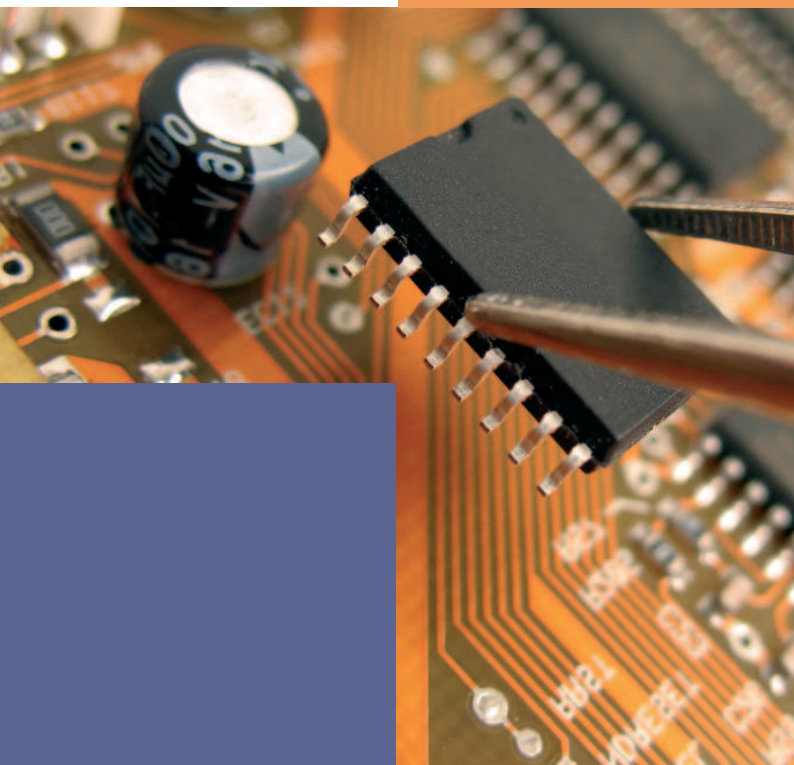


EMERGING TECHNOLOGIES, EMERGING MARKETS



Are You Ready for the Opportunities?

October 2009

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ARE YOU READY FOR THE OPPORTUNITIES?

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The New Engineering Foundation (NEF) is an independent and strategically focused charity (registered in England number 1112354) that works with key partners and stakeholders to support the advancement of education for the benefit of the public. It was established in 2004 as a grant awarding charity and a think-tank that supports vocational Further Education in Applied Science, Engineering and Technology through:

- Research, Policy and Advocacy;
- Programmes and Resources; and
- Knowledge and Technology Transfer.

Our mission is to achieve measurable and visible improvement through collaboration and partnership by providing a shared vision which:

- Engages all the key national and regional stakeholders;
- Enriches teaching and learning professionalism;
- Enhances and develops the capability of individuals , providers and industry; and
- Empowers change in individuals (teachers, trainers and tutors), providers and industry.



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FOREWORD



Lord Mandelson

As a modern knowledge economy, Britain's future competitiveness and prosperity relies on the strength of our science and research base.

Just as much of our past success has been built on the discoveries of great British scientists and engineers such as Wheatstone, Hodgkin and others, future innovations will help this country secure a lead in valuable hi-tech sectors like low carbon, digital technologies, industrial biotech and advanced manufacturing, such as composites in the years ahead.

To drive that innovation, Britain needs people, businesses and infrastructure equipped to maximize these market opportunities and benefit fully from the development and application of new and emerging technologies.

As set out in our policy document Building Britain's Future: New Industry, New Jobs, the Government is taking an active approach to tackling that challenge. Our further education system has a critical role to play, helping Britain's current and future workforce get the intermediate and higher level skills we need to succeed.

In the coming weeks, the Department for Business, Innovation and Skills is bringing forward new frameworks for adult skills and higher education policy that will include tools to track and help meet skills needs and demand in our economy, including in science and engineering.

This report provides a valuable contribution to Government thinking on how we can drive

improvement in our FE sector further, highlighting some important and relevant key messages.

Government is already tackling many of the issues raised in the report, including through the creation of the Skills Funding Agency, and I welcome the continued work of the New Engineering Foundation as Government works to secure a strong future for British science and engineering.

The Rt Hon Lord Mandelson is Secretary of State for Business, Innovation and Skills

ACKNOWLEDGEMENTS

We acknowledge with gratitude the support received from the Gatsby Charitable Foundation.

We are very grateful for the invaluable contributions and feedback received from senior managers and representatives of:

- FE Colleges;
- Business and industry;
- Regional Development Agencies;
- Government Departments and Agencies
- Higher Education Institutions;
- Learning & Skills Councils (national & local);
- Sector Skills Councils;
- National Skills Academies.

We would particularly like to thank Iain Nixon from the KSA Partnership and the science and innovation teams at the Department for Business, Innovation and Skills, for their invaluable contributions.

We would like to thank the participating organisations represented in the national and regional think tanks in Annex 1 and the FE Colleges who participated as case studies for this study in Annex 2.

Finally, we would also like to thank the New Engineering Foundation Advisory Panel¹ for their continued enthusiasm and effective involvement.

¹ The New Engineering Foundation Advisory Panel consists of representatives from the following organisations: London Development Agency; Higher Education Academy Engineering Subject Centre; Learning and Skills Improvement Service; BASF; OFSTED; National Physical Laboratory; Higher Education Academy Physical Science Subject Centre; Procter & Gamble Pharmaceuticals (UK) Ltd; Royal Academy of Engineering; SEMTA; East of England Development Agency; Royal Society; Institute of Directors; Engineering Employers Federation; BBC; North West Regional Development Agency; PriceWaterhouseCoopers; Association of Colleges; National Skills Academy for the Process Industries; Foundation Degree Forward; Bournemouth University; South West of England Regional Development Agency; Cogent Sector Skills Council Ltd; Gatsby Charitable Foundation; Skills for Justice.

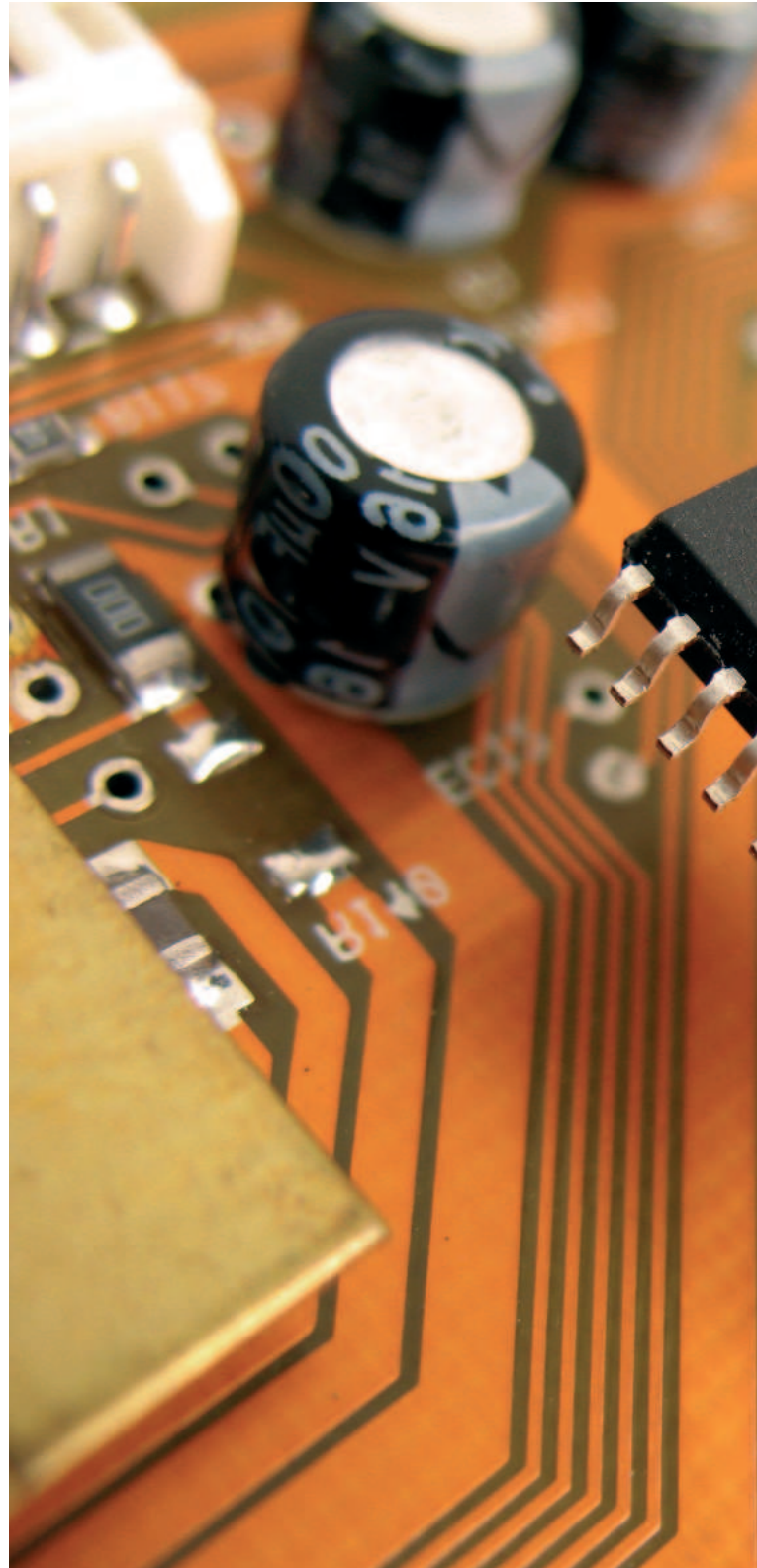


DEFINING 'EMERGING TECHNOLOGIES'

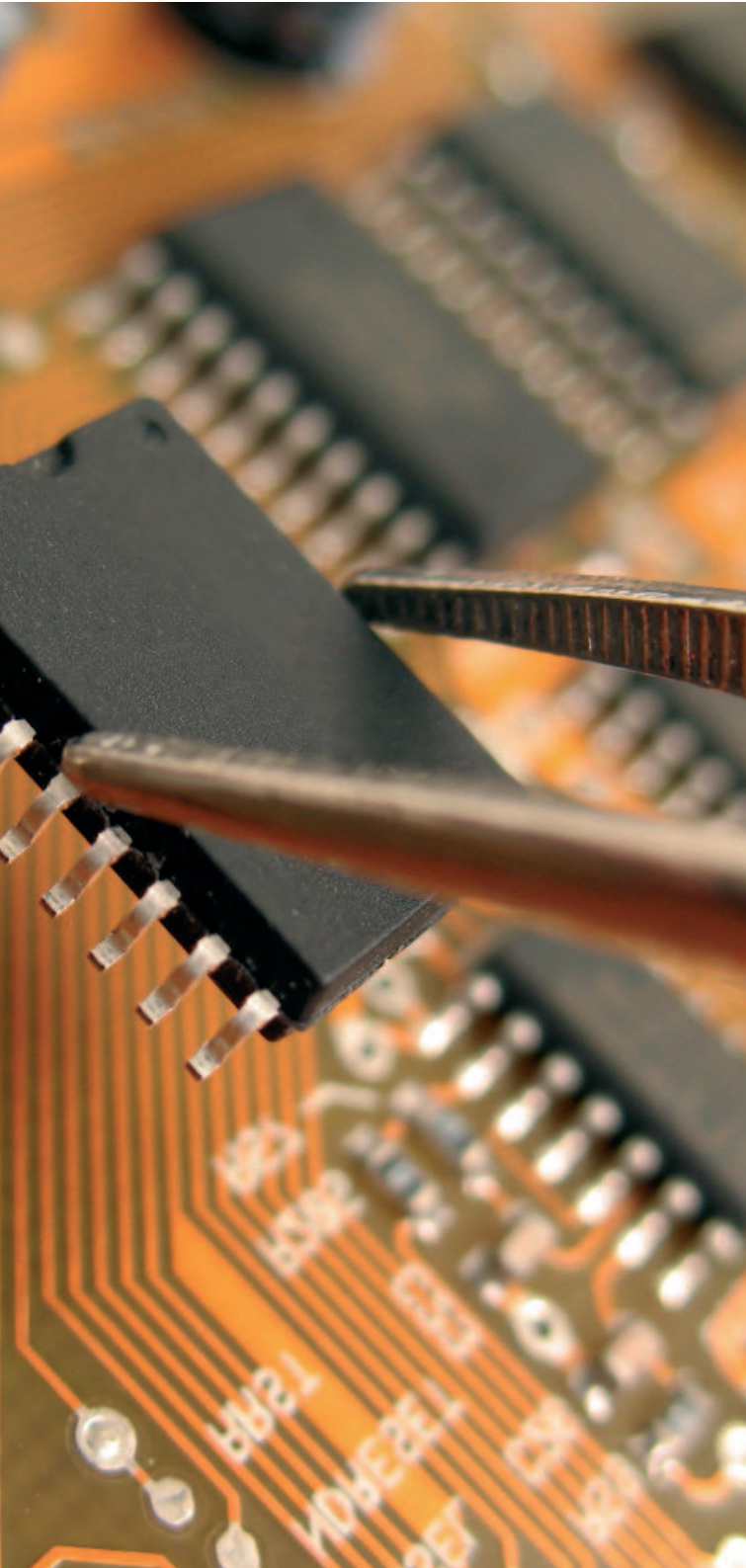
Emerging (new and/or converging) technologies are interpreted in different ways. A key challenge for this study was therefore to provide a meaningful definition of emerging technology.

For the purposes of this study we have defined emerging technologies as:

"New technologies are those aspects of applied science and technology that are currently in commercial development or will be developed over the next five to ten years, and which will substantially alter the business and social environment."



EXECUTIVE SUMMARY



The Further Education system has the potential to play a significant role in supporting the commercialisation and market development of new and emerging technologies, alongside developing the intermediate and, increasingly, the higher level skills required by industry operating in sectors that are dependent on the application of those technologies.

The current situation in the Further Education system, characterised by a recent engagement in knowledge and technology transfer activities and a lack of a strategy and development to address and build capability in the strategically important subjects of applied and vocational sciences, presents a challenge for the system.

