is attractive to HEIs, rather than a financial disincentive as it is at present.
- Academia should examine undergraduate and postgraduate provision and provide flexible mechanisms to ensure courses are easily updated without over-burdensome and slow internal accreditation processes.

SUMMARY

Research shows that the skills required by the IT and software development industry are changing, and the growing Knowledge Economy in the UK and overseas is also demanding employees with a similar range of skills to those required by the IT industry.

While prospects look good for new entrants to the IT industry, research shows that many IT graduates are not entering the industry itself, but are gaining employment in other sectors. The stark figures are that in 2005 only 42% of IT graduates in employment worked within the IT sector (within 6 months of graduating), only 4,829 graduates out of a total population of 15,930.

IT graduates are now in demand across the whole Knowledge Economy and not just within the IT sector, so competition to recruit employees with professional business and technical knowledge is fierce. As the IT sector grows, the existing skills shortfall of IT professionals will become more acute.

The report shows that there are ways in which the industry can work to support the development of the skills that it requires. Undergraduate student numbers are not falling as disastrously as predicted, and in fact there are areas of recruitment which see signs of growth. It is vital that the IT industry is proactive in working closely in partnership with academia to develop courses and programmes of study which offer students the chance to develop appropriate professional skills and find relevant subsequent employment.

Where these partnerships have been developed the report shows that recruitment and subsequent employment for students is high.

Changes to the future demography of the country will mean that we need to develop a range of strategies to ensure more students are equipped with the skills needed for the industry; these will have to address an increasingly ageing population as well as a reduction in birth rate.

IT has an accelerated development profile when compared to other sectors. New technology is produced at a cycle of approximately 18 months. Degrees on the other hand can take between one and two years to develop and accredit; with a delivery time of three years, the outputs from the HE sector are typically 4-5 years out of date by the time the first cohort has graduated. Unfortunately some degrees in HEIs have not been radically overhauled since their creation and are in fact much more dated that this figure suggests.

IT graduates are now in demand across the whole Knowledge Economy and not just within the IT sector, so competition to recruit employees with professional business and technical knowledge is fierce.

the future

How Today's Teenage Kicks Will Turn Into Tomorrow's Best Business Practices

BY MATT LOCKE

The business world is about to go through a major shift from centres of excellence to networks of excellence.

Five years ago, we still lived in a world where the best way to ensure competitive advantage was by centralising investment and resources in a way that still happens in sectors such as the pharmaceutical industry. For example, about five years ago, when I was at the BBC, we signed a three-year contract with the MIT Media Lab in Dublin, giving the BBC access to MIT's research and ideas. But it was already becoming obvious that this sought-after knowledge had already escaped the narrow confines of any single research institution. The writing was on the wall, or rather on the web, as even then researchers at that level were posting blogs on the internet discussing the latest concepts.

Therefore, about three years ago, Tom Loosemore and I developed an open innovation strategy for new media. This was in recognition of the amount of informal projects we were seeing out there that used BBC content as a base. As a result of this, we started a series of experiments. The first lesson we learned about running open innovation projects of this nature is that once you've opened the door, you can't close it again afterwards.

It might seem obvious, but the world outside your organisation isn't one homogenous blob. The web is just a small sub-sector of this world, and that, in turn, isn't one homogenous blob either. It's easy to just stick an invite for ideas online, but it's a pretty crude way of starting a conversation, and leaves you open to getting crude responses back.

We identified a few generic communities that we wanted to build conversations with – Corporate Peers, Academics, Indies and Lead Users – and tried to think about the dynamics of each community. The projects we designed were very different as a result.

As with any information gathering process, listening is a crucial skill. By engaging and supporting a community of interested developers, we found out about trends within the industry. When handling independents, it pays to ask strategic questions and do half-day sessions to establish what we want from proposals, so that people aren't pitching into a vacuum.

The internet may enable your organisation to reach everyone, but it is important to remember that not all the people who might have good ideas for your company are the same. A strategy for starting different kinds of conversation about innovation with different communities is crucial. Does a group you want to reach already have existing mailing lists, meetings, social media sites? Do they prefer to be approached via email? Blog posts? Conferences?

