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Innovation and Research Strategy for Growth

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Innovation and Research Strategy for Growth

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Foreword

The UK has a global reputation for Innovation and Research. Our knowledge base, which includes renowned universities and research institutes, is the most productive among the G8. We have a proud record of invention – from the creation of life-saving medicines to the development of the internet.

This Strategy builds on the UK's recognised strengths, and sets out how we will work with business and the knowledge base to underpin private sector led growth.

We have already made clear our commitment to the UK knowledge base by maintaining the annual £4.6 billion budget for science and research programmes, with £150 million each year supporting university-business interaction which in turn benefits clusters, through Higher Education Innovation Funding.

The UK's universities are increasingly collaborating with each other and with external organisations to develop and commercialise knowledge, last year securing over £3 billion from external sources. Going further, we intend to maximise the impact of our research base on economic growth and have committed an additional £495 million to capital projects in support of this aim since January 2011. Additionally the Research Councils will develop a web based 'Gateway to Research' which will allow ready access to Research Council funded research information and related data.

We are launching a series of technology and innovation centres under the name Catapult – facilities which will commercialise innovation and research to be competitive on the world stage. Three centres – for high value manufacturing, cell therapy and offshore renewable energy – are confirmed, with three more in the pipeline to be established by April 2013. Separately, as part of the extra £495 million capital investment, we have announced dedicated funding for graphene and high-performance computing so the UK can stay at the forefront of these technologies. We will also extend the success of London Tech City to other parts of the country through the Launchpad initiative, encouraging the growth of more innovation clusters.

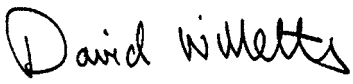
We will improve incentives for companies to innovate – especially SMEs. Beyond our successful changes to the SME R&D Tax Credit, we will invest an additional £75 million to

support small business innovation including additional funding for Smart, grants that support SME research and development. We will implement a new innovation voucher programme, enabling SMEs to engage with universities and wider external knowledge base providers, and will invest more in the Small Business Research Initiative, helping more SMEs to win government contracts for their innovative products and services. Additionally we will increase our funding to support design driven innovation. We will also encourage large company research and development by making the R&D Tax Credit 'above the line' from April 2013.

More widely, we will support innovation and research collaboration overseas, focussing on hot spots and high growth economies, starting with China and India. In particular, we will prioritise securing greater European finance to support R&D by UK businesses.

This strategy is based upon an understanding that Government can be an important driver of innovation. We will support independent bodies, like the Technology Strategy Board, to intervene when the market is unable to foster innovation alone in critical technologies or sectors. More commonly, we will work with the grain of the market by getting rid of unnecessary red tape, making public sector data more accessible and establishing a fund to run inducement prizes in areas where innovation is needed.

The Coalition Government is putting innovation and research at the heart of its growth agenda. Innovation is essential to competitiveness and higher living standards. Through greater investment and increased collaboration, we will make sure that the UK has a promising future.



VINCE CABLE **DAVID WILLETTS**

Innovation and Research Strategy for Growth: Executive Summary

1. The UK has the potential to be a world leader in innovation. The strength of UK universities and the wider knowledge base is a national asset. Our knowledge base is the most productive in the G8, with a depth and breadth of expertise across over 400 areas of distinctive research strength. The UK produces 14% of the most highly cited papers and our Higher Education Institutions generate over £3 billion in external income each year. The Government is committed to invest in maintaining and strengthening the research base, and to continue to fund a balance of blue skies and applied research projects.

2. But the challenges we face in innovation are as big as those elsewhere. Some of them are long-standing, such as ensuring we make the most of the UK's inventions and discoveries, while others are newer. Other countries are spending more on research and working to develop clusters of knowledge and innovation hotspots. The costs of cutting-edge research and the latest high-tech processes are greater than ever before, and are often too large for any one company. There is more competition for European funds. We have always needed to do better in technician-level skills, but have recently slipped down the OECD league for higher-level skills too.

3. To succeed in the global innovation economy, the UK must strengthen its ability to accelerate the commercialisation of emerging technologies, and to capture the value chains linked to these. The private sector is always going to be central to innovation. But Government can play a key role in ensuring entrepreneurs, financiers and innovators have the best possible environment in which to operate, through:

    - Funding blue skies research as well as new discoveries and inventions;
    - Improving the interface between Higher Education Institutions (HEIs) and Business; and
    - Delivering a better environment for commercialising research.

4. We have made a good start, including:

   - Maintaining the £4.6 billion ring-fenced science and research programme funding, much of which goes on fundamental research; in addition to new funding for science capital projects – including £158 million for e-infrastructure, the total increase in capital funding since December 2010 is £495 million.
   - We will be branding the Technology and Innovation Centres as Catapult Centres; a new elite national network to act as a bridge between academia and business and to support the commercialisation of new technologies in sectors such as high-value manufacturing, cell therapy and offshore renewable energy; and
   - Increasing the level of the Small Company R&D Tax Credit from 175% to 225% by April 2012. The R&D Tax Credit is the largest programme of support for business innovation in the UK, providing support of over £1 billion in 2009-10 through both the SME and large company schemes.

5. However, the UK faces the twin challenges of reducing the deficit and promoting growth. We have limited resources to invest, and must prioritise our investments into emerging technologies on the basis of rigorous criteria, and an independent assessment of UK capability to exploit their potential and succeed in global markets.

6. We are also seeking to ensure that government policies stimulate, rather than hinders, UK innovation through:

   - Greater use of public procurement, helping Government take the lead customer role, increasing investment in the Small Business Research Initiative;
   - Increasing access to public data or to knowledge created as a result of publicly-funded research; and
   - Accepting all the recommendations in the review of intellectual property by Professor Ian Hargreaves.

7. But the challenges from competing developed countries, like the US, and the burgeoning BRIICS (Brazil, Russia, India, Indonesia, China, South Africa) economies mean we need to go much further. This paper outlines a series of measures to make it easier for individuals, businesses and the public sector to innovate alone or in partnership.

8. We recognise how difficult it can be for smaller businesses to secure funding for new research and development projects. The Government has already removed the inconsistent support that existed under the Regional Development Agencies and we are now committing an additional £75 million over three years to support small business innovation. As part of this package of support, **we are relaunching the popular Smart brand, which will replace the Grant for Research and Development, and will increase the funding to the Technology Strategy Board**

to run this programme. This will provide funding for proof of concept, market and prototype development activities, enabling more small businesses to develop innovative, technology-based products and services.