It is therefore timely to explore what practical steps can be taken to ensure the FE system is better able to support the learning and skills needs of industry as it takes forward the development and application of new and emerging technologies.

This report summarises the outcomes of a study led by the New Engineering Foundation into the extent to which FE Colleges are already delivering courses (or components of courses) in emerging technologies and to pinpoint the factors which enable and inhibit the FE systems' state of readiness and development.

The current state of play in the Further Education sector

In order to illuminate how industry is working with the FE sector to meet its needs in relation to the exploitation of emerging technologies, a case study based approach was adopted.

The picture that emerged is described below, alongside an articulation of some of the barriers to the FE sector's engagement with emerging technologies.

Strategic and curriculum development plans include components on emerging technologies...

In all the case study colleges, strategic plans and curriculum development plans included components on emerging technology. In at least two instances the response to emerging technologies was integral to the college's plan. In most cases a college's strategic and curriculum development plan was sector orientated, and as such the faculty/department plans made specific reference to emerging technologies (e.g. nanotechnology).

Mechanisms are in place to review opportunities for the development of new provision...

Many colleges have instigated mechanisms to regularly review opportunities for the development of new provision or enhancement to existing provision.

Colleges do not systematically review technological developments including the emergence of new technologies...

Horizon scanning techniques have yet to be used extensively in the FE sector. As a

consequence colleges do not systematically review technological developments (e.g. changes in technologies, the emergence of new technologies, and the application of technology in supporting learning and teaching) or indeed sectoral developments (e.g. the decline of existing sectors, the rationalisation of existing sectors and the emergence of new sectors like renewables).

Access to robust market intelligence is limited...

Furthermore, a college's ability to horizon scan effectively is limited by the ability to use and prioritise available market intelligence. While there is a perceived demand from industry for courses to support professional development in areas related to new and emerging, as well as emerged, technologies, it is very difficult (if not impossible) for industry to accurately predict the workforce and workforce development implications. Macroeconomic conditions and the speed of technical advances significantly affect forecasting.

Design and delivery of programmes in emerging technologies is high risk for colleges...

The design and delivery of programmes in emerging technologies is high risk for colleges, particularly as initial financial investment can be high and the return needs to be projected over time against expected student numbers.

Working with employers is therefore critical to ensure that there is continuity of demand in order to mitigate the risk for colleges. This is particularly the case in very niche (or specialist) markets where the business size can be quite small.

Colleges are becoming increasingly employer responsive...

Colleges are becoming increasingly employer



responsive and have put in place dedicated staff, structures and systems to 'professionalise' their approach to employer engagement. Such approaches can involve business development teams working with employers to identify skills and technology needs and co-ordinating curriculum and funding teams to bring about a tailored response.

There are pockets of excellence across FE...

It appears that the integration of emerging technologies into the curriculum offer of colleges has largely been by way of enhancement activities. Consequently there are pockets of excellence across the FE sector but these tend to form only a small element of existing programmes except where there has been close industry involvement in the specification and design of the curriculum and commitment from industry to ensure a sustainable flow of learners.

Colleges are reliant on a handful of 'opportunistic and enthusiastic individuals' to drive new and cutting edge programmes...

Despite an ability to identify new opportunities in emerging technologies, colleges lack sufficient capacity and capability to design and deliver programmes in new areas. Colleges do not have staff with the appropriate experience or expertise. Hence they are reliant on a handful of 'opportunistic and enthusiastic individuals' to drive new and cutting edge programmes.

Colleges are increasingly using external expertise to strengthen their capacity and capability...

As a result of this situation, colleges are deploying a range of approaches to strengthen their capacity and capability and are increasingly reliant on bringing in external expertise from industry or universities.

Investment has been secured by colleges for facilities and resources to support emerging technologies...

Facilities and equipment that support the delivery of the emerging technology curriculum were identified as being generally 'fit for purpose'. That said, investment in facilities and resources to support emerging technologies is expensive and can limit access to existing courses and capability to open up new provision.

Nevertheless, colleges are investing in resources to enhance the learning experience. Other colleges, by working together, have been able to minimise their capital investment and improve efficiencies through sharing facilities and resources, as well as staff expertise.

Conclusions and recommendations

In thinking about what practical steps need to be taken in order to ensure a better alignment of the FE 'offer' to the skills priorities of industry in relation to exploiting new and emergent technologies, the key messages that emerged from the study included:

- **Advocacy and leadership** is needed at a national level to change deep-rooted perceptions of STEM related sectors and disciplines.
- **Funding and funding methodologies need to be revised**, particularly in respect to encouraging colleges to be more flexible, respond quicker and have the capability to horizon scan.
- **Strengthening the links between industry, Higher Education Institutes and the FE sector is vital** if better alignment is going to be achieved.

- **Response times to emerging market/technology needs must be improved** – the ‘time lag’ is too great – this will require different and more flexible models of course development and delivery, as well as quality assurance.
- **FE Colleges need to be able to access effective market intelligence**, particularly at a regional level. This is a prerequisite if strategic and curriculum planning decisions are to be evidence based and the risks of investment reduced.

From these a set of recommendations have been identified in relation to three key areas for further action:

Recommendations for planning, commissioning and funding

The planning, commissioning and funding of provision in the FE sector is an area of concern. The current model inhibits long-term strategy and planning in colleges and does not readily enable colleges to be responsive to new and emergent skills needs.

Recommendation 1

The Department for Business, Innovation & Skills (DBIS) and Department for Children, Schools & Families (DCSF) should work with the UK Commission for Employment and Skills (UKCES) and the Sector Skills Councils (SSCs), awarding bodies, Regional Development Agencies (RDAs), the new Skills Funding Agency and local authorities, and the FE sector to establish a strategic commissioning approach at a national and/or regional level to facilitate a ‘rapid response’ by providers (individually and

collectively) to address skills needs of economic sectors reliant on the exploitation of emerging technologies. The National Skills Academies may also have a role to play here.

Recommendation 2

The DBIS and DCSF should establish clear guidelines for the new Skills Funding Agency, RDAs, SSCs and local authorities on how best to align national and regional investment into sectoral developments linked to new and emerging technology priorities and integrate the FE system in planning for and supporting the associated skills needs.

Recommendations for strategic investment

Colleges are not well placed to drive strategic investment. Individually and collectively Government departments, strategic funding agencies and leading industry representatives need to examine how colleges and the sector can be better engaged in early strategic discussion and how viable commercial learning solutions can be enabled.

Recommendation 3

The DCSF and DBIS should work with the new Skills Funding Agency and local authorities to ensure capacity and capability exists internally to generate intelligence from a wide range of national, regional and local data sources (UKCES, Alliance of Sector Skills Councils, RDAs, etc.) to inform the strategic commissioning process – at a national level consideration should be given to establishing a ‘research observatory’ to monitor shifts in the demand for skills associated with emerging technologies – a



role the New Engineering Foundation could assist with and support.

Recommendation 4

The FE sector should work with the Skills Funding Agency at a national and regional level and local authorities to put in place effective mechanisms through which to disseminate intelligence (labour market trends, sectoral and technological developments, changes in work practices, etc.) in an accessible and useable format to colleges and other FE providers to better support their strategic planning processes.

Recommendations for better responsiveness

Improving the responsiveness of the FE system to the needs of learners and employers (which are related to new and emerging technologies) will require a streamlining of the processes involved in course approval and/or a rationalisation of the number of awarding bodies and other bodies (e.g. SSCs) that influence the curriculum alongside building the capacity and capability of the sector.

Recommendation 5

The DCSF and DBIS should grant greater awarding powers to FE Colleges and undertake a review with a view to rationalising the number of awarding bodies and other bodies (e.g. SSCs) that influence the curriculum and develop mechanisms to support the FE sector in responding rapidly to meeting the needs of learners and employers as new technologies emerge.

Recommendation 6

The DBIS and DCSF should look to create a sustainable funding stream to strengthen

the FE sector's support for innovation and contribution to meeting the skills needs of employers and learners related to the exploitation of new and emerging technologies. The FE Specialisation & Innovation Fund may provide the basis for such a funding stream.

Recommendation 7

The Learning & Skills Improvement Service should support, with additional funding from DBIS, the implementation of a specialist and dedicated staff development programme in emerging technologies to ensure the FE sector has the capacity and capability to respond to skills needs of economic sectors reliant on the exploitation of such emerging technologies.



1. INTRODUCTION



The Further Education sector has the potential to play a significant role in supporting the commercialisation and market development of new and emerging technologies, alongside developing the intermediate and, increasingly, the higher level skills required by industry operating in sectors that are dependent on the application of those technologies.

Through previous studies conducted by the New Engineering Foundation, *Knowledge and Technology in Further Education* and *Preparing for the Future: Applied and Vocational Science Provision at an Intermediate Level in Further Education Colleges*, we know that the Further Education (FE) sector has only recently begun to engage in knowledge and technology transfer activities and that the sector suffers from a lack of a strategy and development to address and build capability in the strategically important subjects of applied and vocational sciences at the intermediate level. This situation presents a challenge for the FE sector as it strives to maximise its contribution to 'science and innovation' and seeks to position itself to better respond to the needs of industry.

Moreover, relatively little is known about the extent to which colleges have the capacity and capability to deliver courses (or components of courses) in emerging technologies. It is therefore timely to explore what practical steps can be taken to ensure the FE sector is better able to support the learning and skills needs of industry as it takes forward the development and application of new and emerging technologies.

1.1 The focus of the study

This study, led by the New Engineering Foundation, looked to shed light on the issue described above. In doing so it sought to address five key questions:

1. What are the most significant **market opportunities** in science, engineering and technology related sectors over the next three to five years? And, what is the scale of those opportunities?
2. What **emerging technologies and applications** do industry partners foresee using and/or introducing over the next three to five years?
3. In relation to these market opportunities and applications, what **skills priorities** can be foreseen over the next three to five years? And, how best can these priorities be met?
4. To what extent does the FE sector have the **capacity and capability** to deliver responsive, high quality solutions to meet these skills priorities?
5. What **key factors** need to be addressed to assure success and a better alignment of the FE 'offer' to the needs of business/industry?

By identifying and exploring examples of existing practice, we also sought to establish the extent to which FE Colleges are already delivering courses (or components of courses) in emerging technologies and to pinpoint the factors which enable and inhibit the FE sectors' state of readiness and development.

Alongside this study, the Foundation also sought to establish the features and principles of an effective planning, commissioning and funding cycle and determine how FE Colleges and the sector more broadly could make more effective use of horizon scanning as an integral part of the planning cycle. The findings of this work are reported in our report, *Planning and Funding Cycles for the Further Education Sector*.²

In the future, the Foundation intends to establish a contemporary picture of the nature and extent of the demand for skills from industry in sectors of strategic importance to the UK's economy that are reliant on exploiting new and emergent technologies. Consideration is also being given to a study to explore the implications for the 14-19 provision, particularly the new diplomas, in adequately preparing young people to progress in education and work related to emerging technologies.

1.2 Research method

This study involved three inter-related elements of activity:

- Conducting a **literature review** which included reviewing publicly accessible papers and journal articles to help clarify what is meant by new and emerging technologies, and appraising national policy and strategy documents to identify the drivers for changes and explore how policy interventions trigger market responses in relation to exploiting emerging technologies.

² See NEF (unpublished) *Planning and Funding Cycles for the Further Education Sector*



- Facilitating a **national think tank** in London and two regional workshops, one in the south west (Bristol) and one in the north (Leeds). These events drew together a wide range of stakeholder perspectives (Government departments, funding bodies, FE Colleges, Higher Education (HE) institutions, employers and employer representative bodies) to explore how well shaped the FE sector is currently to deliver responsive, high quality solutions to meet the learning and skills needs of industry, and what needs to be done to improve capacity for the future. The think tank and the workshops were attended by over 60 senior representatives from the organisations listed in Annex 1.
- Preparing 22 **FE College case studies** through field visits and telephone interviews to illuminate good practice – the list of case study FE Colleges is provided in Annex 2.
- Consultations with a wide range of **audiences** representing skills providers, business and industry as well as Government departments and agencies were undertaken – a list is provided in Annex 3.

This report summarises the outcomes from the research. It defines what is meant by emerging technologies, it describes where the FE sector's contribution can add most value to the development and application of emerging technologies, it explores the nature and extent of the existing activity supported by the FE sector, and it identifies guidelines and actions to strengthen the sector's contribution into the future.

During the course of this research, it became clear that there were limited examples of practice relating to '*emerging*' technologies in FE. Colleges, in the main, were engaged in activity related to '*emerged*' technologies that are well established in the market place. Therefore, we directed energies towards building detailed case studies of practice based on the working examples we encountered. We recognise that practice will exist elsewhere and as such the examples we provide in this report are by no means exhaustive.

Market space

Advanced Materials (Nano and Metamaterials)

**Bioscience (Synthetic Biology; Genetic Engineering;
Personalised Medicine)**

**Computing, Communication and Cognition (Artificial
Intelligence; Distributed Systems; Holographic Systems)**

**Low Carbon Energy Sources (Hydrogen; Biofuels; Nuclear
Fusion; Electrical Transmission)**

**Electronics, Photonics & Electrical Systems (Storage; LED
Lighting; Nano devices)**

**High Value Manufacturing (Electric Cars; Non-rocket space
launch)**

???