This new way of building a network of excellence is not just some empty hippie liberation rhetoric, it is a crucial element in increasing the speed of bringing products to market. Security is also a central consideration. Most projects have elements that are public and in full view, and some that are private. For example, many entrepreneurs are understandably wary of submitting ideas to an open forum. It is important that participants retain all the intellectual property (IP) on their ideas as this also encourages open discussion.

Far better to not try and own the IP, and instead encourage a collaborative conversation about how you can make something actually happen. To do that, you need people to drop their defences and actually trust you not to rip them off. Keep the lawyers to one side until you've got something that you can actually build.

At the BBC, we ran workshops where we asked the participants to sign a contract that said they owned all the IP on the ideas they develop over the five-day workshop. But we also asked for a 90-day 'first look' clause that means they could only talk to us about developing it for that period after the end of the Lab. After that, or if we decided earlier that we were not interested, the team were free to take their idea anywhere else.

The last thing to remember is that Open Innovation is an evolving process. The speed of this evolution is likely to increase sharply within the next few years as the so-called 'MySpace' generation start to enter the workplace. Just as previous generations of teenagers defined themselves through cars, record album covers and, most recently, mobile phones and music players, today's teens are using social networking to establish their identities. In doing so, they are forming lifetime habits that will soon spread to the workplace.

Used to communicating and planning together online in gaming as well as on social networking sites such as FaceBook and MySpace, younger people will expect to develop projects in a similar way when they enter the business world in a few short years time.

Matt Locke, www.test.org.uk, former head of innovation BBC New Media.

"Just as previous generations of teenagers defined themselves through cars, record album covers and, most recently, mobile phones and music players, today's teens are using social networking to establish their identities."

MATT LOCKE, FORMER HEAD OF INNOVATION, BBC NEW MEDIA

The future of software based technologies is transformational with massive potential to drive significant growth and prosperity in the UK economy.

Futures

EMERGING TECHNOLOGIES

We are entering a new age where computing and software technology start to fulfil the vision of the great science visionaries such as Arthur C Clarke[70] and Isaac Asimov, with new advances pushing the boundaries of human knowledge. Much of what seemed impossible or even improbable only 10 years ago is now a reality.

In the recent report 'Towards 2020 Science',[33] an international expert group was brought together to produce a new vision and roadmap of the evolution, challenges and potential of computer science and computing in scientific research in the next 15 years.

With new discoveries comes complexity and we are generating vast amounts of information or data plus the need to analyse or process data, more rapidly than before is what differentiates the new scientific discovery process from previous generations. Both in science and business, the need to analyse and operate huge data stores in near real-time is essential for success.

Most drugs that are developed today are in fact discovered. Very few are actually designed or specifically synthesised. But what if we could design small molecules to switch genes on or off at will, to stimulate the production of proteins or reduce them, to control the mechanisms of our biological processes directly?

Some recent research, currently being validated by many independent groups around the world, has stumbled across an unexpected mechanism that might be used to switch on genes. In order to do this, small fragments of biological molecules called RNA (specifically RNAi) can be designed to locate specific sections of the human genome, acting as switches that operate at the source of protein production. These molecules can be designed to locate and act as a switch to the gene that might, for example, be an anti-cancer gene.

To locate the regions on the genes and to determine where these bio-molecules (RNAi) attach themselves, or indeed to understand if there is only one specific place that the molecules do act as switches, researchers need to trawl through the entire humane genome, looking for exact pattern matches. They need to interrogate the genome database repeatedly, demanding answers rapidly, modifying their molecular designs, undertaking additional experiments and asking additional questions.

This process of interrogation requires dealing with complexity and speed, utilising new computing technology to provide the means for answering questions rapidly, for undertaking searches and refining the ideas prior to any physical experiments being carried out. Without this new computing technology it would not be feasible to ask the questions, to search for the sections on the human genome and to rapidly redesign experiments.