9. We know that competition is important in driving the quality of research and business innovation. However, there is overwhelming evidence to show that multi-partner collaborations can add more than the sum of their parts. That's why some funding encourages and supports collaboration, both between researchers and with business. Governments cannot create new clusters, but we can encourage new collaboration and remove obstacles that inhibit clusters from growing**. Research Councils UK, working with UK HE funding bodies, and in discussion with individual universities and consortia, will establish a principles-based framework for the treatment and submission of multi-institutional funding bids.**

10. We will continue to look for other ways to encourage more relationships between universities and business. **Sir Tim Wilson's review of business:university links will make recommendations on how to do this. We will implement a new innovation voucher scheme aimed at SMEs which have not previously engaged with universities and the wider knowledge base.**

11. Global challenges in areas like climate change, security and the demographic shift are on an unprecedented scale. The way we respond to them will require greater levels of ingenuity and innovation. Our goal is for the Government to play its full part – in concert with business, academia and the public – to deliver an environment that fosters the world's best innovators and the world's best innovation.

12. One way to stimulate innovation is through prizes and competitions. A range of examples of Innovation inducement prizes, like the Ansari X Prize space competition, shows that these can be a useful mechanism for solving specific challenges. **We will work with NESTA to establish a prize centre to run, design and facilitate new inducement prizes in areas not well covered by existing activity. We will co-fund the first prize with £100,000. We will also contribute £250,000 a year into a new fund to establish future prizes.**

13. Mass datasets have the potential to deepen our understanding of the biggest challenges, for example, in healthcare. We have opened up much public data already, but need to go much further in making this data accessible. We believe publicly-funded research should be freely available. **We have commissioned independent groups of academics and publishers to review the availability of published research, and to develop action plans for making this freely available. We will also create an Open Data Institute, which will develop semantic web technologies for using data more effectively, and will advise the public sector**

and business as to how best to use these and manage their data so it can be exploited for economic and social benefits.

14. Innovation and research are now increasingly international endeavours. Most innovations originate from multiple countries, drawing in components or technologies developed in multiple locations with the high-growth economies playing an increasingly important part. We will develop and support new forms of international partnership and collaboration, with the Government taking an active role in promoting UK expertise around the world. **We will ensure that UK research and innovative UK businesses are fully engaged in Horizon 2020. In the light of agreements made during the state visit of the US President, we will hold an Anglo-US Financing Innovation symposium in London at the time of the 2012 Olympics.**

15. The UK has to aspire to be a world leader in research, technology development and innovation. Our future prosperity rests on our ability to compete in a global economy that is increasingly driven by innovation. The UK has great existing strengths in our knowledge base and ability to conduct fundamental and applied research across a range of disciplines. We also have world-class businesses in technology-based sectors, designers and creative industries. These are national assets that form the foundation of our future competitiveness. However, if we are to realise our vision we need to strengthen our innovative capability and encourage greater investment in innovation. The Government is committed to doing this, through: supporting research and innovation in business; providing incentives for companies to invest in high-value business activities; creating a more open and integrated innovation ecosystem; and removing barriers to innovation. We have already taken measures to deliver these objectives: this Strategy sets out the next steps we will take to secure our future.

1 The Innovation and Research Strategy for Growth

Innovating to Grow

Innovation is the development of new products, services and processes, which may be based on cutting edge research. Improving the UK's innovation performance is an essential component of the Government's growth plan.

A large body of evidence shows that innovative economies are more productive and faster growing[1]*. They deliver higher returns on investment and increased living standards. They are better at responding to changing circumstances through redeploying old activities and jobs. They are more able to find solutions to global challenges such as reducing dependence on fossil fuels, helping people live longer and healthier lives.*

UK businesses have to invest more in innovation activities to grow. Innovative businesses grow twice as fast, both in employment and sales, as businesses that fail to innovate[2]*.*

Innovation will drive the competitiveness of our businesses in the global economy. In technology-based sectors, research is a primary driver of innovation, and research can also discover and exploit new technologies, sometimes giving rise to new industries. In other sectors the rapid adoption of technologies and the development of intangible assets are essential to innovate, sometimes transforming existing industries.

1.1 This strategy sets out the Government's approach to boosting business investment in innovation and ensuring UK success in the global economy. Universities and research, entrepreneurship and risk taking, greater connections between people and organisations, and a more open environment will all be at the heart of our approach.

1 The economic thinking underlying this policy paper is in the Economics Review 'Innovation and Research Strategy for Growth', also published by BIS today. Unless indicated otherwise figures in this document are presented in this Review.

2 For instance in 'The vital 6 per cent.' (2009), NESTA. NESTA econometric analysis shows that firms that had introduced a product innovation in 2002-04 experienced a 4.4 per cent average employment growth rate between 2004-07, in contrast to the 2 per cent average growth rate displayed by non-innovators. And the figures are 10 per cent and 5.8 per cent respectively if we consider sales growth.

1.2 We will invest in critical areas that only government can fund and we will support innovation across the economy:

- Fostering scientific and technological breakthroughs is a fundamental role of government. Both "blue skies" and applied research lead to the industries of the future, better health and quality of life. We will continue to invest in curiosity-driven research in universities and the wider knowledge base. As well as being worthwhile in its own right, this will help us to attract the best researchers, enable our universities to build their capabilities, train future researchers and those who will work in our knowledge intensive industries. We will prioritise our investments in emerging technologies that have wide application, where the UK has relevant scientific and commercial strengths and where global markets are growing, helping create the enterprises of the future. We will also support multidisciplinary programmes linked to global challenges, and invest to support business R&D and those technology-based sectors where the UK has existing strengths. **(Chapter 2: Discovery and Development)**

- Developing emerging technologies is essential but insufficient. The growth of the UK economy depends on the extent to which businesses in all industries and services invest in adapting technologies and developing their own complementary non-technical innovations. This increasingly encompasses investing in intangible assets, from skilled human resources to new business models, design and branding. We will nurture innovation in all its forms. **(Chapter 3: Innovative Businesses)**

- Strong connections between key actors in the innovation system are instrumental to create and disseminate knowledge, and improve our success rate in building high-growth businesses. How businesses access the UK's research and information infrastructure – its facilities and knowledge base – is paramount. We will encourage stronger links through network initiatives between entrepreneurs, researchers and experts in design, intellectual property, measurement and standards. **(Chapter 4: Knowledge and Innovation)**