Technological space

2. EMERGING TECHNOLOGIES

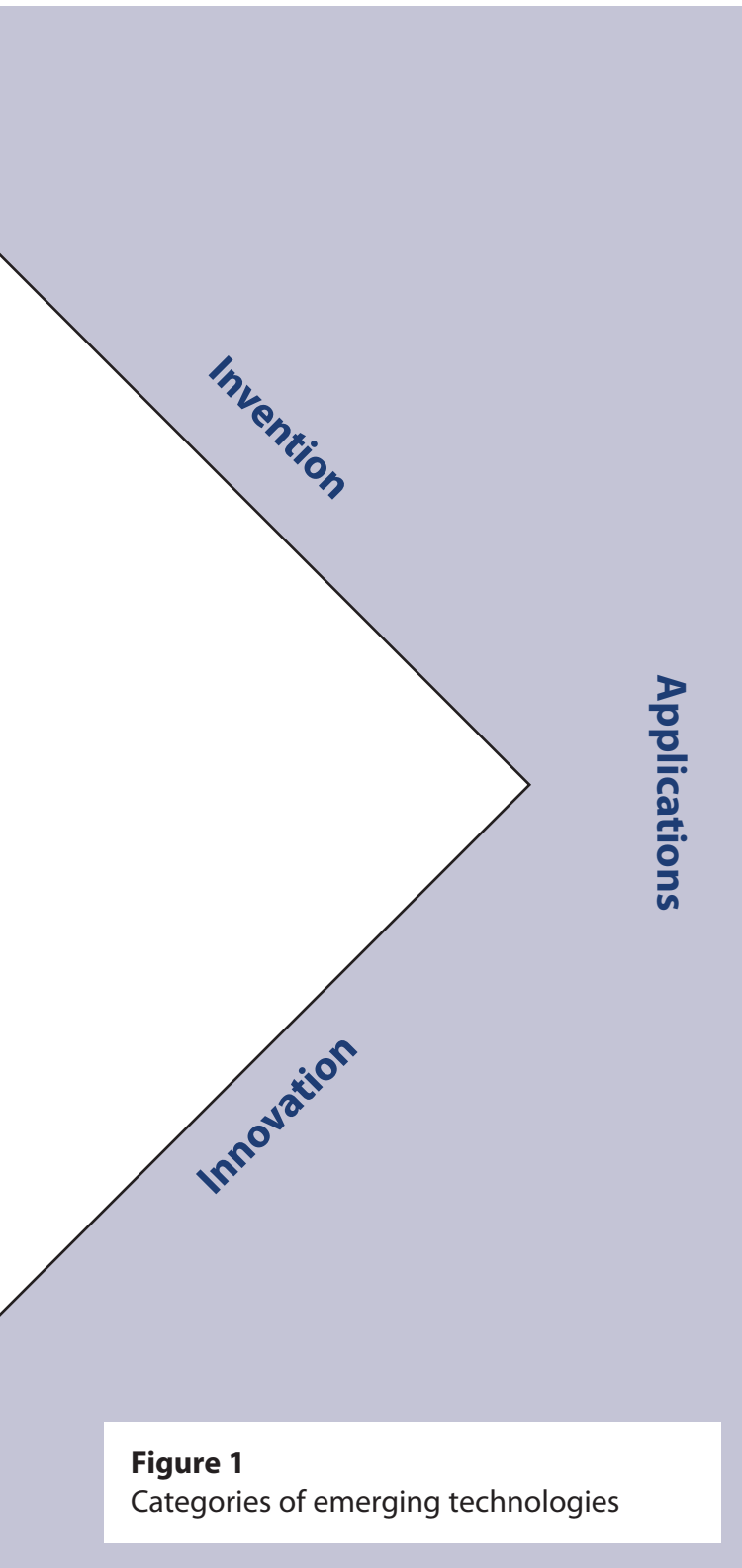
2.1 Emerging technologies defined

Emerging (new and/or converging) technologies are interpreted in different ways. A key challenge for this study was therefore to provide a meaningful definition of emerging technology.

For the purposes of this study we have defined emerging technologies as:

“New technologies are those aspects of applied science and technology that are currently in commercial development or will be developed over the next five to ten years, and which will substantially alter the business and social environment.”

Furthermore, a broad spectrum of classifications is used to shed light on what is meant by emerging technologies. These include various acronyms such as NBIC (Nanotechnology, Biotechnology, Information technology, Cognitive science), GNR (Genetics, Neurons, Robotics) or BANG (Bits, Atoms, Neurons, Genes). With this in mind a working framework was developed for this study which categorises the emerging technologies into six technological categories related to advanced materials, bioscience, computing and advanced communications, low carbon energy technologies, electronics, photonics and electrical systems, and high value manufacturing. Examples of the emerging technologies in each category are provided in Figure 1. Please note that this is an indication only and not an exhaustive list.



2.2 Applications of emerging technologies

An important dimension that needs to be considered is the application of emerging technologies in existing and new markets. Our research has confirmed the intrinsic link that exists between 'markets' and 'emerging technologies'. Development of emerging technologies can be market and/or technology led.

Participants at the think tank and regional workshops considered what the most significant market opportunities were relating to the exploitation of emerging technologies, what technologies were likely to be exploited or introduced, and what the implications for skills and workforce development might be. While the discussions provided a useful context, establishing a definitive list of the market opportunities was neither possible nor necessarily helpful, instead we have used the outcomes of these discussions to shape a working framework of possible areas of application for emerging technologies.

A number of application areas have been adapted from the Technology Strategy Board and are included in Annex 4.³ The box opposite gives some practical examples of the possible applications of emerging technologies.

³ Technology Strategy Board <http://www.innovateuk.org>



Application of emerging technologies

Example 1: Nano charging solar power

Quantum-dot solar power could boost cheap photovoltaics

Photovoltaic cells use semiconductors to convert light energy into electrical current. The photovoltaic material, silicon, performs this conversion efficiently, but silicon cells are relatively expensive to manufacture. Other semiconductors, which can be deposited as thin films, have reached market, and although cheaper, their efficiency doesn't compare to that of silicon. However, quantum dots, tiny crystals of semiconductors just a few nanometers wide could at last make solar power cost-competitive alternative to electricity from fossil fuels.

Example 2: Personalised medical monitors

Computers to automate diagnostics could make medicine more personal

Personalised medicine involves using the advanced tools of molecular genetics and diagnostics to predict how patients will respond to drugs, reducing harmful side effects and increasing benefit.

Example 3: Neuron control

Genetically engineered 'light switch' to turn parts of the brain off/on

Nerve cells called neurons generate electric signals that pass from one end of the cell to another and release chemical messengers

called neurotransmitters to communicate with other cells. A genetically engineered "light switch," will allow scientists turn selected parts of the brain on and off, and through better understanding may help improve treatments for depression and other disorders.

Example 4: Nano healing

Tiny fibres that save lives

Nano scale protein fragments called peptides, can self assemble within the body to form a cluster of fibres. The nano particles are applied to the wound in the form of a gel and appear to speed up healing of spinal tissue and damaged brain. The formation of the fibres into bundles stops the wound from opening.

Example 5: 3D printing

Rapid prototyping and production of not only plastic objects but multi-material items, with the potential to significantly customize products for individual consumers

3D printing is a unique form of fabrication that is related to traditional rapid prototyping technology. A three dimensional object is created by layering and connecting successive cross sections of material. 3D printers are generally faster, more affordable and easier to use than other additive fabrication technologies. While prototyping dominates current uses, 3D printers offer tremendous potential for retail consumer uses.

Case study 1

Grimsby Institute of Further and Higher Education

Humber Seafood Institute (HSI), Grimsby

The Grimsby Institute specialist food teams are based at the £5.6m Humber Seafood Institute (HSI) which is backed by Yorkshire Forward, North East Lincolnshire Council and the European Regional Development Fund.

HSI is responsive to industry needs, delivering professional expert support and state-of-the-art facilities for the seafood sector. It engages in collaborative research with industry leaders so as to optimise market and trade opportunities.

A key objective of the HSI is to provide innovative solutions to the seafood sector and in response to this, four Innovation Groups focusing on trade corridor issues, cold chain developments, process & product and 'green' technical support have been established. Each group consists of sector-specific industry members who are leaders in their respective fields. It is anticipated that the centre will quickly become a catalyst for innovation and creativity, not only in the Humber, but internationally.

HSI provides a broad spectrum of services to support the seafood industry and in particular provides access to incubation and managed workspace units, new product development kitchens, refrigeration research facilities, chemical and environmental laboratory equipment as well as a process hall and microbiological laboratories.

Cells Alive System (CAS)

Grimsby and the Humber region are home to a number of large scale food processing and storage companies, many of which supply the UK with produce. The need to research new and improved methods of storage and refrigeration is essential for the continued growth of the industry.

The Grimsby Institute has recently commissioned the first Cells Alive System (CAS) in Europe, developed by the Japanese company ABI Co Ltd. The Institute can now offer research and experimentation opportunities to the seafood/food industries.

Part-funded by the Ports & Logistics Centre of Vocational Excellence and European Development Agency, the CAS system is at the forefront of freezing technology. By rotating a magnetic field within the freezing environment, it is possible to preserve a wide range of products for extended storage periods at the highest quality levels – 'as fresh'. CAS freezing works on the simple principle that water molecules cannot cluster and form cell-wall damaging ice crystals if they are in motion during the freezing process.

The CAS system further enhances the training opportunities for learners at Grimsby Institute and provides valuable experience for those who have limited access to such systems.



2.3 The currency of emerging technologies in the Further Education sector

Notwithstanding the provision of a definition, the articulation of a working framework and the identification of a set of application areas, it appears that the concept of 'emerging technology' does not have much currency in the FE sector. As noted previously (see section 1.2), colleges tend to be engaged in activity that relates to meeting the skills needs of industries that are applying well established (or emerged) technologies in the market place. Possible reasons for the lack of currency are the lack of flexibility in the system to respond, a staffing led curriculum rather than curriculum led staffing, industry's doubts about whether colleges can deliver and the low risk tolerance of colleges. These are explored in more detail in Chapter 4.

That said, there are examples of colleges engaged in activity related to emerging technologies (see Chapter 4), where they are adding value through knowledge and technology transfer activities, developing the existing skills base in the industry (i.e. through workforce development), and building a pool of talented individuals from which industry can recruit (i.e. through the attraction of new skills into the workforce).



3. THE STRATEGIC IMPORTANCE OF EMERGING TECHNOLOGIES



3.1 A national policy perspective

Following the Innovation Nation white paper in March 2008, the first Annual Innovation Report reflects the Government's determination to support businesses through the current downturn and harness innovation as the driver for a new era of long-term prosperity.⁴ Continual investment in talent, research and innovation is critical if the UK is to emerge in a stronger position and seize the opportunities that will follow.

The Annual Innovation Report 2008 states that highly skilled people with excellent technical, business and life skills are the lifeblood of innovative organisations whether they are developing new technologies or knowledge for cutting edge products or services, using existing knowledge or technologies to bring new products or services to market or working directly with customers, or in support functions.

The report recognises that the FE system makes a considerable contribution to delivering the STEM agenda, especially in delivering the skills needed for technician-level work.

⁴ Annual Innovation Report 2008 http://www.dius.gov.uk/innovation/innovation_nation/~media/publications/2/21390%20AIR%20Report%20AW%20Complete

The Government report, 'Building Britain's Future: New Industry, New Jobs', notes that a number of trends in the global economy will present significant new opportunities for British businesses such as: growing populations and rising prosperity in other parts of the world; new technologies; the transition to low carbon and the green revolution; changes in the age profiles of different societies; and the spread of international supply chains.⁵

Over the last fifteen years the contribution of high-technology manufacturing and knowledge-intensive services to UK gross value added has increased steadily to over 40%.⁶ Thus any constraint on the ability of UK-based businesses to exercise comparative advantage on the basis of high levels of skills or knowledge must be regarded as a serious impediment to the UK's economic success.

The Government has recognised that it will be necessary to pay particular attention to technological change where this is reshaping industries and demanding high levels of innovation, skills and investment from those businesses who will ultimately lead in these markets. These include the shift to digital communications in vital network industries, a range of low carbon technologies and new processes in the chemical, automotive, aerospace and other industries.^{7,8}

New technologies will drive both consumer and business demand. They will also transform existing products, and are likely to force businesses right across the supply chain to develop new business models and adopt new, innovative ways of delivering services. The life sciences, for example, will be transformed by advances in genetics. Developing communications technologies that allow the transfer, processing and

exploitation of huge amounts of data have the potential to radically change the way we provide public services.

The skills system therefore needs to respond to demand but also anticipate future economic growth in areas such as low carbon or bio-science. This report aims to ascertain the capability within the FE sector to deliver skills for new technologies, critical to ensuring the UK's global competitiveness.

3.2 Low carbon strategy: a worked example of a policy intervention

Developing and applying emerging technologies to open up existing and new market opportunities will have significant implications for the workforce and workforce development, both now and in the future. While it is very difficult to generalise what the nature and scale of the impact is likely to be, specific sector or industry examples may help to build understanding.

By using the Government's emergent low carbon strategy, as a worked example, it is possible to explore how a national policy intervention can stimulate concept/technology development, commercialisation and market development, and workforce development.

⁵ Building Britain's Future: New Industry, New Jobs, http://www.dius.gov.uk/~media/publications/N/new_industry_new_jobs

⁶ Work Foundation (2006) Defining the knowledge economy, http://www.theworkfoundation.com/assets/docs/publications/65_defining%20knowledge%20economy.pdf

⁷ BERR and DCMS (2009) Digital Britain: the interim report, http://www.culture.gov.uk/images/publications/digital_britain_interim-reportjan09.pdf

⁸ NEF (Unpublished) Low Carbon Transition Report



Interventions of this nature therefore have significant implications for education and training and, in particular, for the FE sector.

Figure 2 shows how the prioritisation and investment in ultra low carbon vehicles, retrofitting housing stock, eco-towns, marine engineering, renewable energy and high value manufacturing, as a means by which to realise UK carbon reduction targets, energy security and adaptation to climate change, can drive stakeholder responses.

The conceptual model is derived from the intrinsic link between innovation (i.e. the commercialisation of new and emerging

technologies) and the skills required in the workforce to support this process and ensure longer-term sustainability of sectors reliant on these technologies. For instance:

- 'Blue sky' and applied research by industry and universities is required to support technological development and increase levels of innovation.
- Robust labour market intelligence is required to identify skills needs and the likely level of demand so as to inform the development of new curriculum and improve learner support (e.g. through IAG).