33 Towards 2020 Science – Microsoft Research UK 2006 http://research.microsoft.com/towards2020science/background_overview.htm

70 The Arthur C Clarke Foundation – see www.clarkefoundation.org

There are experiments now generating vast quantities of data: the projects at the Sanger Institute near Cambridge, UK, store over 150 terabytes of genomic data and clusters of computers totalling 2.5 teraflops of processing power. The problem is not one of obtaining data, but one of processing such vast quantities of information rapidly. How can billions of data items be searched and manipulated in an acceptable time-period?

The answer to this question lies in novel computer architectures that are vastly different from traditional computers. For example, we are using networks of ordinary computers to develop ever more sophisticated parallel and grid systems to try and accelerate our scientific discovery process. Many of these are being used now on climate prediction models and medical research.

INDUSTRIAL R&D AND PURE RESEARCH

Research into new computing technologies can be divided into two equally important categories: industry based research and pure research. The former, industry led, is typically geared towards advancement of products and services (often termed R&D) to develop new, usable technologies that can transform our lives in society immediately or in the near future.

The second, pure research, is unfettered exploration into sciences that could radically transform human knowledge or understanding; all of which may have no immediate financial return. Like previous research in physics and electronics that led to the development of the transistor and ultimately the modern computer, much of today's computing research could change our lives drastically in the future, in twenty, fifty or a hundred years from now.

Both aspects of research are equally important and Government investment and support for each is required if we are to accelerate the development of usable research that will drive society forward (see sections on Innovation & Education for specific recommendations and also the initial introduction that provides the data on the contribution to UK GDP).

EMERGING TECHNOLOGIES

Web Services are operations that users access via the internet through a well-defined interface, independent of where the service is executed. It is estimated that worldwide spending on web services-based software projects will reach $11 billion by 2008, compared to $1.1 billion in 2003;[71] a growth factor of 10 over a five-year period. The conclusion we draw here, is that the financial future for service based software technologies is massive.

For most of the 20th century, computing power was driven by Moore's law – as the number of transistors on a chip doubled more-or-less every 18 months this was translated into a doubling of computational throughput, producing faster machines more capable from one generation to the next. Now, in 2007 it is becoming clear that such growth has physical limitations.

But although individual computers may not get much faster, we will see the development of parallel computers, with multiple processing elements on one piece of silicon or within one integrated circuit package (what is termed multi-core computer architectures). Many of the new types of machine are now on the shelves ready to buy today. Typically they contain two to four computing cores, but in future we will see the next generation of computers delivering many orders of magnitude more processing power than we have seen to date. Multi-core machines will be the norm within the next twelve months. From a programming point of view this will require a paradigm shift away from the current sequential approaches to software design to one that exploits a parallel approach to computation.

"Bringing together advances in data management, analysis, knowledge discovery and visualisation could change the way in which some science is carried out."

ANDREW HERBERT,
MANAGING DIRECTOR OF MICROSOFT RESEARCH, UK. MICROSOFT DISTINGUISHED ENGINEER

71 Leavitt N., 2004, 'Are Web Services Ready to Deliver?'. IEEE Computer, 37(11), 14-18

From the new Web 2.0 systems the current web service enables towards the next generation, including the semantic web, we shall see an increase in the development and use of peer-to-peer computing, enabling the construction of distributed systems without any centralised control or hierarchical organisation. These will scale up to large systems and use the fact that there are multiple machines, cooperating with one another, to build in fault tolerance. Should one or even several machines be removed from the network (or indeed fail completely) the system will adapt to the event and continue to operate as if nothing had occurred.

This technology will be integrated into the new mixed or multi-media computing and communications channels that are just emerging.[72] Rapid advances in distributing video on demand, integrating voice with other forms of interaction and communication to provide novel and exciting interactive experiences in entertainment are among some of the latest ideas that will use these technologies.

We are also witnessing the emergence of haptic devices, that allow sensory feedback to the human from the computer, in areas such as surgery. This new technology allows surgeons to practice high risk surgical procedures in a virtual world. Operating on a brain, learning the procedures and techniques in a virtual world with sensory feedback to the hands holding the scalpel emulates what would be experienced when operating on a patient.