1.3 We will establish an open environment where the most promising ideas are rewarded:

- Open innovation means harnessing new knowledge wherever it comes from. UK businesses and research institutions already have strong partnerships with the USA and the EU, which we will reinforce. But the geography of innovation is changing. Fast growing economies like China and India offer new opportunities for both business and scientific co-operation. **(Chapter 5: Global Collaboration)**

- Innovation must occur in all parts of our society. We will make data and research findings widely available online for anyone to remix and reuse, and use inducement prizes and challenge-led innovation to solve tough problems. The Government will also encourage UK innovation as a customer of new products and through delivering public services. **(Chapter 6: New Innovation Challenges)**

UK Innovation and Research

1.4 The UK possesses the ingredients for success. We have excellent universities and research institutions and dynamic businesses:

- Our science and research base is world-class and a crucial asset. UK universities train a large number of graduates and postgraduates and host a very large number of international doctoral students across a wide range of disciplines.
- We have a strong base of research-active universities, with 4 of the top 20 universities in the world, and 32 universities in the top 200[3].
- Our research institutes include world-leading facilities which combine flexibility to pursue innovative research with a unique environment for developing outstanding students and early career researchers.
- Our excellence in teaching and research is underpinned by institutions with a global reputation, such as the British Standards Institution, the UK Accreditation Service, the National Physical Laboratory, and the Intellectual Property Office.
- Our R&D intensity in high tech industries such as pharmaceuticals, aerospace and information and communication technologies, is comparable with industries in key competitor nations. However, UK R&D is more concentrated in a relatively small number of sectors by relatively few businesses. Greater business investment in R&D is needed across all sectors of our economy.
- Our businesses invest in broader innovation such as branding, training, design and improvements in business process. These intangible investments are new sources of growth, and our high-growth businesses are not just high-tech companies but also logistics providers, facilities managers, professional services firms and manufacturers.

Global Innovation and Research

1.5 Other countries understand that innovation is fundamental to economic success. Despite marked differences between national innovation systems, some countries – like the USA (the world's most innovative economy), Japan and Germany – innovate more effectively than others. Scale confers advantage, yet much smaller

3 Times Higher Education World University Rankings (2011-12).

countries – like Sweden – also perform strongly **(see boxes: Global Innovation Leaders)**.

1.6 Fast growing economies like China, Brazil or India are rapidly raising their game. China, for instance, is set to become the second largest recipient of foreign direct investment in the world and is already the second largest investor in R&D after the USA[4]. In the BRIICS countries (Brazil, the Russian Federation, India, Indonesia, China South Africa) high-technology manufacturing trade now represents 30% of their total manufacturing trade, compared to 25% for the OECD area. New scientific hubs have been created over the last decade, for instance in Seoul, Shanghai and Sao Paulo. Some universities in Asia, such as the Hong Kong University of Science and Technology, are emerging as leading research institutions.

1.7 Many factors influence the effectiveness of any innovation system: governance regime; taxation and regulation of enterprise, and their access to finance; size of manufacturing base; organisation of the university sector; levels and orientation of government-funded research; and the role and weight of different public institutions. Industrial and technological specialisations also differ between countries, because of different historical circumstances.

1.8 The most successful national systems, however, share common characteristics. They exhibit an ability to generate long-term and risky investment at scale for new ideas, both public and private. These new ideas are the result of relationships among people producing, sharing, applying and developing various kinds of knowledge through cohesive networks. These networks also allow them to engage with international collaborators and adopt innovations that emerge elsewhere in the world. Their Governments, delivery bodies and agencies take a leadership role. They develop technological capabilities through funding research and R&D. They actively support strong collaborations between actors and take investment decisions on research and technological priorities, and institutional frameworks as well as education, regulation and infrastructure provision.

1.9 The UK is engaged in an increasingly competitive global market. Scientific research, technology development, industrial production, financial capital flows, and skilled people are more mobile than ever. Our ability to thrive in this environment depends in large part on the effectiveness of our own innovation system; how we design it and how we choose to invest in it.

4 4 All figures in this section are from OECD Science, Technology and Industry Scoreboard (2011).

1.10 The following chapters describe our plans to make sure that businesses in England, Scotland, Wales and Northern Ireland benefit from operating in an innovative global economy[5].

Global Innovation Leaders

The US Innovation Ecosystem

The USA is widely acknowledged as the most innovative nation in the world. The size of US markets provides an advantage to the US innovation system. It allows US innovative businesses to grow large, delivering high returns from successful marketing or technological innovation. But the US Government plays a major role, perhaps greater than recognised, in shaping innovation.

The Cold War years saw significant investment by the Federal Government in supporting Research & Development activities in industries and universities, especially in defence-related technologies, life sciences and energy. It provided a powerful impetus to the development and commercialisation of new civilian technologies in commercial aerospace, semiconductors, computers, and computer software. These then attracted increased private investment into the development of civil technologies with wide commercial applications.

The Defence Advanced Research Projects Agency (DARPA), created in 1958, remains instrumental in fostering these spillovers by developing technological initiatives, providing funding but also skills and management support to businesses, and providing a brokering function between university research, businesses and the public sector. The budget of this Agency is about $3 billion per year and funds exclusively challenge-led schemes in high-risk high-reward areas of life sciences, physical sciences and engineering.

US federal research funding for academic and business institutions is distributed by governmental departments and agencies, including the Department of Defence (DoD) the Department of Energy (DoE), the National Science Foundation and the National Institutes of Health (NIH). The NIH has an annual budget of $32 billion and is the largest civil agency.

5 Components of both innovation and research policy are devolved, but we will work closely with partner organisations in the Devolved Administrations to raise awareness, build capacity and ensure coherence. We will:
- help build the innovative capacity of businesses throughout the UK;
- increase take-up of the innovation advice and support services being funded and delivered through the various bodies and agencies in Scotland, Wales and Northern Ireland; and
- ensure coherence between the initiatives and investments being carried out in each of the Devolved Administrations with UK programmes and priorities, so as to maximise their reach and impact.

Over the last couple of decades, faced with more intense foreign competition, more limited financial resources and the growth of regional US clusters, federal policymakers launched more decentralised programmes spread across a number of agencies. These programmes sought to strengthen civilian technological capabilities by subsidising and promoting joint research, encouraging collaboration between US universities and industry in technology development, and supporting collaboration between US industry and the federal laboratories. In the late 1980s programmes such as the National Center for Manufacturing Sciences (NCMS), the semiconductor research consortium SEMATECH, the Advanced Technology Program (ATP) of the Department of Commerce, and the National Science Foundation's Engineering Research Centers all represented a new technology policy and relied on expanded funding from the private sector.