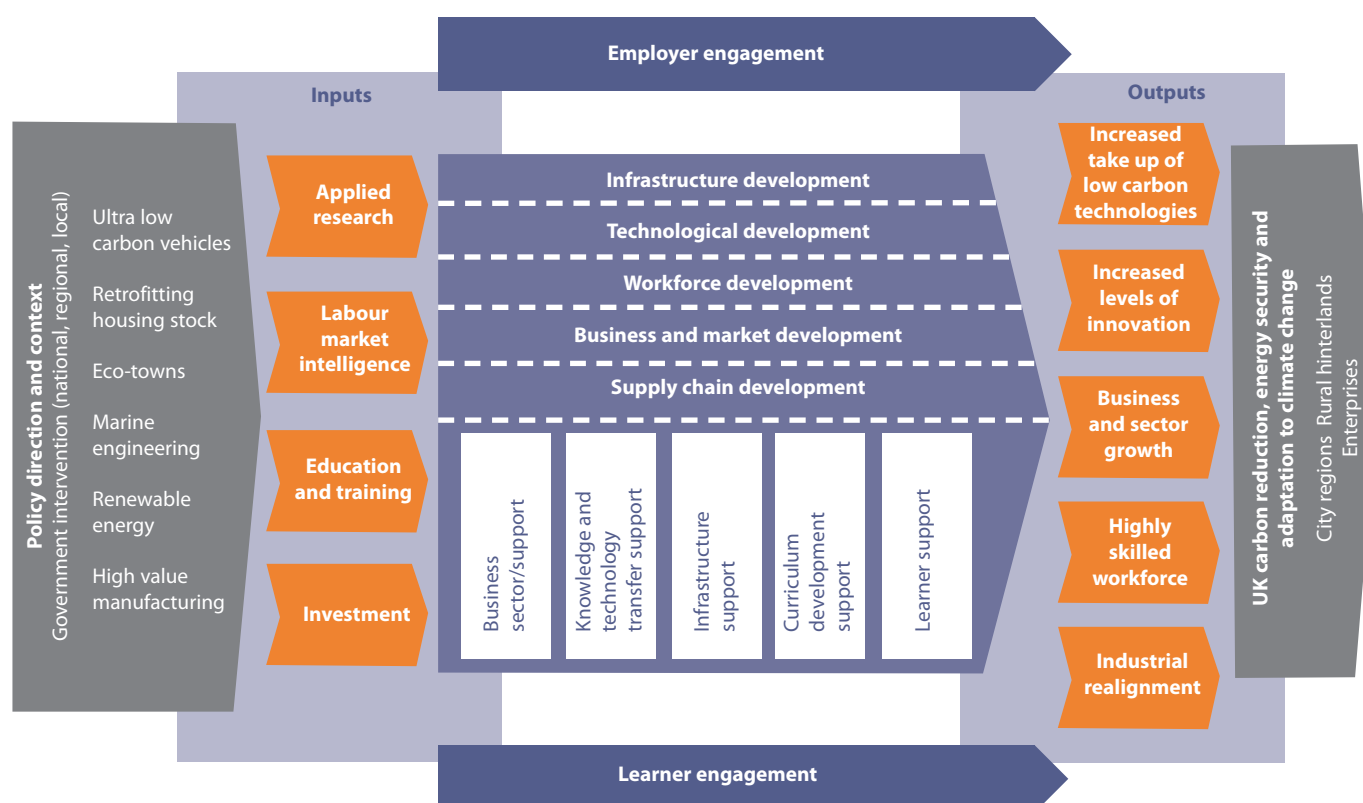
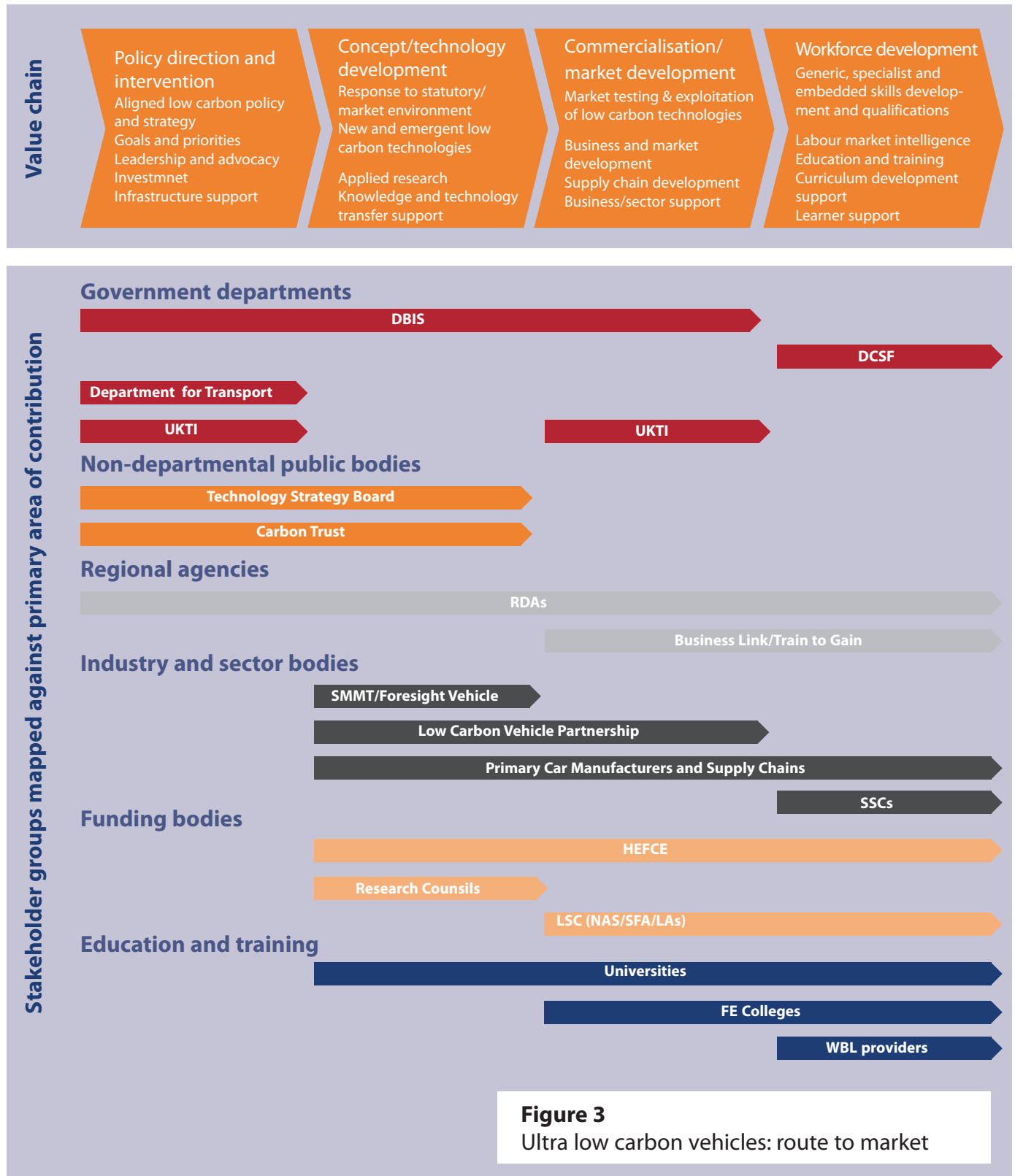


Figure 2
The skills dimension of a low carbon strategy





- Responsive and tailored education and training at all levels is required to support workforce development in shifting towards a highly skilled workforce.
- Accessible business/sector support is required for business and market development underpinning sector growth and leading to increased take up of low carbon technologies.

FE – as an input to the ‘skills system’ – has a key role to play in providing responsive and tailored provision to meet the identified skills needs of industry, particularly at an intermediary level. Additionally, for some colleges where the capacity and capability exists there is the potential to support market development through their knowledge and technology transfer activities (e.g. consultancy, access to specialist facilities). The issue for colleges will be how best to position themselves in an increasingly complex landscape – as captured in Figure 3.

Using ultra low carbon vehicles as an example, it is clear that there are a wide range of stakeholders with an interest and investment in this policy imperative. That said many of the stakeholders could be described ‘enablers’ in the system and thus it could be argued that the bi-directional relationship between industry (the ‘demand side’) and education and training providers (the ‘supply side’) is of paramount importance.

Factor in the need for leading edge, applied research in developing and testing new technologies, and the requirement for a strong tripartite relationship between industry, universities and colleges emerges.



4. THE CURRENT STATE OF PLAY IN FURTHER EDUCATION



In order to illuminate how industry is working with the FE sector to meet its needs in relation to the exploitation of emerging technologies, a case study based approach was adopted.

The case studies, which focused on specific examples, explored a number of related dimensions including how the needs and level of demand were identified, who was involved in the design and delivery of the solution to meet the identified needs, what the characteristics of adopted pedagogical approach were, what facilities and equipment were used to support the delivery of the solution, and what was the investment/funding model underpinning the design and delivery of the solution.

The picture that emerged is described below, alongside an articulation of some of the barriers to the FE sector's engagement with emerging technologies. It has many similarities to the issues established through the New Engineering Foundation's previous projects on knowledge and technology transfer and applied sciences.

4.1 Nature and extent of the FE sector's engagement in emerging technologies

4.1.1 Strategy and planning

Colleges increasingly recognise the need to take a longer term view of their business by extending their horizons beyond the 'here and now' with a view to clarifying their market position and growth strategy. The extent to which colleges have become more strategic in their outlook varies considerably. For those that have,

their approach is characterised by having at least a ten year vision and a unified five year corporate (or strategic) plan, they have a capital investment plan over a similar timeframe, and use a three year planning cycle which accommodates detailed operational planning requirements on an annual basis.

'Development of college curricula is evolutionary rather than revolutionary. Curriculum development it thus set against emerging trends and industry needs.'

– Rotherham College of Art & Technology

Strategic and curriculum development plans include components on emerging technologies...

In all the case study colleges strategic plans and curriculum development plans included components on emerging technology. In at least two instances the response to emerging technologies was integral to the college's plan. In most cases a college's strategic and curriculum development plan was sector orientated, and as such the faculty/department plans made specific reference to emerging technologies (e.g. nanotechnology). In these cases the exploitation of opportunities presented by emerging technologies occurred at a departmental and/or cross-institutional level.

'The College is using the priorities and opportunities identified in new technology to inform curriculum development and future strategy.'

– New College Swindon

Bridgwater College's strategic plan, published in October 2009, identifies developments in new technology and expanding links with industry as priorities in its approach to improving provision. Each prioritised development has an operational

plan which is then reflected in the plans of appropriate curriculum areas. In the case of Barnet College, curriculum development plans are aligned with the development of their new labs site due to be opened in 2010. The development of this state-of-the-art facility is providing renewed impetus around learner and employer engagement, as well as a stimulus to reviewing and developing the curriculum offer and exploring new ways of delivering the curriculum (e.g. through extended off-site projects, work placements).

Mechanisms are in place to review opportunities for the development of new provision...

Many colleges have instigated mechanisms to regularly review opportunities for the development of new provision or enhancement to existing provision. For example, Leeds College of Technology reviews provision at a departmental level every term. Similarly, the Curriculum Area Managers from each of Cornwall College's seven campuses come together twice a term to discuss strategy and tactics for meeting the skills needs for their sector area. This group is chaired by a Corporate Curriculum Leader whose responsibility it is to develop operation and strategic planning across the college.

The area of strategy and planning in an FE College is explored in more detail in the *Planning and Funding Cycles for the Further Education Sector* report.

4.1.2 Horizon scanning

Colleges do not systematically review technological developments including the emergence of new technologies...

Horizon scanning techniques have yet to be used extensively in the FE sector. As a consequence colleges do not systematically review technological



developments (e.g. changes in technologies, the emergence of new technologies, and the application of technology in supporting learning and teaching) or indeed sectoral developments (e.g. the decline of existing sectors, the rationalisation of existing sectors and the emergence of new sectors like renewables).

‘College does not have a budget for horizon scanning and thus has limited ability to regularly review the needs of business and industry with reference to new technology.’

– New College Swindon

Access to robust market intelligence is limited...

Furthermore, a college’s ability to horizon scan effectively is limited by the availability of robust market intelligence. While there is a perceived

demand from industry for courses to support professional development in areas related to new and emerging, as well as emerged, technologies, it is very difficult (if not impossible) for industry to accurately predict the workforce and workforce development implications.

Macroeconomic conditions and the speed of technical advances significantly affect forecasting. Accessing improved market intelligence, particularly at a regional level, for FE Colleges is a prerequisite if strategic and curriculum planning decisions are to be evidence based. For instance, labour market information at a regional level was critical for Doncaster College in identifying a potential market for a Foundation degree in Animation & Games at Levels 4 and 5 – there are 250 small and medium sized creative

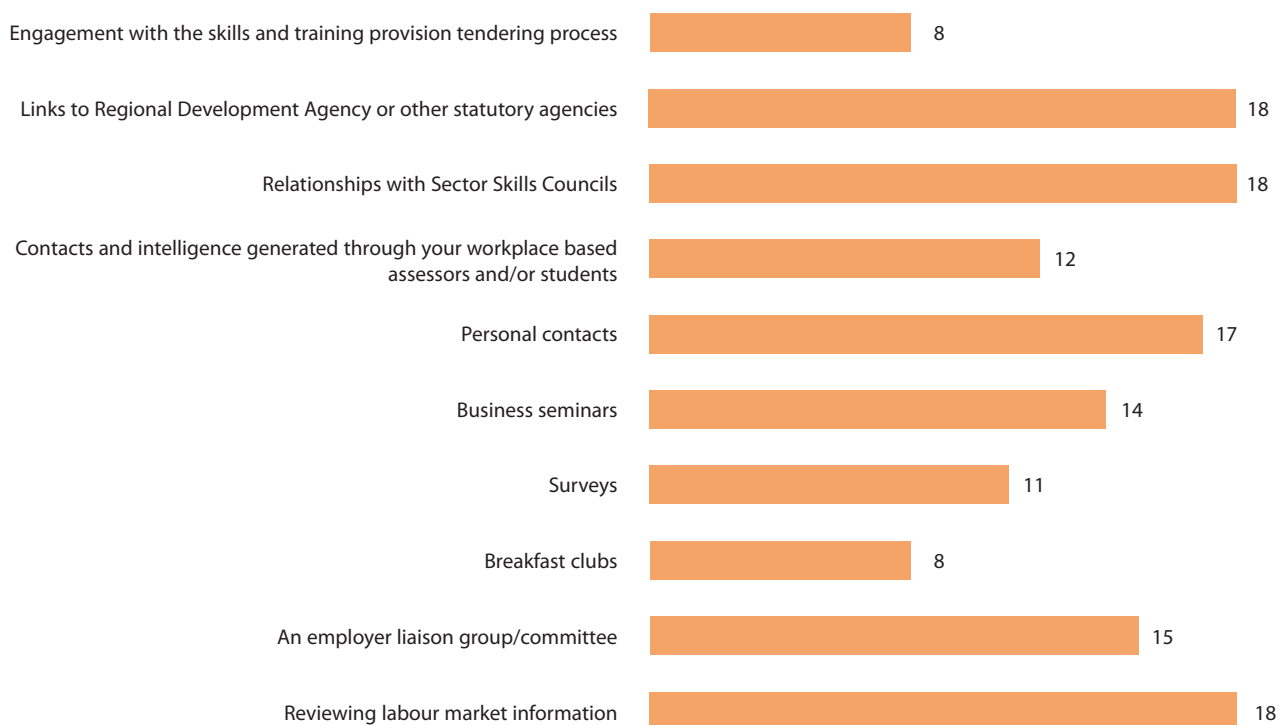


Figure 4
Sources of market intelligence (23 colleges)

and digital enterprises operating in the South Yorkshire sub-region.

