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Research and Development Best Practice in North East England, North West England and North Carolina

This research briefing looks at the structural factors affecting research and development (R&D) within the SMEs sector in North East England, North West England and North Carolina.

The comparator regions were selected to give a balance of case studies from which Northern Ireland might take examples of good practice. Other examples of good practice were provided in the research paper “Research and Development Best Practice in SMEs Sector”.

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INTRODUCTION

Research and development (R&D) is the driving force behind innovation and sustained economic growth. Companies, universities, and research institutions performing R&D create new product innovations, thus expanding markets and sales, stimulating investment, and ultimately creating jobs. Firms located near R&D centers benefit from knowledge and expertise shared between businesses, universities, and government and research institutions. Such firms are often the first to adopt new product technologies.

The following comparator regions were selected to give a balance of case studies from which Northern Ireland might take examples of good practice. Other examples of good practice were provided in the recent research paper "Research and Development Best Practice in SMEs Sector[1]".

NORTH EAST ENGLAND[2]

North East England has shared many of the problems faced by Northern Ireland, within a UK context. The region suffers from poor infrastructure and transport links, peripherally within the UK, and serious decline in its traditional industries. Over the last few years, One NorthEast has been implementing the Strategy for Success, a programme to realize the potential of the region's research base. As a case study, the region is useful as being both similar to Northern Ireland, and one step ahead in developing a detailed strategy to develop its R&D base.

Strategy for Success is a strategy for the North East of England, based upon the exploitation of the Region's research base to generate innovation, competitiveness and growth. It is a major programme to build a knowledge economy in the Region and to transform the North East's future potential. The details of this strategy are as follows:

Focus investment on a refined set of priority clusters

It was decided that a clear and realistic regional focus was needed, recognizing that a relatively small region is unlikely to excel either in a large number of industry sectors simultaneously, or across the full breadth of a wide sector such as the life sciences.

There was scope for reducing the number of clusters which were seen as targets and for redefining those which remain, with a view to focusing on the specific aspects where the North East had both existing strengths and the potential to develop. Resources could then be provided to build up key clusters and exploit niche strengths, without trying to excel in every area.

Create a Regional Science and Industry Council[3]

To combat barriers to growth, a Regional Science & Industry Council has been established. The overall purpose of the Council is to set a clear and focused business lead, but it also has an equally important role in bringing private and public

[1] Research briefing submitted for Employment&Learning Committee on 6th June, 2007.
[2] Source from http://www.strategyforsuccess.info
[3] Source from "Strategy Review Process" http://www.onenortheast.co.uk/lib/liReport/897/Business_Update_Autumn_2002.pdf

sector players together to agree common strategy and priorities, and to boost the image and vitality of science in the North East. The Council is chaired by a senior industrialist, Sir Ian Gibson, and the Council comprises 14 senior public and regional representatives who oversee the development and implementation of the Strategy for success.

Specifically, the Council's role is to:

- Guide and advise One NorthEast[4] in development and implementation of the Strategy.
- Promote the Strategy to other partners and relevant parties
- Act as an influential voice for science and technology to attract public and private investment to the region
- Foster productive partnerships between industry, commerce, policy makers, support organizations, universities and colleges
- Influence the structure and composition of the management structures of the Centres of Excellence and the Exploitation Company(North STAR)
- Influence the terms of reference and scope of activity of the Centres of Excellence
- Influence the business plans and strategies of the Centres of Excellence and the Exploitation Company(North STAR)

Develop Centres of Excellence

Five Centres of Excellence have been identified as focal points to the development of R&D in the North East. These areas have been identified on the basis of their potential to achieve world-class competitive excellence through technology transfer from the research base to the Region's Clusters.

The principal function of the Centres of Excellence are to "condition" technologies arising from the research base to a form whereby the technologies can be utilized for commercial purpose. In addition, Centres seek to secure additional funding for research, transfer and business development activities, market the knowledge base and the Clusters, provide intelligence on Cluster needs, secure suitable equipment and related facilities and secure appropriate incubation facilities. A lean operating structure is proposed, whereby the Centres are virtual organizations with a core co-ordinating staff. Five Centres of Excellence are being set up are described below.