Public procurement is also a lever effectively used by the US Government. The Small Business Innovation Research Programme (SBIR) require Government Departments and agencies with large budgets to use 2.5% of their research procurement to support small business initiatives. SBIR funding is about $2 billion annually with additional contributions at local levels. For instance North Carolina matches all federal SBIR funds dollar for dollar.

Other US initiatives in technology policy were to reduce antitrust restrictions on collaboration in research and improved intellectual property protection.

Today's US Innovation System has some strong characteristics. Integrated innovation systems within US Government Departments (e.g. DoE, DoD and NIH) include support for research and proof of concept work, as well as support for product development and public sector organisations acting as a lead customer for innovative products and services through programmes such as the SBIR.

Public funding to undertake long-term, challenge-led research and R&D activities with universities and businesses. These programmes have played a significant role in the development and commercialisation of major innovations, e.g. telecoms and the internet. Increasingly the funding of these programmes is linked to international collaborations.

An exceptionally strong public and university research base, supported through federal agencies like the National Science Foundation and National Institute of Health, provides a bridge to commercialisation and help to de-risk private investment, funding activities at a later stage of the innovation cycle than UK Research Councils. The US also provides significant incentives for universities and business to commercialise innovations, through offering ownership of all IP arising from federally-funded research, which has encouraged US institutions to invest in their technology transfer and exploitation capability.

The existence of diverse and large companies that are investors in R&D and also in wider forms of innovation, ranging from ICT companies such as IBM, Microsoft or Cisco, to aerospace and defence companies such as Boeing, and Life Science companies such as Pfizer, Amgen, and Johnson & Johnson. Large companies in non technology-based sectors are also important customers for innovative products, notably Amazon and Wal-Mart, whose investment in logistics and supply chain management technologies in the 1990s had a significant impact on US retail productivity growth.

A dynamic entrepreneurial culture which tolerates failure, linked to strong clusters e.g. Silicon Valley, Boston, Austin and North Carolina helps to drive innovation. The combination of the availability of venture capital, business angels, and other forms of public and private investment alongside strong mentoring programmes, facilitate business start-up and rapid growth to large scale in high-technology sectors. The important role of new small businesses in commercialising technological advances appears to be unique amongst major economies.

A successful government sponsored funding programme for small businesses (SBIC). For every $1 an SBIC raises from a private investor, the Government provides $2 of debt capital, subject to a cap of $150 million. This attracted $840 million of private capital in 2010-11. Since its inception, the SBIC program has helped finance thousands of small businesses, which have grown to a significant scale, including Costco, Amgen, Staples, Apple, AOL, FedEx, Intel etc.

In 2009 the President announced a Strategy for American Innovation, a broad-based economic development strategy that channelled stimulus funding.

The Japanese Innovation Ecosystem

Although the Japanese economy faces the major problems of an ageing population, negative economic growth over recent years and a fragile environment, the Japanese innovation system still remains one of the most effective in the world. It is based on central government and the role of the Ministry of Economy, Trade and Industry (METI), large conglomerates and social and educational innovations.

The industrial and economic miracle of Japan was carefully designed and directed. In the 1960s and 1970s Japan was a big importer of technology through various mechanisms of technology transfer while simultaneously developing the basis for self-reliance and the ability to absorb technologies. Since the 1980s Japan has been at the forefront of most generic technologies. This transformation has been done on the basis of a national consensus in which central government played a leading role.

METI shapes the long-term economic development of Japan. Technology forecasting and targeting is under its responsibility, which it performs in collaboration with the Ministry of Education, Culture and Sports, Science and Technology (MEXT). METI creates the 'technology strategy maps' through consultation with industry, academic institutions and government departments.

Research, development and innovation are seen as strategic priorities by the Japanese government as well as by industry. The capacity to mobilise very large resources in pursuit of strategic priorities is a feature of the Japanese innovation system. Research expenditure represents about 4% of GDP. METI supports innovative investment through research and funding agencies such as the National Institute of Advanced Industrial Science and Technology and the New Energy and Industrial Technology Development Organisation. However large corporations provide about 80% of the national research expenditure.

Japanese large corporations have close links with central government. The strategic visions developed by METI are used as guiding maps for future industrial developments by industry associations and large conglomerates such as Mitsubishi, Honda, Mitsui and Sumimoto. They allow for large strategic investments with long-term objectives. They also facilitate the access of the world markets through strong marketing strategies and networking. In the 1980s most of their research was conducted by in-house laboratories. More recently, they have been developing research collaborations with universities and research institutes.

Flexibility within Japanese companies and the dedication to quality of product design and development is also a feature of Japanese innovation. Thorough product design and aims for customer satisfaction are the main factors behind the constant quality improvements of the Japanese products. Companies often have the practice of rotating engineers from the R&D departments to the shop floors and back again which gives them additional customer knowledge.

Japan also has among the highest skilled workforce in the world. A high proportion of Japanese complete a higher level of education and a significant proportion of them study science and engineering. On-site training is considered by companies to be the most important element in the formation of technical skills. In addition, companies often have established formal training courses and skill formation centres. This is favoured by an economic system where traditionally employment in a Japanese company is for life.

In August 2011, METI released a 5-year science and technology plan. It identifies innovative culture and funding for science and technology as a national priority. The plan includes a target of R&D of 4% of GDP, with corporations contributing 3% and Government 1% (about £190 billion).

The German Innovation Ecosystem

Germany built much of its economic success over the past decades through maintaining high-value added engineering and heavy industries, which demonstrates the strength of the German innovation system. It is the integration of high-tech into medium and low-tech products that forms the basis of German innovation. The German system has a decentralised structure with multiple actors, strong SME networks, and national technology and infrastructure priorities.

Germany is committed to increasing R&D spend to 3% of GDP by 2015. Investment in education and research remains a priority through the economic crisis. R&D spend was 2.8% of GDP in 2009 – two-thirds of this provided by industry. Some federal states (Lander) have their own innovation programmes which contribute to competition, regional differentiation and cluster development, with over 3% of GDP invested in R&D in Bavaria and Baden-Wuerttemberg. Germany's Laender are involved in joint policy co-ordination processes and co-fund research organisations and university infrastructure.