Within the next few years, such haptic devices will find their way into multi-media systems, games technology and sports training systems.

REVOLUTION IN SCIENTIFIC INVESTIGATION

A revolution is taking place in the scientific method of: "hypothesise, design and run the experiment and then subsequently analyse the results" – in some instances this is being replaced by "hypothesise and look up answer in a database," says Andrew Herbert, Managing Director of Microsoft Research in the UK. Herbert adds: "Databases are an essential part of the infrastructure of science: they may contain raw data, results of analyses or simulations or the results of the organisation of data."

A major issue is the distribution of data. It has long been known that it is expensive or impossible to move large amounts of data. Traditionally, queries have been optimised for small numbers of databases, but how do we optimise queries for say a network of several million environmental sensors or massive amounts of online information? How do we explore the data from the Human Genome Project or the LHC particle accelerator at CERN, the European organisation for nuclear research?

Herbert says: "Attempting to solve the problems of scientific management by building large centralised archival repositories is both dangerous and unworkable. New distributed data sources are required and these in turn present their own challenges."

Today much of this scientific processing is done using home-brew software or simple spreadsheets. There is a tremendous opportunity to exploit Online Analytical Processing (OLAP) add-ons to modern database engines. These allow for the construction of 'data cubes' serving as replicas of pre-computed, multi-dimensional aggregations of information. These facilitate data analysis from multiple perspectives.

Bringing together advances in data management, analysis, knowledge discovery and visualisation could change the way in which some science is carried out. Herbert goes on to say that "such changes empower the individual scientist; we can envisage a truly smart (electronic) lab notebook. Such a device would unlock access to data and make it extremely easy to analyse, discover, visualise and publish new phenomena."

INTELLIGENT SCIENTIFIC AND BUSINESS COMMUNICATION

The worldwide web was invented for publishing and communication. In future, information will be transformed for visualisation for an individual, determined by personal preferences. Online pages will be generated at the moment they are requested allowing customisation according to a particular time and place. The reader's access device could be a smart phone, electronic paper, a personal computer or richly equipped collaboration environment.

Computational approaches to systems biology may also help address the challenge of finding sustainable forms of energy, for example from bio-energy crops with near carbon neutrality if grown, harvested and converted efficiently with predictable performance.

72 See www.skinkers.com for an example of current sophisticated peer-to-peer solutions

Understanding the large-scale structure of the universe requires that data from surveys are compared to models which predict the distribution of galaxies. There is great potential for tools that steer computation, fit models and automate data analysis to improve our knowledge of the universe.

RECOMMENDATIONS:

- A curriculum review of teaching computing and ICT in schools is required. We need to find ways to inspire young people in computing in order to generate new recruits into the industry.
- The IT sector needs to communicate technological developments and their implications to the youth sector in particular in an attempt to generate interest and enthusiasm.
- The Government needs to radically review computing skills with a view to future requirements.
- The development elite within the IT sector and those who truly understand the scientific basis of emerging technologies need to collaborate in order to advise and guide on the development of the skills agenda for the growing computing sector. It is not reasonable to expect those who do not understand the fundamental technology within the sector and how it can be applied and developed to be able to forecast and develop a skills and education programme which will feed through to the sector in the future.

SUMMARY

The 21st century presents some of the most important questions, challenges and opportunities in human history. Some have solutions in scientific advance (eg. health). Others require political or economic solutions (eg. poverty). Some require significant scientific advance in order to provide the evidence necessary to make economic and political decisions (eg. our environment).

Computing is changing the way we work and live enabling new discoveries in almost every field of knowledge, creating massive opportunities for global collaboration, and at the core of most business practices and operations. The future of software based technologies is transformational with massive potential to drive significant growth and prosperity in the UK economy.

The impact of Web 2.0 on the way that companies sell goods and services to the public will be even greater than the changes already wrought in sectors such as travel and entertainment. The convergence of computing and telecoms will continue to allow consumers increasingly to determine the nature of the products and services on offer.