I. Codeworks

The Digital Centre of Excellence is currently being developed and has been branded as "Codeworks". Codeworks will have three major activities.

It builds and exploits new technologies in software and digital media; it invests in promising regional digital technologies and companies as and early-stage venture capitalist and it ensures the growth of a thriving regional digital cluster. Specific programmes include: the establishment of a fast-track system through which SMEs can interact with relevant University R&D expertise; identification of key collaborative projects that deliver a reputation for world-class excellence; marketing the Region's capabilities and technology; and providing the necessary facilities and services to enable rapid innovation and support the growth of these activities in the Region.

[4] One NorthEast is the Regional Development Agency set up in April 1999 to help the people of the North East create and sustain jobs, prosperity and a higher quality of life. The Agency is responsible to the people of the North East and to the Government.

The industry-led Centre integrates and exploits the expertise in the Region's Universities, specializing in technology and content creation. Codeworks focuses on the exploitation of nascent digital technologies and media. It applies these emerging technologies to a number of important applications, most notably, GRID computing, reliable computing, visual computing and broadband content and applications.

II. Centre of Excellence for Nanotechnology, Micro and Photonic Systems (CENAMPS)

CENAMPS both facilitates and invests in projects and partnerships, which generate new business for the region and the UK through the application of nanotechnology, micro and photonic systems. The Centre of Excellence bridges the gap between technology push and market pull, working with commercial companies and academia to stimulate business-driven R&D.

CENAMPS aims to provide:

- The global promotion of regional facilities and skills to attract inward investment
- The identification and management of investment opportunities for market-driven research, development and production
- The facilitation and management of partnerships for research, proof of concept, manufacturing and go to market
- The provision of facilities, services and investment to support SMEs, for example IP exploitation, incubation, prototyping and production

CENAMPS market-driven approach to research, training and business excellence offers a number of benefits to UK companies. These include low-cost access to processing and manufacturing skills and facilities, accelerated cooperation with partners and users, facilitation of business ventures and international technology exploitation.

The North East of England has notable academic and commercial strengths in Nanotechnology, Micro and Photonic Systems. The region hosts the University Innovation Centre for nanotechnology, which builds on the research strengths of Durham, Newcastle, Northumbria, Sunderland and Teesside Universities. The region is also home to a large number of established and growing manufacturers for polymer materials and Microsystems. By matching regional strengths with national and global partnerships, CENAMPS aims to create and grow world-class business, delivering innovative solutions to meet market needs.

III. Centre for Process Innovation (CPI)

The Process Industries are the biggest generator of wealth in the North East, and constitute one of the major employers, with over 30,000 jobs in the chemical sector alone. The North East contributes 20% of the total UK process industry production. CPI based at the Wilton Centre, Tees Valley, is based on the existence of a ready-made and comprehensively equipped facility and the established presence of a critical mass of research-active organizations supporting the process sector. Wilton already contributes a significant percentage of the industrial R&D conducted in the North East and a high percentage of the required technical skills.

The key objectives of the CPI are to: develop a self-sustaining capability in technology and management necessary for the regeneration, diversification and growth of the process industries; provide a demand-led management process that will enhance and enlarge the contribution of the Universities through improved focus

and effectiveness of programmes in both applied research and education; and effect a major improvement in the commercialization of relevant technologies and to support emergent business through to full-scale manufacture. The Centre has focused on a small number of high-profile collaborative projects, reflecting company and university strengths in areas such as fuel cells, polymer electronics and associated advanced materials.

IV. Centre of Excellence in Life Sciences (CELS)

The region is rich in bioscience - it contains many leading universities, research and clinical institutes. These include the International Centre for Life, a unique "science village" with 500 people involved in research and technology transfer and the Life Knowledge Park - a world-class genetic research centre delivering fundamental improvements in human health. The region is also home to a host of global bio-companies and generates more than 30% of the UK's entire economic output of pharmaceuticals.