Alongside reviewing labour market information, those colleges that do regularly review the needs of business and industry with particular reference to emerging technologies also draw on a wide range of other sources of intelligence (see Figure 4) primarily drawn from Regional Development Agencies (RDAs) and other statutory bodies, Sector Skills Councils (SSCs), and through personal contacts with industry and attendance at business seminars.

'The College engages with the Doncaster Chamber on a regular basis, through the Chamber's Focus Groups. Doncaster Chamber is a business led membership body representing almost 20% of registered businesses within the Metropolitan Borough of Doncaster and approximately 80% of the employed people of the Borough equating to around 43,000 employees. The Chamber has focus groups that provide a forum for Doncaster businesses to work collaboratively to address issues and concerns, as well as exploit opportunities. The groups are sector specific and include: Construction Doncaster; Creative and Digital Doncaster; Employment Doncaster; Knowledge and Enterprise Doncaster; Manufacturing Doncaster; and, Transport Doncaster.'

– Doncaster College

Wherever possible, colleges utilise well established partnerships and networks to source intelligence. The Department of Engineering at Grantham College is, for example, represented on the Association of Colleges and East Midlands Development Agency's Energy Task Group for FE Colleges. This group regularly meets to identify skills needs in the power and

Case study 2: Digital Knowledge Exchange, Doncaster College

The formation of the Digital Knowledge Exchange (DKE) as a private company was the result of the drive and determination of individuals at Doncaster College. It operates, however, as a subsidiary of the college and employs 12 FTE staff.

The DKE was formed to help accelerate South Yorkshire's transition to a global information economy and to improve its capacity for innovation, research and development. So far DKE has established significant global partnerships in order to progress evolving technology platforms in the UK around Imagineering, visualisation and communication.

As a result of initial development work conducted by DKE, the College now offers a number of courses in new technology including:

- ND Media Production – Games Development (Level 3)
- BA (Hons) Illustration & Animation (Level 6)
- Foundation degree in Animation & Games (Level 4 and 5)
- NCFE Level 2 Diploma in Interactive Media and Animation
- BTEC National Diploma in Interactive Media

DKE has therefore operated as a delivery mechanism for courses in new technologies, identifying opportunities for exploitation and integrating them back into college provision.



energy industries, including new skills related to reducing carbon emissions and the adoption of renewable energy systems.

'The Regional Economic Strategy, Sector Skills Council publications and representation on employer groups has helped the School [...] of Applied Science & Technology...' develop its business development approach to inform development of strategy and redevelop the curriculum offer to reflect sector and regional needs.'

– Newcastle College

All of the case study colleges are finding ways and means of identifying what the skills priorities are in developing and applying emerging technologies across a wide range of industrial sectors.

4.1.3 Employer engagement

Given the limited extent to which FE Colleges generally are systematically reviewing technological and sector developments, courses which are wholly or in part related to emerging technologies have tended to come about through a college's ongoing employer engagement activities. For example, Leeds College of Technology Network Academy responded to an industry need by providing part-time commercial training on certified ethical hacking, awarded by the EC-Council. This programme certifies individuals in the network security discipline of ethical hacking from a vendor-neutral perspective. The Certified Ethical Hacker certification builds the application knowledge of security officers, auditors, security professionals, site administrators, and anyone concerned about the integrity of a network's infrastructure.

Design and delivery of programmes in emerging technologies is a high risk for colleges...

The design and delivery of programmes in

emerging technologies is also high risk for colleges, particularly as initial financial investment can be high and the return needs to be projected over time against expected student numbers.

Working with employers is therefore critical to ensure that there is continuity of demand in order to mitigate the risk for colleges. This is particularly the case in very niche (or specialist) markets where the business size can be quite small. Sheffield College's Manufacturing Department, for example, is working with Nielberg, Forgemasters and other green industry companies to develop new programmes in response to identified skill needs.

Additionally the FE sector is not necessarily seen as a natural partner by industry in helping to up-skill, multi-skill and re-skill their workforce.

Although employers do recognise that the sector makes a valuable contribution in developing young people with the knowledge and skills required to progress into careers in sectors that apply and/or exploit new technologies. Hence, ongoing employer engagement activity to build and sustain links with industry is a must.

Colleges are becoming increasingly employer responsive...

As noted in previous reports, colleges are becoming increasingly employer responsive and have put in place dedicated staff, structures and systems to 'professionalise' their approach to employer engagement.⁹ Such approaches can involve business development teams located in a college, or a faculty of a college, working with employers to identify skills and technology

⁹ In some cases faculties and departments within colleges are expected to deliver on a number of 'employer responsive' performance indicators and/or targets (e.g. level of private sector investment and sponsorship, number of guest lecturers from industry, number of external site visits).

needs and co-ordinating curriculum and funding teams to bring about a tailored response. In these cases the business development staff tend to be governed by different terms and conditions compared to lecturers which helps to overcome any inflexibility in the response. Some colleges have also established 'project units' to maximise investment from other funding opportunities in order to support the design and delivery of new provision.

Newcastle College's School of Applied Science & Technology business development strategy centres on building sustainable partnerships with industry by working with both intermediary organisations (e.g. SSCs) and directly with employers to meet their specific needs. The approach ensures that the curriculum offer is informed by robust labour market intelligence and enables emerging scientific and technology oriented opportunities to be identified.

In colleges that have instigated a distributed approach to employer engagement (i.e. it is reliant on the activity of individual faculties, schools and/or departments) they retain a level of cross-institutional co-ordination through either central units or formal committees. An example of which would be Grantham College – an Employer Engagement Committee co-ordinates and supports employer engagement as well as knowledge and technology transfer activity across the institution. Each faculty has a sub-group, co-ordinated by staff, which identifies employer skills. Meetings are held in the evenings, once every three months. By comparison some other colleges have established dedicated faculties or schools to deal with all of the employer-related activity because it tends to increase flexibility and responsiveness, and enables a better working partnership with employers.

Case Study 3: Centre for Innovation & Partnerships, Newham College

The Centre for Innovation & Partnerships (CIPs) was established in 1997 through European and other regeneration funds.

CIPs continually reviews the needs of business and industry and has opened up new ways to train in addition to support for individuals and businesses. The department employs approximately 90 staff.

In 2008, CIPs opened the Discovery Lab. This state-of-the-art centre provides training in cutting edge technology including Radio Frequency Identification (RFID) and nanotechnology.

The Discovery Lab has delivered RFID and nanotechnology components to both full-time learners and part-time learners from the college and industry/business. In addition to learners, lecturers gain an introduction to cutting edge resources, in readiness for the future integration of nanotechnology components into the college's curriculum. It offers a route for professional development of college staff, in new areas of technology. Lecturers can visit the Discovery Lab at any time to get 'hands on' experience of nanotechnology and RFID applications.

The Discovery Lab also provides a range of services to industry including support in developing nanotechnology applications on a commercial basis.



Often, a formal review of employer needs is conducted through an advisory board. Employer representation in advisory groups help colleges like Burnley, Newcastle and Northampton to inform strategy development, develop their business services approach, and redesign the curriculum offer to reflect sector and regional needs. At Northampton College, for instance, each curriculum area (e.g. engineering and automotive) within the Faculty of Technology & Enterprise has its own Advisory Board. On an annual basis the boards review the Faculty's provision and the needs of business and industry, which may reveal opportunities presented by new technologies.

In becoming ever more responsive to employer needs, colleges will need to 'fine tune' their consultancy and relationship management skills to better support all stages of the employer journey, particularly in diagnosing needs in more specialist areas like new and emerging technologies.

4.1.4 Existing provision

Notwithstanding the perceived demand for skills at an intermediate and higher level that enable industry to exploit and apply emerging technologies in a wide range of areas, indicative evidence from industry suggests that what they require are individuals who have a solid foundation in 'pure science' alongside a contemporary appreciation of how the 'science' can be applied in practice. Industry requires individuals who have breadth as well as depth (e.g. in specialist areas) of understanding, and the ability to work in multidisciplinary teams.

Alongside colleges supplying new entrants to the workforce, industry identifies a need to consolidate, extend and refresh their existing employees' understanding of scientific concepts (i.e. to maintain a scientific literate workforce).

There are pockets of excellence across the FE sector...

In responding to this demand, it appears that the integration of emerging technologies into the curriculum offer of colleges has largely been by way of enhancement activities. Consequently there are pockets of excellence across the FE sector but these tend to form only a small element of existing programmes except where there has been close industry involvement in the specification and design of the curriculum and commitment from industry to provide a sustainable flow of learners. Moreover, as emerging technology is not necessarily a 'concept' that is recognised within the FE sector what practice there is tends to be hidden away.

Where provision is well developed it is often linked to Foundation degrees (Fds). Fds appear to offer greater flexibility to colleges in adapting the curriculum to embed emerging technology elements. For example, Bridgwater College offers Fds in Forensic Science with Forensic Archaeology and Race Car Motor Sport which includes elements on advanced vehicle electronics and composite materials technology. At Newcastle College they offer Fds in Renewable Energies, Sub Sea Technology, Computing Forensics, Biotechnology, Network and Security Technologies, and Computing for Games & Interactive Media.

By contrast at Northampton College, new areas such as composites, wind turbine and photovoltaic technology have been included in existing courses as enrichment activities. For example, wind turbine generation is a six hour learning activity offered to all Level 2 and 3 courses in engineering and advanced engineering. To date 120 learners have taken part in this activity. Similarly, components of hybrid car technology

are delivered at Grantham College as part of their BTEC First Diploma Vehicle Technology and Level 2/3 part-time Automotive Apprentice courses. Leeds College of Technology offers similar opportunities to its students.

'Integrating old technology into new courses'
– Deeside College

As well as integrating new technologies into existing curriculum, some colleges such as Deeside have merged traditional disciplines, for example integrating internet protocol and production engineering.

4.1.5 Staff capacity and capability

The response of a college to new opportunities in relation to emerging technologies is, however, limited by the commitment and competence of their staff.

'The development of programmes in new technology is peripheral to the main business of staff, which is teaching 16-19 year olds, thus any development of new technologies is reliant on highly motivated staff.'
– Leeds College of Technology

Colleges are reliant on a handful of 'opportunistic and enthusiastic individuals' to drive new and cutting edge programmes...

Almost all of the colleges surveyed stated that despite an ability to identify new opportunities in emerging technologies they lacked sufficient capacity and capability to design and deliver programmes in new areas – nanotechnology, robotics, composites, nuclear, thermal optical imaging, etc. – colleges do not have staff with the appropriate experience or expertise. Hence colleges are reliant on a handful of 'opportunistic and enthusiastic individuals' to drive new and cutting edge programmes.

This situation is compounded by the demographics of staff working in science, technology, engineering and maths (STEM) related areas in a college (see Figure 5). Age profiles suggest that the greatest number of staff teaching STEM related subjects fall in the age range of 41 to 60 years old. This highlights two significant challenges for the future – the loss of expertise and experience of existing staff through retirements, and the ability of colleges to attract new entrants to sustain capability. It has also been suggested by colleges that the aging profile of the workforce creates

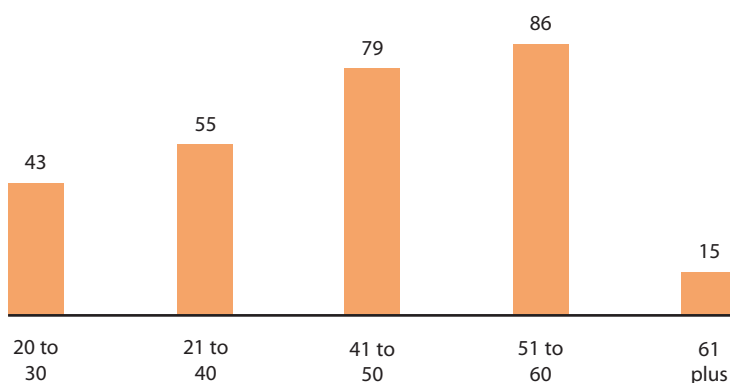


Figure 5

Number of STEM qualified staff by age range in colleges (9 Colleges)



apathy towards the development of new courses and curriculum.

In areas such as optics and advanced materials (composites), colleges noted a shortage of confident and competent staff. In addition, the retention of staff with expertise in these areas is challenging. As specialists, college staff in these areas are in high demand in both the education and business sectors, thus salaries are competitive.

'Attracting people to work in the FE sector is particularly challenging in the areas of new technology. Staff with experience in new technology are highly marketable and thus a 37 hour week at £27k per annum is not an attractive offer.'

– New College Swindon

'A very clear concern from colleges with past experience of working in fields close to industry is the potential for leakage of staff to considerably better paid industrial jobs. FE conditions reward a

staff member's teaching qualifications and their ability to get individuals through exams, rather than for any intrinsic technical expertise. Quality and appraisal systems are similarly skewed.'

– South West Composites Gateway

Colleges are increasingly using external expertise to strengthen their capacity and capability...