Germany has a well-funded research landscape. Some 70 Max Planck institutes specialise in basic research, while about 60 Fraunhofer institutes conduct applied research, collaborating closely with industry. About 80 Leibniz institutes and 17 Helmholtz large science centres engage in basic, strategic and applied research. The Federal and Lander Governments will increase base funding for Germany's research organisations by 5% per annum.

The High-Tech Strategy is Germany's cross-departmental mechanism to promote innovation. With a €15 billion budget in 2006-2009, it promoted a mix of sectors and enabling technologies supporting national priorities and addressing global challenges: climate/energy, health/nutrition, mobility, security and communication. The second phase of the High-Tech Strategy launched in 2010 focuses on scenario-based innovation strategies and roadmaps. It places even greater emphasis on knowledge transfer, commercialisation, and strategic science-industry partnerships.

Industry plays an important role in defining priorities and in leveraging public-sector funding. The High-Tech Strategy has created long-term public-private partnerships in emerging technology areas. Industry is involved in roadmap development and priority setting. Leading companies such as BASF, Bosch, Daimler, Deutsche Telekom, Siemens and Deutsche Post DHL contribute to Germany's High-Tech Startup Funds launched in 2005 and 2011, providing over €500 million for start-ups. So far 250 start-ups have been supported, leveraging over €300 million in private-sector follow-on finance.

Almost 80% of R&D is channelled into automotive, electrical engineering, chemicals and machine tooling industries, but Germany increasingly invests in advanced sectors like ICT, biotechnology and nanotechnology. The influential Mittelstand, family-owned innovative SMEs, lies behind Germany's leading position in export markets, from machine tools to laser systems. Recognising this, the German government actively promotes innovation in SMEs. The Central SME Innovation Programme (*Z*IM), launched in 2008 with an annual budget of €300 million, funds research co-operation between SMEs and between SMEs and research institutes. As part of Germany's economic stimulus package a further €900 million was provided in 2009-2010. The programme successfully secured and created jobs during the crisis.

The Swedish Innovation Ecosystem

The Swedish economy, like other small economies, has a strong international orientation and this is reflected in its innovation system. The high performance of Sweden is also linked to the interplay between large multinational companies, industrial policy, university research, and dynamic public sector organisations.

Around 4% of GDP is invested in R&D: 1% is government spending and 3% from industry. The Swedish industrial system is characterised by a large knowledge-intensive and export-oriented manufacturing sector dominated by a small number of large multinational groups grown from traditionally strong domestic industries, such as Ericsson, Volvo, SAAB, AstraZeneca, Electrolux, etc. With the growth of clean technologies, digital and service sectors, and life sciences, SMEs are playing a strategic role but concerns persist about their ability to grow.

Most government funding goes to universities. A few universities (Karolinska Institutet, Lund, Uppsala, Goteborg, Chalmers and Stockholm) and the Swedish Royal Technical Institute dominate Swedish research. In 2009-2010 the Government released €250 million to 21 national Strategic Research Areas for the first time.

The Swedish innovation system is made up of many organisations under the national innovation agency (VINNOVA) with a budget of around €200 million per annum. For instance, the industrial research institutes' main mission is to provide research services to the business sector, the Government covering the costs of facilities and skills development. Their work is demand-driven and they act as an interface between academic research and product development in the business sector.

VINNOVA develops research and innovation strategies for specific sectors in close dialogue with businesses and key actors in the respective sector. It produces analytical work to try to understand the future needs for a specific industry, what type of competence is available at the Swedish universities, what the international competition is, and where growth areas are including information and communication technologies (ICT), services and IT implementation, biotechnology, manufacturing and materials. This type of approach aligning industrial and research needs will continue to drive Government funding for both research and innovation in the next National Research Bill in October 2012. VINNOVA is also moving towards challenge-led innovation as an overriding goal e.g. more innovative public sector procurement, maintaining its focus on four national priorities: sustainable cities; health wellbeing and medical; competitive industry; and information society.

2 Discovery and Development

The ability to develop, commercialise and adopt new technologies across the economy will define successful countries in the 21st Century. To compete effectively, the UK must harness its strengths in blue skies research, R&D, a favourable business environment and its expertise in areas such as design and behavioural science.

However, the UK does not have either the capability or the resources to succeed in every emerging technology. Whilst the Government remains strongly committed to maintaining funding for curiosity-driven research, which delivers broad economic and social benefits. However, it is also essential to prioritise investment in technologies that emerge from the research base, into those that offer the greatest potential returns. As innovation is increasingly driven by challenges such as climate change and the ageing population, the Government will back challenge-led innovation in these areas to drive interdisciplinary collaboration to develop new business models, products and processes. Where technology-based sectors are an important element of our economic base, or provide an important technical capability through enabling a range of products and other sectors, we will invest to strengthen these.

The Economic Impact of Research

2.1 Strong universities and the wider research base drive UK competitiveness in the global economy, through underpinning technology-based sectors and enhancing our health, quality of life and creative output. They train the skilled researchers and technologists who work in knowledge-driven sectors. A vital element of this is the support that the UK provides for fundamental, or "blue skies" curiosity-driven research, which attracts leading researchers to work here, and allows the combination of ideas from different research fields. This is an investment in the future, delivering a significant return:

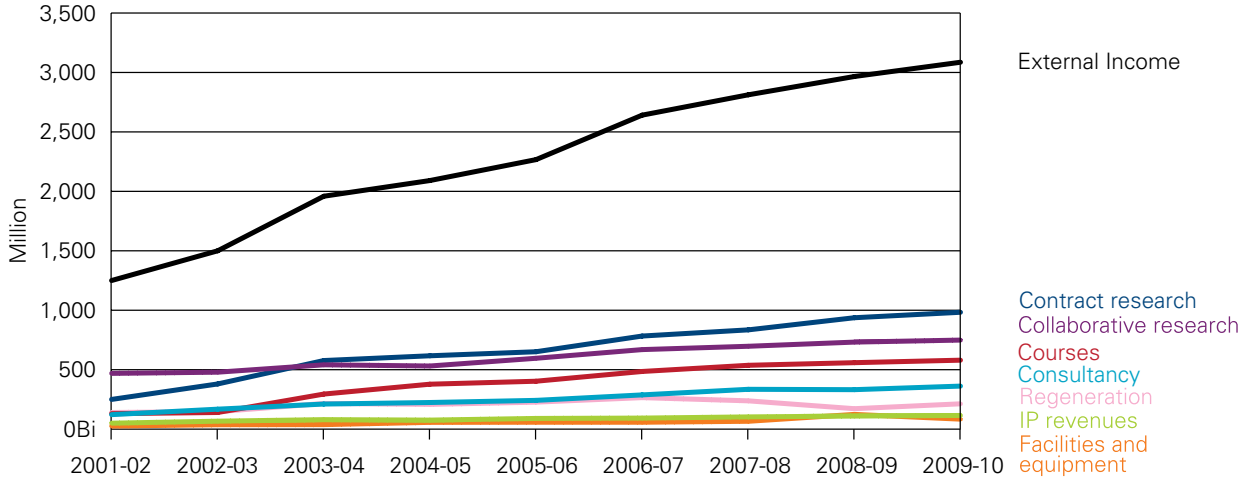
- The UK research base is the **most productive in the G8**, generating more papers and citations per pound spent than any other large country[6];