V. The New and Renewable Energy Centre (NaREC)

NaREC mission is to create and enable world-class new and renewable energy provision building upon the North East's industrial and academic expertise.

NaREC is capitalizing on the North East of England's world-class science and industrial base to deliver an internationally recognized facility for fast-tracking new and renewable energy research and development through to commercialization. NaREC activities directly address the key economic and performance drivers of wind, wave, current, solar, biomass and clean fuel energies in order to accelerate and exploit future markets. NaREC outputs greatly assist the UK to meet its obligations under the Kyoto protocol and enable the UK to exert international leadership and influence on climate change and energy policy.

Exploitation Company

The One Northeast Development Agency has established a new exploitation company called NorthSTAR[5], charged with transferring knowledge and technology from the research base and acting as an intermediary between the research base and users. The company becomes a custodian of a well thought out, integrated innovation process covering all steps "from concept to customer".
Part of such a process has been to facilitate access to funding. The company provides crucial support to both companies and business, including specialist expertise and advice, access to customers and access to source of finance-all services which are difficult for many companies to access independently.

To combat barriers to growth in the Region's R&D investment and weaknesses in the links between universities and businesses, One NorthEast is working with partners to progress the establishment of a new exploitation company charged with transferring knowledge and technology from the research base. In brief, NorthSTAR provides commercial expertise, access to sources of finance (including Proof of Concept Funding) and access to potential customers and thereby maximizes the commercial value generated from the Region's technological assets.

[5] Source from http://www.strategyforsuccess.info

NorthSTAR understands the Region's knowledge capital, as embodied in particular by the technology portfolios of the University and other RTD (Research and Technology Development) organizations. It uses this understanding to identify opportunities for wealth creation via the exploitation of these portfolios, and then provides comprehensive support for that exploitation.

Its objective is to generate the maximum commercial value from technology on behalf of those organizations responsible for discovering and developing the technology.

NorthSTAR provides resources to developers and owners of intellectual property. This intellectual property could originate from the Centres of Excellence, elsewhere in the Region's University of Colleges, or SMEs. Resources available to IP owners include:

- Market assessment capabilities
- Legal advice on IP protection and exploitation agreements
- Advice on routes to market and exploitation
- Access to finance

NorthSTAR interfaces with the research base principally but not exclusively via the five Centres of Excellence. For technology not covered by the Centres, NorthSTAR interfaces directly with the organization responsible for the technology and used three stages to be responsible for generating the maximum commercial value from that technology.

NorthSTAR develops and maintain excellent links with potential investors, both inside and outside the Region. These include venture capitalists, business angles, One NorthEast and others. They also include both general investors and investors who specialize in technology investment. NorthSTAR develops and maintains excellent contacts with global markets for the Region's technology-for example, potential customers, licensees and joint venture partners. In particular, NorthSTAR focuses on commercial and other organizations active in the areas of the five Centres of Excellence. To this end, NorthSTAR's key exploitation staff is well-networked university and industry figures.

Lessons learned from Northeast of England

- Focus investment on a refined set of priority clusters
- Create a Regional Science and Industry Council
- Develop Centres of Excellence
- Exploitation Company

NORTH WEST ENGLAND

North West England was chosen because it is widely recognized as a leading R&D region which built and enhanced R&D infrastructure around a major business R&D performer and a regional University. Now North West England is one of the UK's top three clusters for the biomedical sector including biotechnology, pharmaceuticals and health care based on UK major pharmaceutical presence, a rapidly expanding biotechnology community with internationally renowned academic and clinical research strengths. The North West is also home to AstraZeneca's largest R&D facility. Northwest England is a useful case study to examine best practice.

R&D in the Northwest of England

The region hosts a number of major world-class industrial laboratories, with total business R&D investment in excess of all other regions outside the South East and East (£1.56 billion of a total of £12.79 billion business R&D investment in 2003)[6]. International companies including AstraZeneca, Unilever, BAE Systems, Rolls-Royce and British Nuclear Group[7] are all major R&D investors in the region along with a growing number of smaller enterprises, most notably in life sciences.