As a result of this situation, colleges are deploying a range of approaches to strengthen their capacity and capability (see Table 1) and are increasingly reliant on bringing in external expertise from industry or universities. In developing niche areas of the curriculum and in exploiting market opportunities, Doncaster College has collaborated with Directions Finningley Airport Training at Robin Hood Airport, bringing expertise from industry to deliver training in the Aviation Academy. The college is also looking to integrate new materials and composites into courses run by the

Recruit teaching staff with expertise in 'emerging technology'	15
Utilising the staff resources and expertise of partner organisations (e.g. other FE Colleges, HE institutions, employers) to facilitate delivery	16
Buying in expertise (e.g. on a consultancy basis)	10
Access to professional development activities in emerging technologies. (i.e. Lecturers take secondments in industry/ HEI)	16
Access to e-learning resources and web based learning.	16
Links with local business/ industry to access specialist technologies and high specification equipment	15
Liaison with higher education or regional centres of excellence to access specialists or high specification equipment	14
An employer/HEI liaison group to support Level 3,4, and 5 course development	11

Table 1

Department/Faculty interventions to develop capacity and deliver expertise in 'emerging technologies' (11 colleges)

Aviation Academy by drawing on expertise in TWI, the Welding Institute.

In addition to drawing on external expertise colleges are investing in targeted professional development activities. However opportunities and budgets to support such activity are limited.

Expenditure on staff development tends to be directed to improving teacher qualifications, such as PGCE and assessor units as this is a key performance indicator. As a consequence the professional development of lecturers and exposure to new technologies is often a lesser priority for the colleges.

‘Outside of schemes such as the NEF Industrial Fellowship Scheme and NEF Knowledge Transfer Enterprise Nodes there is little funding available for staff development in new technology or opportunities to horizon scan and connect with industry.’

– Northampton College

Schemes such as the Industrial Fellowship Scheme provided by the New Engineering Foundation and the services provided by the national network of Science Learning Centres were identified as effective means of raising awareness and building understanding of emerging technologies in staff.

4.1.6 Facilities and equipment

‘High capital expenditure to update and replace kit is very challenging’

– Newcastle College

Facilities and equipment that support the delivery of the emerging technology curriculum at

Case Study 4: Food Innovation Service, Duchy College

The Food Innovation Service has been set up to provide assistance to small and medium food processors, and manufacturers and agri-food enterprises throughout Cornwall and the South West of England.

The Food Innovation Service is part of the Agri-Food Innovation Centre at Duchy College, and was opened in 2007. The Centre holds facilities to help businesses and learners gain access to processing equipment, technical support and industry specific training.

A key strategic focus for Duchy College is the creation of a business environment, thus there is a high value attached to the establishment of an industry facing body, such as the Food Innovation Service, offering commercial solutions. The ‘Innovation Service’ model could be rolled out across the College to cover the principle skill sets offered in the FE sector.

The Food Innovation Service is supported by a team of staff with specific expertise and experience in the food industry, offering industry specific training and facilitating innovation within the food sector. In addition the industrial experience of the staff is applied in the maintenance and up keep of industry standard equipment and facilities within the Centre.



Level 3, 4 and 5 were identified as being generally 'fit for purpose' by the colleges interviewed; in so much as they met the requirements of the current curriculum and/or reflected industry standards. Colleges, for instance, had good facilities to support delivery of components in computer numerical control, computer aided design, computer aided manufacturing, 3D modelling, electronics, programmable logic controllers, rapid prototyping, 3D scanning and electro/hydraulic/pneumatic control.

Investment has been secured by colleges for facilities and resources to support emerging technologies...

That said, investment in facilities and resources to support emerging technologies is expensive and can limit access to courses and capability to open up new provision. For example, the number of learners enrolled on the Fd in Animation & Games Art at Doncaster College is limited by the extent of facilities, specifically the number of workstations.

Case Study 5: Learning pods, Barnsley, Doncaster and Rotherham Colleges

In partnership with Barnsley, Doncaster and Rotherham Colleges, and a private training provider, Strategic Training Partnership, the Manufacturing CoVE has developed two 'Learning Pods' on employer premises to help address the growing need for specialist training.

A learning space at each Pod has hardware, software and learning materials, funded by the CoVE, catering for up to 12 learners, with activity aligned to school, FE College and Higher Education curriculum.

As each Learning Pod is situated within a real manufacturing environment, tours of each factory can be arranged to experience the processes of design to manufacture and the implementation of business improvement techniques. Live high speed web links are under-development to provide real-time communication between learners and engineers. Work placements are offered in both Pods especially for Engineering Scholars.

A further 'Super Pod' is under negotiation which will help satisfy the specialist training needs of the print, food technology, packaging and glass manufacturing sectors in the region. Some high cost equipment has already been pledged by industry.

It is evident that many companies have the specialist equipment but not the staff or resources to prepare and deliver the training and assessment to employees and are, in most cases, unable to access training through traditional means. The Manufacturing CoVE provides the resources to deliver and assess the training, on company premises at a time convenient to the employer.

A memorandum of agreement between the CoVE and Learning Pod ensures the equipment, by negotiation, is made available for demonstrations and training purposes. A proportion of any fee charged by the employer is paid to the CoVE, thereby contributing to its sustainability.

'It is a case of delivering courses to the equipment you have, as the annual capital spend on equipment is heavily capped.'

– Northampton College

Nevertheless, colleges are investing in resources to enhance the learning experience.

Northampton College has a surface to air missile and guidance system, a wind tunnel, a light aircraft, composite materials, a wind turbine and photovoltaic material (funded by the East Midlands Development Agency). Leeds College of Technology has a hybrid car to support the observation of 'technology' in its current application. Deeside College has established a new optics laboratory to support the delivery of a Fd in Optics, as well as BTEC unit at Level 3 in Optic Electronics & Photonics.

Recent LSC funding has enabled some colleges to invest significant amounts of funding into capital developments. However where colleges have secured capital for a complete redevelopment, often the learning spaces have not been increased to accommodate new resources or equipment. This situation arises because of the LSC funding relationship between learner numbers and floor space.

Northampton College recently invested £80m in a new capital build. In order to make equipment in renewable technologies available for learners the plans for capital build had to incorporate such technologies into the infrastructure of the building (e.g. photovoltaic cells on the roof of the building, wind turbines on the exterior of the building).

Similarly, Bridgwater College is investing approximately £5m in an 'Energy Skills Centre'. This new facility will provide space for the delivery of

courses on engineering and science supporting nuclear technology. This centre has been supported through private investment and college capital. Private companies such as Magnox have donated equipment and resources to the scheme. Employees from Magnox South and Radwise will also act as work-based assessors.

Other colleges, by working together, have been able to minimise their capital investment and improve efficiencies through sharing facilities and resources, as well as staff expertise. In fact, most colleges use site visits to support the delivery of programmes in new technologies and access to specialist equipment. For example, New College Swindon makes use of specialised equipment at Rutherford Appleton Laboratories, Harwell Reactors and Imperial College to deliver Level 4 programmes.

In addition, many colleges are providing e-learning resources as a cost effective means by which to ensure learners have access to up-to-date materials.

4.2 Barriers to engaging the FE sector in emerging technologies

Three key factors emerged from the case study colleges that currently inhibit the degree to which the FE sector has designed and delivered courses (or components of courses) in emerging technologies.

4.2.1 Local and regional economy

The influence of 'place' impacts significantly on a college's portfolio of provision. The make-up of the local and regional economy directly affects the extent to which there are likely to be opportunities for colleges to engage in emerging technologies as well as the nature of those opportuni-



ties. For instance, New College Swindon has oriented its technology-based curriculum to prominent industries in the locality including Honda, Motorola and Intel while Hartlepool College of Further Education's offer aligns to the needs of the process industries located at Wilton in Teesside.

Success is dependent on there being a critical mass in employer and learner demand...

Furthermore, the success of any curriculum development linked to emerging technologies is dependent on there being a critical mass in employer and learner demand. The extent to which regional sectors of strategic importance have been invested in to stimulate sustainable growth influences the size and nature of demand.

Given the specialist nature of curriculum provision and the potentially higher levels of investment involved, the ability of a college to attract a sufficient volume of learners over a defined period of time to ensure viability will be a major factor in decision-making processes.

For example, the Department of Engineering at Grantham College explored the possibility of developing a course on refrigeration – the delivery of which would be supported by a functioning refrigerating facility. The course would bring together components in electrical motors, control, pumps, plumbing and piping, amongst other aspects. Its development would have also required a significant investment in infrastructure and equipment. Market research, however, indicated that the likely level of demand would be 10 to 12 learners a year and it was felt that the course would be unsustainable. In addition, market fluctuations with business closures and relocations (e.g. the closure of Fenland Food), increased the risk.

4.2.2 Planning, commissioning and funding

The planning, commissioning and funding of provision in the FE sector was identified by college principals and other senior managers as an area of concern. The current model inhibits long-term strategy and planning in colleges and does not readily enable colleges to be responsive to new and emergent skills needs. Yet the evolving model could result in an added layer of complexity and issues such as the application of volume targets, short-term funding mechanisms and entitlements, and inspections focused on processes not being addressed. In our report, *Planning and Funding Cycles for the Further Education Sector*, we explore these issues further.

There is a need to strengthen the direct link between industry and colleges...

The key to unlocking the sector's engagement in emerging technologies will therefore be to strengthen the direct link between FE Colleges and other providers and industry. This will effectively mean reducing the influence of an ever increasing range of bodies like the LSC, UK Commission for Employment Skills (UKCES), SSCs, RDAs, local authorities, Ofqual and Ofsted in the planning processes. It will also require funding models to 'incentivise' or support the development of strategic and sustained relationships between industry and the FE sector. At present the funding models have tended to encourage short-termism focused on the delivery of outputs.

The situation is compounded further because future investment in facilities and equipment has been significantly affected by the LSC funding crisis. Colleges will therefore need to increasingly look towards investing in shared facilities and/or accessing specialist facilities off-campus (see section 4.1.6).

4.2.3 Course approval and development processes

Improving the responsiveness of colleges to the needs of learners and employers is critical...

Response times to emerging market opportunities (including technology-based) needs to be improved. The current models of course approval and development (including for Foundation degrees) results in an unsatisfactory lag time between need identification and solution delivery. For example, a Foundation degree can take between 12 to 24 months to development.

'Awarding bodies lag behind developments in technology therefore the curriculum units have not yet been developed'

– Kirklees College

The influence of awarding bodies is particularly telling. Without exception all the colleges involved in this study indicated that courses approved by the range of awarding bodies did not take into account well enough new or emerging technologies. Not only does this disincentivise many colleges but for those keen enough to press ahead with new or innovative course developments it means a much longer lead in. Awarding bodies will need to approve new courses and in some instances, SSCs may need to be involved in developing new occupational standards.

'The delivery of training required by industry has been constrained by the lack of appropriate qualifications available. Training for the aerospace industry must meet EASA Part 66 standard. Following a lengthy process of mapping the EASA Part 66 requirements against existing qualifications, Exeter College identified that the National

Diploma in Aerospace by Edexcel was the closest to meeting all training requirements. However, there were still some gaps in the curriculum, and thus the college has spent time and resources in developing and accrediting components to fill those gaps. This process was incredibly time intensive and thus costly for both the employer and the college.'

– Exeter College

Improving the responsiveness of the sector to the needs of learners and employers (which are related to new and emerging technologies) will require a streamlining of the processes involved in course approval and/or a rationalisation of the number of awarding bodies and other bodies (e.g. SSCs) that influence the curriculum in FE.

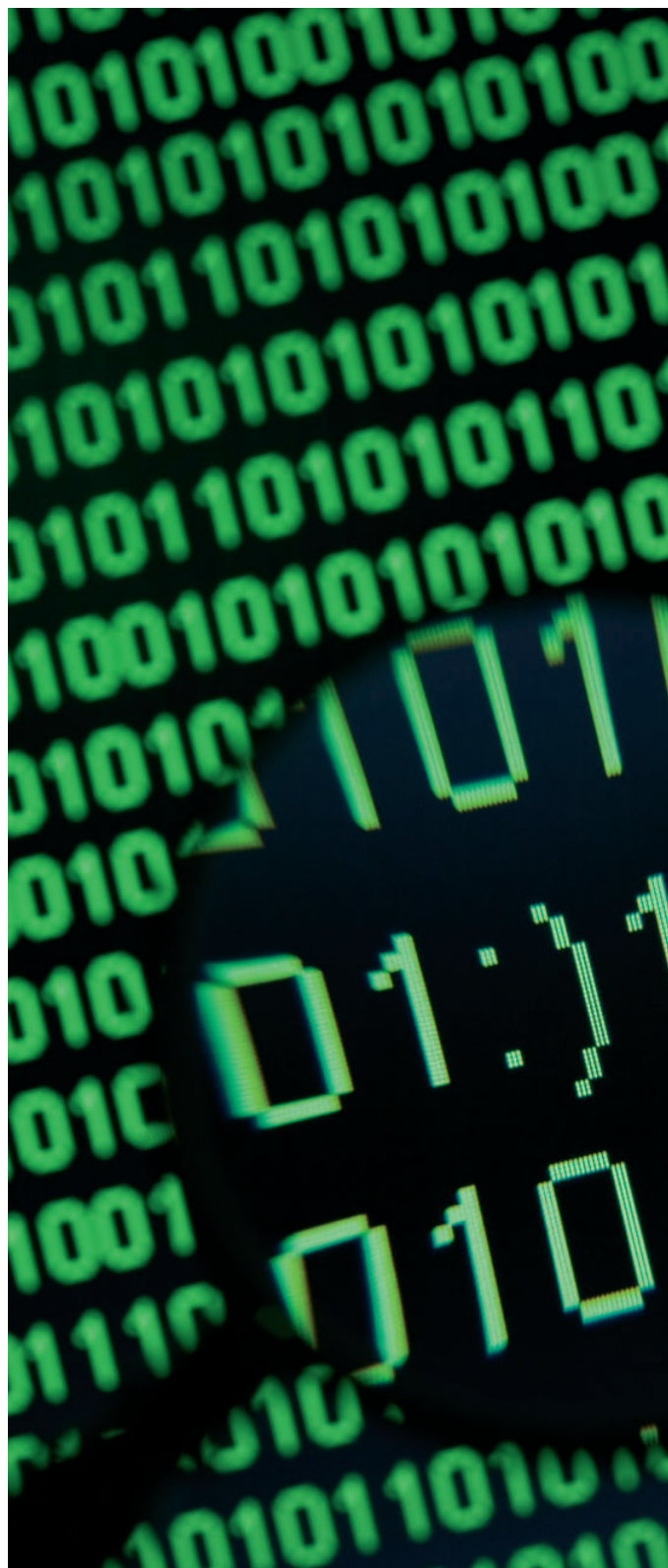
'Pioneering provision versus measured government success rates and grades'

– Northampton College

Moreover, the performance of the FE sector tends to be judged on the delivery of volume targets which in themselves do not encourage colleges to engage in cutting-edge curriculum developments.