6 Elsevier International Comparative Performance of the UK Research Base 2011.

- UK research is of **top quality**, accounting for 14% of the world's highly-cited articles, behind only the USA. The UK also has more articles per researcher, more citations per researcher, and more usage per article than researchers in the USA, China, Japan and Germany;
- The UK is excellent in a **wide range of disciplines**, with over 400 areas of research where the UK is distinctively strong[7];
- This research is **valued by business and other users**, with external income to UK universities from knowledge exchange reaching over £3 billion in 2009-10; and
- The research base is also a **driver of foreign direct investment**, attracting multi-national companies such as Boeing, Pfizer, Microsoft, Tata, Intel, GE Healthcare and Huawei to the UK.

Universities working with business

A period of growing government funding for universities has also seen universities do increasingly well at business interaction and attracting external income. Last year universities secured over £3 billion from external sources.



Sources: HEBCI surveys, PACECCBR analysis

2.2 The Government is investing in the research base as a national asset. The annual £4.6 billion budget to support science and research projects has been protected. When additional capital investment is included, over £20 billion will be invested in the research base between 2011-15, to maintain and expand our world-leading research capability and to help drive sustainable economic growth over the long-term.

7 International Comparative Performance of the UK Research Base (2011), Elsevier on behalf of BIS.

2.3 High priority capital projects have been financed, including £495 million of extra capital investment announced since the conclusion of the Spending Review in 2010. The Government will also continue to invest in translational research at Public Sector Research Establishments, such as the National Physical Laboratory, which support businesses to develop innovative products and services. In addition, the established system for funding research,will be maintained based on the principle of supporting excellence with high potential impact, through competitive funding processes. The Haldane Principle, of basing funding decisions on independent professional expertise, remains the best means of protecting academic independence and excellence.

2.4 Economic and societal benefits flow from both fundamental, curiosity-driven research and research applied to the challenges facing business and public services. Therefore, we need to maintain a balance in the breadth of disciplines funded and between fundamental and user-led research.

2.5 Research Councils will continue to fund both responsive, curiosity-driven research proposals, and research initiatives into specific areas. Around two thirds of research funding is invested in responsive research. This funding will continue to be complemented through the UK Higher Education funding bodies, which will provide universities with flexible, quality related research funding, informed by institutions' performance in the Research Assessment Exercise (RAE 2008). This will be replaced by the Research Excellence Framework 2014, which will combine recognition of research excellence with reward for the impact of past research. This dual support system provides stability for universities to build their research capabilities, together with an important competitive element which directs funding on the basis of the excellence of the proposals.

Blackford Analysis

Eleven years ago, Professor Alan Heavens of Edinburgh University set out to determine the age of stars in distant galaxies and devised a mathematical algorithm that compresses huge datasets while keeping all the information needed to solve a problem, a much faster way of making calculations than traditional techniques. "It was pure scientific inquiry" he says, "We wanted to find a better way to solve a particular problem. It was only when we had invented a technique that was fast and accurate that I realised there could be a number of commercial applications outside astronomy or cosmology, and which could have some societal benefit."

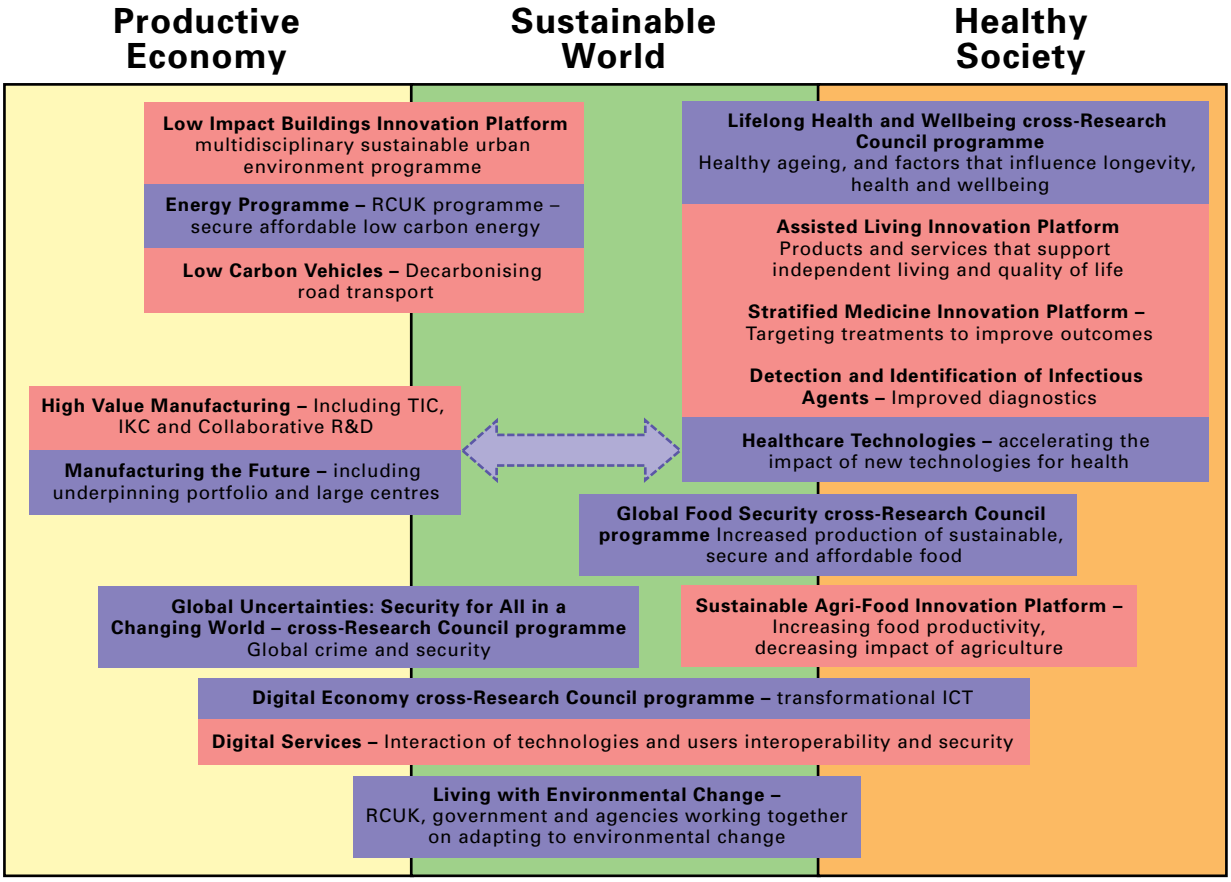
Professor Heavens realised that the technology could be used to speed up analyses of 3D brain imaging by MRI scanners. "The machine may take many images of cross-sections of someone's head, with each image having hundreds of thousands of pixels. The clinician needs to align this information up very quickly with previous scans to see what changes have happened within the brain. So you have a large dataset, but only need a few numbers to identify how things have changed. That is where the patented 'MOPED' technology we have devised can help." A spin-out company Blackford Analysis won the 2008 Research Councils UK (RCUK) Business Plan Competition. It was also awarded a grant from Scottish Enterprise, and a follow-on award from the Science and Technology Facilities Council, which funded the original research. It continues to grow commercially, and is developing applications for the defence and oil and gas sectors.