NEW SCIENCE STRATEGY LAUNCHED TO POSITION THE NORTHWEST AS AN INTERNATIONAL CENTRE OF EXCELLENCE[8]

In 2002 the North West was the first region in the UK to publish a science strategy. The Northwest Science Council, the body established by the Northwest Regional Development Agency (NWDA) ensures coherent and active promotion of scientific excellence and a structured approach to scientific investment. The new Northwest Science Strategy, developed by the Northwest Science Council, brings together businesses, universities and other science partners in the region to ensure the region competes internationally and enjoys the benefits of a world-class science sector and was launched in April, 2007.

The strategy reflects the growing importance, nationally, of science and R&D investment as a key driver for economic growth and aims to ensure the Northwest is renowned as an area of world-class scientific achievement, attracting scientific talent and investment.

The strategy focuses on industries that are critical to the success of the Northwest economy and where science has a major impact, such as aerospace, biohealth, chemicals and nuclear development. It also includes activity and recommendations for these sectors, including; improving support to both maturing and established companies, the creation of world-class science and knowledge transfer, and investment in specialist skills development.

The new Northwest Science Strategy focuses on three underpinning foundations, six strategic pillars and the promotion of the region. This is represented diagrammatically as follows (Strategic Science Site as one of the 'six pillars' and the 'priority cluster' making up the other 5 pillars)

[6] Source from Regional Economic Indicators February 2006. Office for National Statistics.
[7] Source from Northwest Science Strategy 2007-2010. http://www.northwestscience.co.uk/uploads/documents/apr_07/northwestscience_1176911562_Science_Strat_07.pdf
[8] Source from http://www.nwda.co.uk/pdf/Science%20Strat%2007.pdf

Business capability

The Northwest does have the business ecosystem in place to benefit from emerging science and technology. It is internationally strong across a range of sectors and contains a number of large global companies that not only take the lead in exploiting science within their own company structures but also form the customer base for many SMEs. These companies are increasingly looking to their suppliers to provide innovative, leading edge solutions. This presents a key issue for those sectors where SMEs are not sufficiently engaged in R&D and innovation. The injection of a more entrepreneurial approach to the implementation of new science within the National Health Services (NHS) and the use of NHS capacity for scientific studies is an important special element of business capability.

CASE STUDY: N8 LTD IN NORTHWEST ENGLAND[9]

The N8, a business-academia collaboration led by the eight most research intensive universities in North of England (Durham, Lancaster, Leeds, Liverpool, Manchester, Newcastle, Sheffield and York), had its official Parliamentary launch in June 2007. The N8 will be creating pioneering world-class research centres to power new technological advances. By using the research excellence of the N8 the northern businesses will be able to innovate faster and gain a larger share of rapidly changing global markets. This is the first time that a group of UK universities have formed a jointly held company, especially to work together, and to work with business. Teams of researchers from each of the universities will work on programmes jointly developed from discussions with industry in the following areas:

- Energy
- Sustainable water use
- Ageing and related health matters
- Regenerative medicine
- Molecular engineering

The N8 partnership aims to match and complement the intellectual excellence of the golden triangle of Oxford, Cambridge and London. Five business plans were drawn up to identify research priorities and were published in June 2007.

Lessons learned from Northwest of England

- The new Science Strategy
- N8, the business-academia collaboration

NORTH CAROLINA

North Carolina has one of the fastest growing economies in the United State. According to the North Carolina Tracking Innovation Report 2003, released by the North Carolina Department of Commerce Board of Science and Technology, the state is undergoing a major transformation in employment from labor-manufacturing industries such as textiles and furniture, to knowledge-based industries such as information technology, telecommunications, pharmaceuticals and biotechnology.

North Carolina has 156 biotechnology companies that generate more than $2.5 billion in annual revenues, employ 18,000 people, and provide an annual payroll of more than $850 million. In addition, the state has 75 contract research organizations and testing companies-the world's greatest concentration-which generate annual revenues of more than $4.5 billion, employ about 13,000 people, and have a collective payroll of about $650 million[10]. The Research Triangle Park (RTP) in North Carolina is the largest research park in the United States and home to about 140 organizations and 38,500 full-time employees.