In summary, these three key factors along with the limitations in the staffing resource have a seriously negative effect on colleges' responsiveness and their willingness to take the risks necessary to invest in new technologies.

5. SOME POSSIBLE MODELS FOR MOVING FORWARD



In examining what practical steps need to be taken in order to ensure better alignment between the FE ‘offer’ and skills priorities of industry in relation to the exploitation of new technologies we have considered models that attempt to build a better understanding of how industry is working with FE Colleges.

The solutions for improved capacity and capability in FE, and better alignment to industry needs are likely to involve close collaboration between industry, FE Colleges and universities (see section 3.2). Such models will have to recognise and integrate the respective contribution of in-house training and development delivered by industry and education programmes provided by the FE sector and indeed other publicly funded providers (e.g. universities).

Three possible models are considered below. The first involves industry-led training that uses shared specialist facilities, the second involves strategically commissioning the development of provision based on identified employer needs and the third centres on providing a ‘gateway’ to relevant services and provision to meet the needs of a particular a sector.

5.1 An industry-led training model

Group Training Associations (GTAs) are training and development centres designed to simulate real working conditions where employers can have employees trained to their own requirements and benefit from the ‘at cost’ structure.

The Association of Learning Providers defines a GTA as:

- A training organisation whose governance is conducted by representatives of (usually member) employers;
- A company limited by guarantee and a registered charity reinvesting all surpluses;
- A training provider whose curriculum is centred on apprenticeships for engineering, construction and manufacturing.

There is usually a group of subscribing member companies from which senior executives are drawn to form a GTA board of between eight and 15 members. The resulting sense of employer 'ownership' is the engine of a vocational training service offered to a wide range of companies and the communities in which they sit.

In a survey conducted by the then Department for Education & Skills (DfES) in 2002, most GTAs charged membership fees designed to gain the commitment of employers to the GTA and to take a longer term view of training.¹¹

In many instances GTAs appear to be used by their members and clients as external training managers, a resource that employers can call upon as and when they need to and in which they have confidence but whose overhead costs they do not have to carry. Some would argue that without GTAs there would be much less training undertaken, simply because many firms would have neither the time nor the money to source and manage the training they needed.

In addition GTAs co-operate with FE Colleges, delivering engineering and construction curricu-

la. A number of GTAs have been absorbed by colleges. For example, City of Bristol College has acquired two GTAs – Brunel Training and Gordano Training – strengthening its employer engagement through access to their business links. Forming partnerships with colleges is mutually beneficial for the GTAs, colleges and industry, helping to spread costs and risk taken in developing innovative curriculum provision, particularly where the cost of equipment and resources is high.

In the report conducted by the then DfES, GTAs consider themselves to have a superior offering, especially in their ability to respond to employers' needs quickly and flexibly and to dedicate experienced staff to carry out work-based assessments.

According to the Association of Learning Providers, the GTAs offer a very special learning experience which is not available elsewhere:

- School pupils are able to receive an induction to real working conditions and adult environments, and adult environments, in secure circumstances.
- The great majority of learners are employed and they bring with them the protective dress and disciplines of the workplace.
- Highly specialised equipment and environment used to serve business customers as well as apprentices.
- The closeness to employers ensures that skills remain up to date.

¹¹ DfES 2002 The Role and Impact of Group Training Associations Research Report No 384



- The curriculum is specialised in the more intellectually taxing disciplines, with mathematics, for example, taught alongside the practical skills which demand it.
- Very advanced skills are taught and tested alongside apprenticeships and Train to Gain, offering the 'pull-through' of, for example, research in the university context.
- There are comprehensive ladders of programme and award from age 14 to in-employment updating at all ages, within a relatively restricted range of occupations.
- The close association with industry and its health and safety standards allows hazardous occupations to be taught.

In addition, GTAs serve as an important interface between employers and colleges, ensuring that the training provided meets employers' needs. They provide both colleges and employers with training that they might not otherwise be able to access and which is delivered cost-effectively, aiding productivity and profitability.

The Association of Learning Providers suggests that GTAs should gradually develop into regional and sub-regional centres of excellence in technical training, meeting projected manpower requirements in established occupations like engineering construction and addressing the skill requirements of 'sunrise' industries, notably those in low-carbon technologies. These technical centres of excellence, which offered 'all through' learning opportunities, uniting knowledge acquisition and practical skills from age 14, through world-class apprenticeship, to HE (in association with universities), to continuous professional devel-

Case Study 6: Training 2000

Training 2000 is one of the largest GTAs with extensive facilities throughout the North West, acquired through successive mergers and acquisitions. As one of the leading GTAs it achieves high standards across a diversified technical curriculum.

Training 2000 has 11 buildings, 200 member companies and 2,000 other employer customers, more than 3,000 learners, 300 staff, an annual turnover of £13m from LSC and a very substantial amount of full cost commissioned training. It owns its buildings. It has no debts. It is a Centre of Vocational Excellence in several disciplines. It has diversified from its engineering and construction core into dental nursing. It offers its services to 500 school children each week through Young Apprenticeships, GCSE courses, the new Diploma, and a Saturday Morning Club; and, to NHS Cadets. It offers both practice and technical theory in the more traditional apprenticeships at all levels, including those for adults; Train to Gain programmes, including those in social care; and, commercial training to a very wide range of customers.

Its curriculum delivery is highly innovative with classrooms on the workshop floor serviced by the Promethean interactive teaching, demonstration and testing system. Employers have online, real time access to their trainees' punctuality, attendance and performance records.

opment, adaptation and accreditation, would help ensure the UK's ability to secure jobs at the top of global value supply chains and drive the UK economy.

5.2 A model for strategically commissioning provision

An example of strategically commissioned provision can be demonstrated in the North West. The development of higher level skills is a crucial component of delivering the ambitions for economic change and growth as indicated in the Regional Economic Strategy (RES) and skills action plan in the North West.

In 2006, the North West Universities Association (NWUA) agreed funding of £4m with the Higher Education Funding Council for England (HEFCE) for a region-wide Higher Level Skills Pathfinder, one of three established nationally to embed HE in regional and sectoral workforce development strategies, to embed workforce development in HE providers' strategies, and to promote greater co-funding of HE provision by employers. It has since secured further funding from the North West Development Agency (NWDA) through until March 2011. The North West Higher Level Skills Partnership (NWHLSPP) brings together the whole HE sector, including FE Colleges, together with key partners in the region to increase employer engagement with higher education to deliver flexible and responsive provision needed drive economic growth.

The NWHLSPP has focused on meeting the higher level skills needs in the region's strategic sectors – three of which have a strong technology base, namely advanced engineering and materials (including aerospace, automotive, chemicals and advanced flexible materials), biomedical, and energy and environmental technologies

supporting the project until March 2011.

In total eight new course developments led by universities and, in many instances, involving college partners have been strategically commissioned by the NWHLSPP to meet higher level skills in the advanced engineering and materials sector and further developments are about to be commissioned in the other two technology based sectors. The delivery of these new courses is supported through employer contributions and HEFCE co-funded Additional Student Numbers.

Examples of new courses in the advanced engineering and materials sector currently under development or being delivered include:

- A suite of postgraduate programmes entitled Composite Design & Analysis Training and Education led by the University of Bolton in partnership with the University of Manchester for employers such as Airbus, BAE Systems, Sigmatex and others
- A *Fd in Nuclear Related Technology* led by the University of Central Lancashire in partnership with GEN II (an independent training provider) for Sellafield Ltd and other site licensed companies

Courses being developed and delivered in the other sectors include ones led by FE Colleges and partnerships between universities and colleges.

The process involves sector panels proactively commissioning higher level skills provision which is demand-led and meets identified employer needs, and providing guidance on current skills needs to providers (universities, colleges and independent training providers) in the region. The panels comprise representation from SSCs,



cluster organisations, LSC, NWDA and relevant sector advisors from the NWHLSP team – the advanced engineering and materials sector panel has Cogent, ProSkills, SEMTA, Skillfast-UK and the North West Aerospace Alliance represented.

The sector advisor team from the NWHLSP and the SSCs work with providers to shape their responses to the identified needs and to secure strong employer involvement and commitment. Proposals to secure development funding are assessed by the sector panels.

Elements of the process adopted in the North West have been replicated at a national level through another HEFCE funded initiative, *Working Higher*.¹² The initiative is seeking to develop a suite of flexible, work-based Foundation degrees in collaboration with a consortium of HE and FE institutions and employers.

5.3 A coordinated virtual node or gateway model

Amongst companies in the aerospace sector in the South West of England (and beyond) there is an urgent requirement to develop greater capacity for the design, manufacture and repair of composites. The sector is moving very rapidly away from products based on high alloy metals to structures built using advanced composites. As the demand to use light weight materials accelerates because of environmental pressures and the cost of fuel, there is a real risk that the large number of SMEs making up the supply chain to the prime aerospace businesses will not adapt to the new technologies quickly enough.

In response to this Aerospace Training South West (ATSW), established in 2006 by the South West Regional Development Agency, together with the

West of England Aerospace Forum (WEAF) have developed a 'Composites Gateway' for aerospace businesses and those from other sectors to access knowledge transfer services, research and skills, at all levels.

The South West Composites Gateway acts as an industry specialist link for referrals from external organisations (e.g. Business Link and Train to Gain services in line with Business Simplification). The Gateway provides access to a virtual network of providers (singly or in combination) which may be involved in responding to identified demand from companies. However, understanding of knowledge transfer by each independent provider is channeled via the Gateway to other participating providers and employers as appropriate and within commercial constraints.

There are both lateral and vertical dimensions to the virtual gateway including both FE level providers across the region and higher education institutions. Providers who lack the depth of composites expertise are nevertheless in a position to pass-on enquiries from firms with whom they are in contact for other reasons, or may be able to develop niche provision or facilities so as to participate in a response led by the Gateway team. The Gateway service provides a single point of access for employers to a range of services, such as:

- Knowledge Transfer Partnerships from FE and HE;
- Placements of students with employers;
- Skills delivery;

12 www.heacademy.ac.uk/physsci/home/projects/workinghigher

- Consultancy services;
- Specialist facilities;
- Applied research.

Together, these services will increase the extent of Knowledge Exploitation delivered from HEIs through Further Education partners to the industrial supply chain.

Industry experts located within the Gateway can quickly assess the technology requirements of a business and ensure that an appropriate solution is available. This specialist input helps to raise the credibility of the FE and HE sectors amongst the aerospace industry and other sectors which use composites. The Gateway service works with employers to identify their specific needs and arrange the most suitable solutions package from the regional provider partnership. It also proactively engages with regional businesses to ensure that the services available from the providers continue to match their requirements, updating and building on the 'demand signal' on behalf of ATSW. A further key role of the Gateway is to work with SMEs to generate interest in new composite technologies and market opportunities that this may present.

The three models described above each have their merits yet no one model is likely to be 'right' in all situations.

However, combining the strengths of the different models may provide the critical elements of an overarching approach which is not only replicable and scalable but also sustainable.



6. CONCLUSIONS AND RECOMMENDATIONS



6.1 The current situation

Throughout this research a consistent picture has emerged which describes the engagement of the FE sector with new and emerging technologies. The key features are as follows:

Colleges have the potential to play a significant role, but supporting emerging technology has little currency in the sector...

- New technologies are those aspects of applied science and technology that are currently in commercial development or will be developed over the next five to ten years, and which will substantially alter the business and social environment.
- The FE sector has the potential to play a significant role in supporting the commercialisation and market development of new and emerging technologies, alongside developing the intermediate and higher level skills required by industry operating in sectors that are dependent on the application of those technologies.
- The FE sector makes a considerable contribution to delivering the STEM agenda, especially in delivering the skills needed for technician (or 'super-technician') level work.
- However, the concept of 'emerging' technology does not have much currency in the FE sector – colleges tend to be engaged in activity that relates to meeting the skills

needs of industries that are applying well established (or 'emerged') technologies.

Strategic investments have been made, but investment costs and risks are high...

- Investment to support emerging technologies needs to be within a strategic context.
- Investment in facilities and resources to support emerging technologies is expensive and can limit access to existing courses and capability to open up new provision – in addition existing funding models have led to short term planning.

Good practice exists but it is limited by the capacity and capability of college staff...

- Colleges can present examples of good practice in their response to emerging technologies – these point the way forward and in each case where a development has worked, success has been dependent on there being a critical mass in employer and learner demand.
- Pockets of activity in emerging technology have tended to be driven by individuals within a college rather than strategically led. Thus development in provision is from the 'bottom up' based around the interests and networks of an individual.
- Generally colleges lack sufficient capacity and capability to design and deliver programmes in new areas – nanotechnology, robotics, composites, nuclear, thermal optical imaging, etc. – and do not have staff with the appropriate experience or expertise.

- Staffing is a problem – age profiles of college staff suggest that the greatest number of staff teaching STEM related subjects fall in the age range of 41 to 60 years old – and as such there is inertia to the development of new curricula, and college staff working with emerging technologies are very marketable.

Strong links with employers is the key to ensuring an effective response and sustainable investment...

- Close working with employers is the key to sustainable development particularly in securing the case for continued investment.
- There is a need for FE Colleges to 'fine tune' their consultancy and relationship management skills to better support all stages of the employer journey, particularly in diagnosing needs in more specialist areas like new and emerging technologies.
- Colleges need to establish mechanisms to access and process market intelligence to build the case for investment – contacts and intelligence generated through work-based assessors, as well as secondments or site visits to industry, research organisations or universities can improve awareness of emerging technologies and consequently highlight opportunities for the college.

'Lag times' as a result of course approval and development are too great...

- The current models of course approval and development (including for Foundation degrees) results in an unsatisfactory 'lag



time' between need identification and solution delivery.

Technologies have been used to enhance the learning experience...

- The application of virtual learning technologies such as virtual classrooms, conferencing in Second Life and complex visualisations could have the potential to radically alter the learning environment, changing the delivery of courses and ultimately the role of the lecturer.