[9] Source from Northwest Regional Development Agency http://www.nwda.gov.uk/working-with-us/supplying-nwda/current-tenders/n8-research-centre-business-pl.aspx

[10] Source from "North Carolina Emerging Technology and the State of North Carolina: Creating World-Class Technology Clusters" John R. McIntyre, March 2005.

Information technology is thriving in North Carolina. More than 4,000 IT companies employ more than 200,000 workers, according to the North Carolina Electronics and Information Technology Association. These companies are found throughout the state, with 37 percent located in the Research Triangle area and others spread through the Charlotte, Piedmont Triangle, and other regions.

R&D in North Carolina[11]

A variety of institutions-industry, universities, government agencies, and nonprofit research institutes-actively participate in R&D. Nationally, industry performs the overwhelming majority of R&D (75 percent), while universities and colleges perform a much smaller share (12 percent). North Carolina's industry R&D share is consistent with the national average, yet the share performed by its universities and colleges (21 percent) is nearly twice as high as the national average. North Carolina's strength is its university based R&D.

Traditionally, state and local governments have played a minor role in directly supporting research and development efforts, though they have played a critical indirect role in developing universities, infrastructure, related agencies, and institutions. In 2000, North Carolina state and local governments accounted for 10.9 percent of university and college R&D expenditures.

The relative strength of North Carolina's R&D activity is its universities and colleges. The University of North Carolina system and North Carolina's private universities are key drivers of the state's innovation economy. Emphasis on R&D, regardless of performing sector, is critical to the economic success of North Carolina and its ability to attract and retain innovative companies.

Patents and License Options

The ratio of patents and license options to research expenditures by academic institutions reflects the ability of university researchers to generate innovations that are available for commercial use. This indicator must be interpreted carefully, however. Basic research plays an important role in yielding marketable innovations, but its influence is often difficult to detect in the short run[12]. A low number of technology transfer actions per R&D dollar expended does not necessarily indicate an inefficient or inappropriate research effort by the state's universities and research institutions.

In 2000, North Carolina research institutions produced one patent application or invention disclosure for every $1.30 million in R&D, ahead of the national average ($1.60 million) and fourth among comparison states. In 2000, North Carolina executed one license or option per $6.46 million, ahead of the national average ($8.59 million) and down from one per $6.75 million in 1997.

The ability of North Carolina's academic institutions to generate innovations that can be patented and licensed for commercial use remains average when compared to peer states. The more efficiently North Carolina is able to generate patentable and

[11] Source from "Emerging Technology and the State of North Carolina: Creating World-Class Technology Clusters" Georgia Tech Center for International Business Education and Research Working Paper Series 001-05/06.
[12] Source from "Industry Technology Has Strong Roots in Public Science" CHI Research Newsletter, Vol.V, No.1, March 1997.

licensed innovations, the greater the chances its innovative ideas will enter the marketplace and the greater the opportunities for industry expansion within the state.

PhD. Scientists& Engineers

Scientists, engineers, and innovators who generate breakthroughs in process and product technologies drive the technology economy. The availability of scientists and engineers for technology-related industries is an important indicator of accessible workforce resources and a key component considered by potential business when considering firm relocation. The number of Ph.D. scientists and engineers, as a share of the U.S. total and per capita, is an indicator of the relative size of the overall scientific and technical existence in the state, an input measure of innovation activity similar to R&D expenditures.

In 2001, North Carolina employed approximately 2.9 percent of Ph.D. scientists and engineers in the United States, and ranked twentieth out of all 50 states and the District of Columbia, with 2.0 Ph.D. scientists and engineers per 1,000 populations.

States with higher concentrations of Ph.D. scientists and engineers are more attractive to relocating companies. Relocating technology firms often cite specialized employment clusters as a key criterion determining their relocation. Furthermore, a competitive concentration of Ph.D. scientists and engineers is essential to provide the human capital foundation required by technology-related start-up firms. The ability of North Carolina to attract potential Ph.D. scientists and engineers to existing doctoral programs and the ability to attract out-of-state or retain in-state science and engineering students upon graduation enhances the state's ability to establish a strong technology-related human capital foundation.

Perceived Academic Science Strength

Graduate program rankings in science and technology are one indicator of a university's academic science strength. The rankings presented here provide a broad picture of the leading programs in various U.S. universities[13]. Strong reputations tend to draw premier scientific talent, top graduate students, research dollars, and other resources to the state. Graduate students in top programs may go on to staff North Carolina companies. The total number of highly ranked programs in particular areas also provides an indication of the state's principal research specialties.

In rankings made by U.S. News and World Report, 16 North Carolina graduate programs in engineering, biological sciences, physical sciences, mathematics, and computer science appear among the top 50 graduate programs.

In order for North Carolina to remain competitive in the innovation economy, highly ranked graduate programs in science and technology are critical in attracting top-ranked talent, in terms of professors, students, and research dollars to the state. While subjective in nature, the reputation of North Carolina's science and engineering graduate programs has the potential to lead to increased research funding, a specialized science and engineering employment pool, and enhanced technology related resources. Highly ranked graduate programs in science and technology are critical if North Carolina is to remain economically competitive. Talented professors and students drawn to the top-ranked programs will generate an increase in research

[13] Such rankings are an important, though imperfect and sometimes controversial, indicator of a university's academic strength. The *U.S. News and World Report* rankings presented here are the most current and widely used nationally.

funds. As a result, a positive impact on the state's economy is likely, given the potential for a specialized science and engineering employment pool and enhanced technology-related resources.

New Firms

Because many new business ventures fail within the first few years, a vibrant economy is typically characterized by a high rate of transition, including both firm openings and closings. Net firm creation is the overall change in the number of firms from one year to the next and takes into account start-ups, firm closings, locations and relocations, and reorganizations. Positive net firm growth generally reflects a healthy economy in which new business locations and start-ups are outpacing firm closings and relocations out-of-state.

Over the 2001–2002 periods, North Carolina ranked second among comparison states and sixth among the 50 states and District of Columbia in terms of percentage change in number of firms (1.8 percent).

North Carolina remains very competitive in terms of firm growth, suggesting the presence of a dynamic and healthy economy. This is especially impressive considering the downturn in the economy and continued global pressure affecting manufacturing industries in the state.

State Incentives

The Small Business Innovation Research (SBIR) Program provides competitive grants to entrepreneurs to help finance Research and Development, start-up, and commercialization of innovative business ideas[14].

- Phase I SBIR funding helps entrepreneurs conduct research on the technical merit and feasibility of an idea;
- Phase II funding helps entrepreneurs with implementation and prototype development[15]. Success in the SBIR program also attracts additional outside capital investment. Nationally, companies that receive SBIR Phase II funding have significantly out-performed similar companies that do not receive such support.

The Small Business Technology Transfer (STTR) Program facilitates partnerships between small businesses and non-profit research institutions, including universities[16]. Tracking STTR funds provides an indication of how well the state's

[14] Source from "Index of the Massachusetts Innovation Economy, 2002". The federal SBIR program is reputed to be the world's largest seed capital fund for development of new products and processes. The U.S. Department of Defense, National Institutes of Health (NIH), and National Science Foundation (NSF) are recognized as some of the top funding sources for the SBIR program.

[15] Source from Small Business Administration. Phase I is the startup phase. Awards support exploration of the technical merit or feasibility of an idea or technology. Phase II awards expand Phase I results. During this time, the R&D work is performed and the developer evaluates commercialization potential. Only Phase I award winners is considered for Phase II.

[16] Source: Small Business Administration. The five federal departments and agencies required to provide these funds are as follows: Department of Defense, Department of Energy, Department of Health and Human Services, National Aeronautics and Space Administration, and National Science Foundation.

universities are collaborating with small businesses on R&D efforts. Similar to the SBIR Program, the STTR Program follows a dual-phased approach.

Lessons learned from North Carolina

- Alliance with large research institutes incorporating the advanced technologies
- Tie-ups with universities and colleges
- High number of patent applications
- State incentives North Carolina