6.2 Better aligning the FE 'offer' to the needs of industry

In thinking about what practical steps need to be taken in order to ensure better alignment of the FE 'offer' to the skills priorities of industry in relation to exploiting new and emergent technologies, the key messages that emerged from the discussions included:

- Advocacy and leadership is needed at a national level to change deep-rooted perceptions of STEM related sectors and disciplines – the appointment of a Chief Scientific & Engineering Officer will help to create a level playing field by balancing a focus on 'science' with a balance on the other STEM related areas.
- Funding and funding methodologies need to be revised, particularly in respect to encouraging colleges to be more flexible, respond quicker and take time to horizon-scan – the contribution of industry also needs to be factored into the funding mix.
- Strengthening the links between industry

and the FE sector is vital if better alignment is going to be achieved – understanding the interrelationships and interdependencies in the context of emerging technologies will be key (e.g. does HE lead industry, industry lead FE, and so on):

- Incentives for industry to engage are likely to be required particularly given the current economic climate and a lack of willingness on behalf of employers to invest in training and development.
- Existing forums (and indeed new ones) need to be utilised on an ongoing basis to maintain an active dialogue and ensure FE, HE and industry have a shared and contemporary understanding of emerging technologies, their potential application and the implications for the workforce and workforce development.
- Effort needs to be directed towards helping employers to better understand what FE and HE has to offer and clarity/transparency of the 'offer' will be important.
- Response times to emerging market/technology needs must be improved – the 'time lag' is too great – this will require different and more flexible models of course development and delivery, as well as quality assurance.
- FE Colleges need to be able to access effective market intelligence, particularly at a regional level if strategic and curriculum planning decisions are to be evidence based and the risks of investment reduced.

6.3 Features of FE Colleges, effective in engaging with emerging technology

In reviewing the examples of good practice a number of common features can be determined.

Taken together these provide a useful checklist for others in seeking to improve their response to opportunities arising from emerging technologies.

The common features of good practice were:

- **Integrated planning and investment** within a strategy led approach characterised by 10 year vision for the college, a unified five year corporate (or strategic) plan and capital investment plan, and a three year planning cycle used to accommodate detailed operational and curriculum planning requirements and annual plans.
- Adopted **a sectoral focus** in which faculty/department plans made specific reference to emerging technologies.
- Established **cross-cutting mechanisms to regularly review opportunities** for the development of new provision or enhancement to existing provision.
- Implemented **processes for accessing robust market intelligence** which drew on a wide range of sources of intelligence primarily from RDAs and other statutory bodies, SSCs, and through personal contacts with industry and attendance at business seminars.
- Engaged with and **utilised well established partnerships and networks to source intelligence** and find ways and means to identify what the skills priorities were in developing and applying emerging technologies across a wide range of industrial sectors.
- Focused on **ongoing employer engagement** as a means to create commercially sustainable solutions and ensure that the college was professional in its approach to employers.
- **Shared the cost of investment** and extended capacity by partnering – working with employers, agencies and other providers to establish commercially viable solutions.
- **Involved industry in the specification and design** of the curriculum and brought in expertise from industry or universities to help in developing niche areas of the curriculum and in exploiting market opportunities.
- Retained **cross-institutional co-ordination** through either central units or formal committees, particularly where a distributed approach to employer engagement had been adopted.
- Conducted **regular formal reviews of employer needs** (many colleges used advisory boards for this).
- Used **Foundation degrees as a flexible means to adapt the curriculum** to embed emerging technology elements.
- Invested in **targeted professional development** activities.



6.4 Areas for further action

The planning, commissioning and funding of provision in the FE sector is an area of concern. The current model inhibits long-term strategy and planning in colleges and does not readily enable colleges to be responsive to new and emergent skills needs.

In the process of this research a number of issues and areas for further action were highlighted which need to be addressed at a national and regional level – these include:

Recommendation 1

The DBIS and the DCSF should work with the UKCES and the SSCs, awarding bodies, RDAs, the new Skills Funding Agency and local authorities, and the FE sector to establish a strategic commissioning approach at a national and/or regional level to facilitate a 'rapid response' by providers (both individually and collectively) to address skills needs of economic sectors reliant on the exploitation of emerging technologies. The National Skills Academies may also have a role to play here.

The strategic commissioning approach should also enable strong and sustainable tripartite partnerships to be formed between industry, universities and colleges. The approach adopted by the NWHCSP and the *Working Higher* initiative involving Cogent and SEMTA provide an insight into how this might be best achieved.

Recommendation 2

The DBIS and DCSF should establish clear guidelines for the new Skills Funding Agency, RDAs, SSCs and local authorities on how best to align national and regional investment into sectoral

development linked to new and emerging technologies and integrate the FE sector in planning for and supporting the associated skills needs.

Colleges are not well placed to drive strategic investment – individually and collectively Government departments, strategic funding agencies and leading industry representatives need to examine how colleges and the sector can be better engaged in early strategic discussion and how viable commercial learning solutions can be enabled.

Recommendation 3

The DCSF and DBIS should work with the new Skills Funding Agency and local authorities to ensure capacity and capability exists internally to generate intelligence from a wide range of national, regional and local data sources (UKCES, Alliance of Sector Skills Councils, RDAs, etc.) to inform the strategic commissioning process – at a national level consideration should be given to establishing a 'research observatory' to monitor shifts in the demand for skills associated with emerging technologies.

Recommendation 4

The FE sector should work with the Skills Funding Agency at a national and regional level and local authorities to put in place effective mechanisms through which to disseminate intelligence (labour market trends, sectoral and technological developments, changes in work practices, etc.) in an accessible and useable format to colleges and other providers to better support their strategic planning processes.

Improving the responsiveness of the FE sector to the needs of learners and employers (which are related to new and emerging technologies) will require a streamlining of the processes involved in course approval and/or a rationalisation of the number of awarding bodies and other bodies (e.g. SSCs) that influence the curriculum alongside building the capacity and capability of the sector.

Recommendation 5

The DCSF and DBIS should grant greater awarding powers to FE Colleges and undertake a review with a view to rationalising the number of awarding bodies and other bodies (e.g. SSCs) that influence the curriculum and develop mechanisms to support the sector in responding rapidly to meeting the needs of learners and employers as new technologies emerge.

Recommendation 6

The DBIS and DCSF should look to create a sustainable funding stream to strengthen the FE sector's support for innovation and contribution to meeting the skills needs of employers and learners related to the exploitation of new and emerging technologies – the FE Specialisation & Innovation Fund may provide the basis for such a funding stream.

Such a fund should be matched by FE Colleges earmarking funding in their operational and financial plans to enable research to identify opportunities and developmental support for emerging technologies, and demonstrate the sector's ability for responsive innovation and improvement.

Recommendation 7

The Learning & Skills Improvement Service should support, with additional funding from DBIS, the implementation of a specialist and dedicated 'emerging technology' staff development programme to ensure the FE sector has the capacity and capability to respond to skills needs of economic sectors reliant on the exploitation of emerging technologies.

The programme should include joint staff development involving both FE and industry based on, and extending the reach of, the New Engineering Foundation's Industrial Fellowship Scheme, and should build on other existing initiatives like the Principal and Senior Manager programmes and the Centres of Excellence in Teacher Training programme.

ANNEX 1 – List of participating organisations

A1 Technologies	Sheffield College
Aerospace Training South West	South West Composite Gateway
Association of Colleges (AoC)	South West Regional Development Agency
AstraZeneca	South West Regional Skills Partnership
BAE Systems	Technology Strategy Board (TSB)
BASF	The National Skills Academy for Nuclear
Bournemouth University	TWI Ltd
Bradford College	Unilever UK
British Telecom	University of Bristol
Castle College Nottingham	University of East London
CATCH	University of Leeds
City College Plymouth	University of the West of England
City of Bristol College	Watershed Media Centre
Cogent Sector Skills Council Ltd	Yeovil College
Department for Children Schools and Families (DCSF)	Yorkshire and the Humber Regional Skills Partnership
Department for Business, Innovation and Skills (DBIS)	Yorkshire Forward
Doncaster College	
Doncasters Group Ltd	
Dyson	
Engineering Employers Federation (EEF)	
Engineering Professors' Council	
Environmental Lean Solutions Ltd	
Exeter College	
Exeter University	
Flybe	
Foundation Degree Forward	
Gatsby Charitable Foundation	
Grantol Park	
Grimsby Institute of Further & Higher Education	
Health Tech & Medicines KTN	
Humberside Engineering Training Association	
James Dyson Foundation	
Learning Skills Council (LSC)	
LJ Group	
Loughborough University	
Learning and Skills Improvement Service (LSIS)	
National Metals Technology Centre	
North East Process Industry Cluster (NEPIC)	
New College Swindon	
Northampton College	
The National Skills Academy for Manufacturing	
SEMTA	

ANNEX 2 – List of case study colleges

The FE Colleges identified as case studies for this study were:

Barnet College
Bridgwater College
Bromley College
Burnley College
Carnegie College
Cornwall College
Deeside College
Doncaster College
Duchy College
Exeter College
Grantham College
Grimsby Institute of Further & Higher Education,
Hackney Community College
Kirklees College
Leeds College of Technology
New College Swindon
Newcastle College
Newham College
Northampton College
Park Lane Keighly College
Rotherham College of Arts & Technology
Sheffield College

ANNEX 3 – Consultations

The organisations consulted on a broader level were:

ATG Training	Heysham Power Station	Rothamstead Research
British Telecom	Higgins Construction PLC	Rutherford Appleton Laboratory
Carbon Trust	Holroyd Precision	RWE N-Power
Cogent	Huawei Technologies	Schneider Electric
DATA	Imerys Minerals Ltd	Sellafield Reprocessing Plant
Department for Business, Innovation and Skills (DBIS)	Inchcape Automotive Limited	Sharp UK
Department for Children, Schools and Families (DCSF)	Indesit Company UK	Siemens PLC
East Midland Regional Development Agency (EMDA)	Integra Composites Ltd	Smith & Byford Ltd
Higher Education Funding Council	Jaguar Land Rover	Smiths Electric Vehicles
Hiremech Training	JCB	SR Technics
Knowledge and Technology Partnership	Johnson Controls Automotive (UK) Ltd	St Marys Hospital (Imperial College Healthcare)
Learning and Skills Council (LSC)	Liberty PLC	Suzuki/Yamaha Marine Engines
Linx Associates	Lincoln Electric	Teleperformance
Mdna	Magnox South	Texa UK Ltd
National Apprenticeship Service	Marshall Aerospace	Thames Water
National Skills Academy for Manufacturing	Martin Audio	The CBRN Team Ltd
NHS	MBDA Missile Systems	The Product Workshop
Park Royal Partnership	MDVSE	The Soil Association
Pera – The Innovation Network	MetroNet Rail	Trafford General Hospital
Portia	MHE	TWI Ltd
Pro Skills	Michael Smith Switchgear Ltd	Unilever
Real Time Training	Monarch Airlines	Universal Rubber Company
SEMTA	Moorhouse Brewery Company	UPM Shotton Paper
Technology Strategy Broad (TSB) Edwards	Moss Plastics Parts	Viridis Technology
English Welding	Movevirgo Ltd	White Young Green Consulting Ltd
European Dairy Industry	Moy Park	Yorpower Generators
Fabtrol Engineering	MyTravel Engineering	
Famic	Nebriidge Engineers Ltd	
Fast Helicopters	Ned Potters	
Feedback Instruments Ltd	NEFF	
First Choice Airways	Newburgh Engineering Ltd	
Fish Engineering	Newcastle Airport	
Flybe	NHS Clinical Dispensaries	
Ford Engine Plant	Nissan UK	
Forensic Science Service	Nobobop	
Forensic Toxicology Service	Northumbria Police	
FR Aviation	Paktronic Engineering Company Ltd	
General Motors Ltd	Pathtrace Engineering Systems	
Gifford	PDC (CNC) Engineering	
Group Lotus	Pelican Controls	
Health Protection Agency	Polestar Group	
	Protec Fire Detection Plc	
	Reliance Precision Ltd	
	Robert Bosch Ltd	
	Rolls Royce	

Annex 4 – Areas of application of emerging technologies

Application areas are broad fields where technological innovation has a major role to play and which represent major societal challenges. Adapted from the Technology Strategy Board, examples include:

1. Environmental sustainability technologies:

Bioscience
Green economy
Resource efficiency, waste and pollution management
Energy efficiency
Water supply, sanitation and use
The sustainable food chain

2. Energy generation & storage technologies:

Hybrid economy
Nano wire battery
Ultra capacitor
Nuclear fusion power
Hydrogen economy
Bio fuels
Marine
Offshore wind
Distributed energy
Carbon capture and storage
Energy networks

3. Healthcare technologies:

Genetic engineering
Synthetic biology
Systems biology
Nootropics
Anti ageing drugs
Bioinformatics (computational biology, biomedical informatics)
Personalised medicines
Assisted living
Detection and identification of infectious disease

4. Transport technologies:

Electric cars
Personal aircraft
Pre cooled jet engines
Non-rocket space launch
Advanced materials
Nano materials, e.g. carbon nano tubes
Low carbon vehicles
Intelligent transport systems

5. Creative industries technologies:

Digital economy
Design
Architectural design
Communication design
Designer fashion
Film and video industry
Game development
Music industry
Performing arts
Publishing
Software development and computer services

6. High value systems technologies:

Computing and advanced communications
Artificial Intelligence
Machine translation
Machine vision
Machine augmented cognition
3D optical data storage
Quantum computing
3D printing
Wireless communications
High value manufacturing
Food production & processing
Electronics Photonics & Electrical Systems
Robotics

7. Built environment technologies:

LEDs
Micro electronics
Advanced Materials
High temperature superconductivity
Nano materials, e.g. carbon nano tubes
Meta-materials
Low impact buildings
Zero carbon emissions
Water efficiency

8. Defence Systems:

(Installation, maintenance and decommissioning)
Synthetic environments and augmented reality technologies
Unmanned aerial vehicles, autonomous vehicles and drones
Survivable underwater systems and structures
Battlefield airborne communications
Electromagnetic weaponry

EMERGING TECHNOLOGIES, EMERGING MARKETS



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