Challenge-Led Innovation and Research

2.6 Innovation is increasingly driven by the challenges that all nations face in the 21st Century. Current patterns of natural resource use are unsustainable and put prosperity and growth at risk. Demographic change is affecting all developed economies. By 2050, the proportion of the population aged over 65 will increase from one in six to one in four. We need solutions to these emerging societal needs, and to develop more sustainable patterns of living. Because of their pervasive and interconnected nature, these challenges can only be resolved through interdisciplinary collaboration, across technological and sectoral expertise, involving both fundamental and applied research.

2.7 These challenges will transform sectors such as automotive, healthcare, agri-food, construction and digital systems, requiring the development of new business models, technologies and manufacturing techniques. The Technology Strategy Board and Research Councils undertake joint programmes or aligned activities in key challenge areas, including the Cross-Research Council programmes and the Innovation Platforms. Research Councils are partners in the Technology Strategy Board's Innovation Platforms, which link academia, government and business, to identify barriers to meeting a challenge, scope routes to overcoming these and develop innovative solutions. The Technology Strategy Board is engaged in the Research Councils UK (RCUK) challenge programmes, which co-ordinate multidisciplinary research.

Research Council and Technology Strategy Board Challenge-Led Programmes

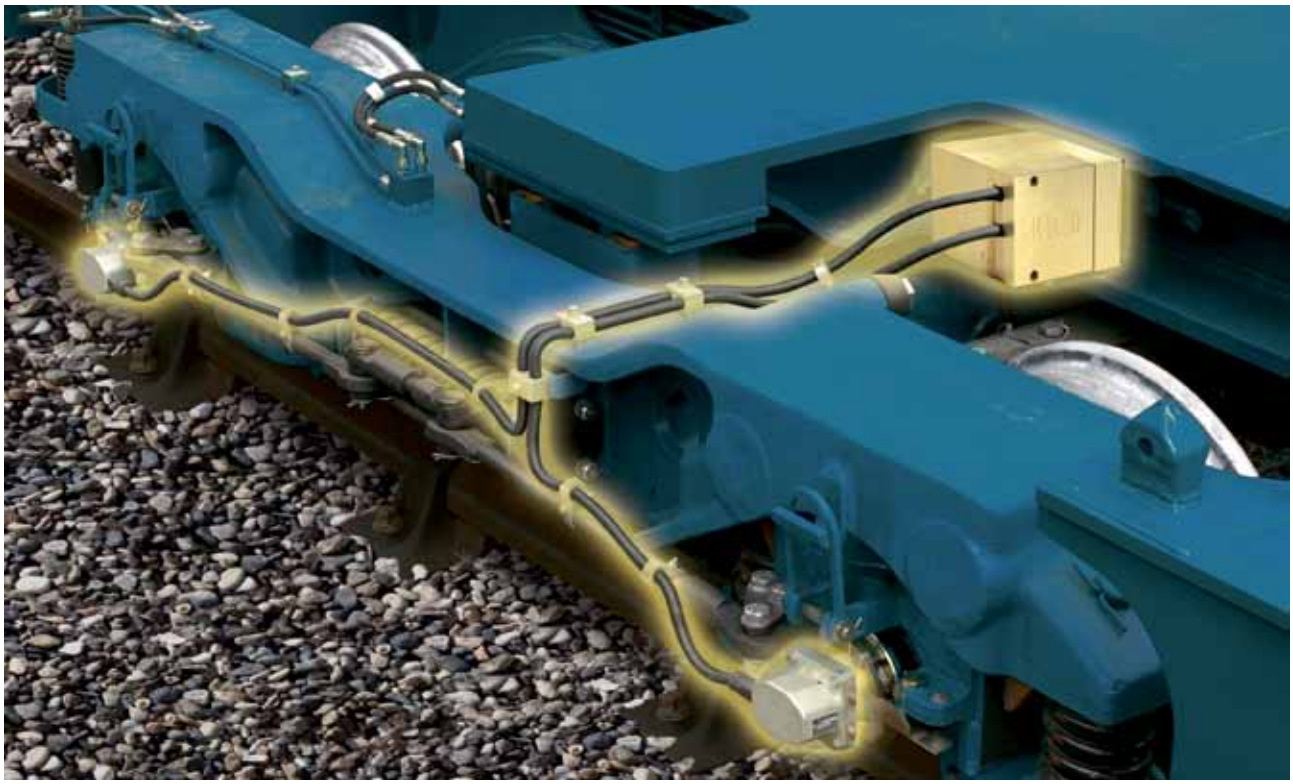


Technology Based Sectors

2.8 The UK has the fourth highest concentration of the world's top 1,400 international companies for R&D expenditure. In 2010, UK businesses spent £16.1 billion on non-defence R&D, a 3.7% increase in cash terms compared to 2009. Overall employment in R&D increased by 4,000 staff in 2010. Business investment in R&D has been maintained throughout the economic downturn, in contrast to previous recessions, providing a foundation for future economic growth. Key technology based sectors in the UK include:

- **Life Sciences:** the UK has a strong pharmaceutical and biotechnology sector, accounting for nearly a third of all business R&D investment. The UK is a world leader in fields such as Stratified Medicine, or targeting treatments on populations based on genetic type and cell therapy, which will enable the growth of new tissue to treat damaged or partially functioning organs or systems within the body. It could provide treatments or cures for diseases such as Parkinson's, diabetes, strokes and heart disease. The TSB will invest over £75 million through the Stratified Medicine Innovation Platform, and the Medical Research Council will invest £130 million over 4 years into research into stem cells and cell therapy;

- **High Value Manufacturing:** building on strengths in the sectors such as automotive, aerospace and electronics, the UK is a leader in the development of high-value manufacturing technologies, the ability to manufacture customised products using fabrication devices controlled by advanced digital technologies. The UK is also a leader in pioneering and manufacturing space technologies, including communications satellites. The Engineering and Physical Sciences Research Council has a portfolio of research projects worth over £58 million, and the Technology Strategy Board supports over £50 million of projects;
- **Nanotechnology:** over 200 companies create wealth through the theoretical development, design, the scaling up of new manufacturing technologies for specific materials. The UK has strengths in the development of coatings, composite materials and nanomaterials such as graphene, medical technologies, and displays and sensors. The Research Councils currently fund a portfolio of over £200 million in this area, with an additional £30 million of funding for applied research delivered by the Technology Strategy Board; and
- **Digital technologies:** the UK has strengths in systems and software engineering, the development of advanced 3G mobile products and services, interface design and intelligent systems and high performance computing, which increases the number of operations per second undertaken by computers and enables the modelling of complex systems and processes in sectors such as the life sciences. The Engineering and Physical Sciences Research Council has a research portfolio of over £32 million in networks and distributed systems. The Technology Strategy Board has invested over £30 million in a portfolio of projects, supporting the development of digital technologies, including through the IC tomorrow online testing facility.

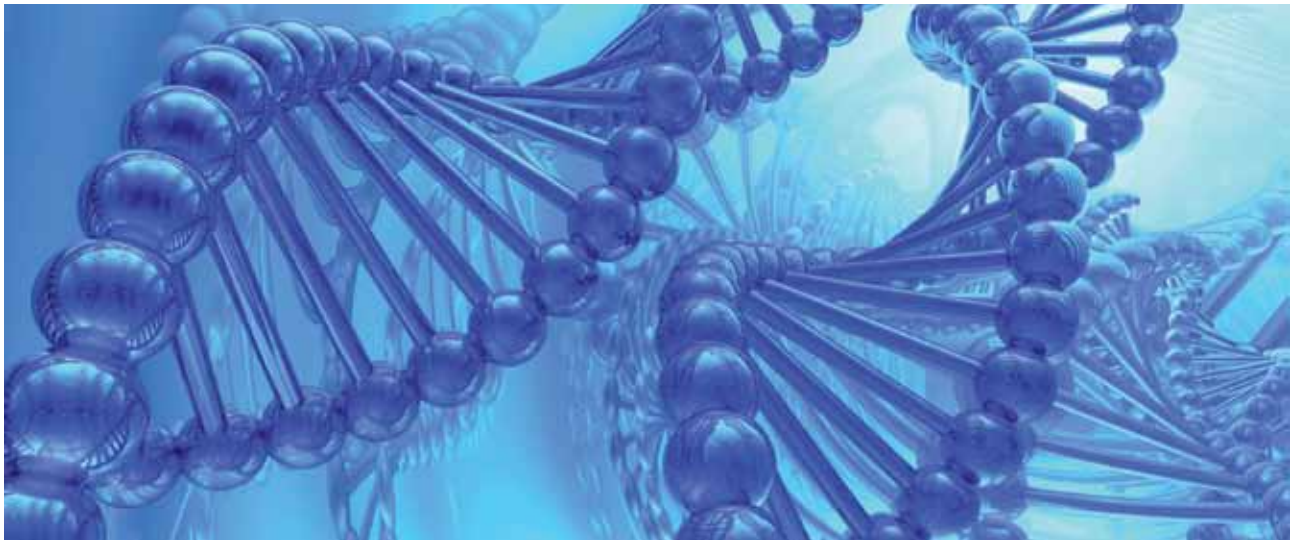


EP1001 is a unique, self powered, wheel slide protection system specifically developed in the UK for rail freight wagons to reduce incidence of wheel slides and hence wheel flats, reducing track damage and noise.

Image: courtesy of Knorr-Bremse.

UK Life Sciences Strategy

2.9 The Government is committed to ensuring the UK strengthens its position as a leader in the life sciences sector. The **UK Life Sciences Strategy** sets out how we will make the UK the best place in the world in which to translate discovery into clinical use for medical interventions. As part of this, we will invest £180 million over the next 3 years in a **Biomedical Catalyst Fund**, to be managed by the Medical Research Council and the Technology Strategy Board. This will provide seamless support for new innovations from the research phase in universities through to commercial development in SMEs, helping develop new products and technologies able to attract private investment.



Representation of DNA.

Source: Technology Strategy Board.

Space Technologies

2.10 To further develop UK strengths, we will invest £21 million to enable the UK to become the leading player in the next generation of remote sensing services, based on a combination of innovative UK radar technology and small satellite platforms to create a low-cost constellation of operational small radar satellites (NovaSAR) offering new commercial services. This investment will leverage further industry investment, and NovaSAR will meet UK security needs and provide substantial opportunities for export earnings, making the UK a 'first-mover' into affordable space radar and associated services.

UK Space Agency research formed the basis for Hylas, the UK's first broadband internet satellite.

Source: European Space Agency.

Creative Industries

2.11 Britain's creative industries represent the fastest growing sector of the UK's economy with annual revenues in excess of £70 billion. Crossing many sectors (such as music, publishing, advertising and the arts), the creative industries employ many people. This is also an area in which the UK has a significant and distinctive international reputation, exporting to global markets.

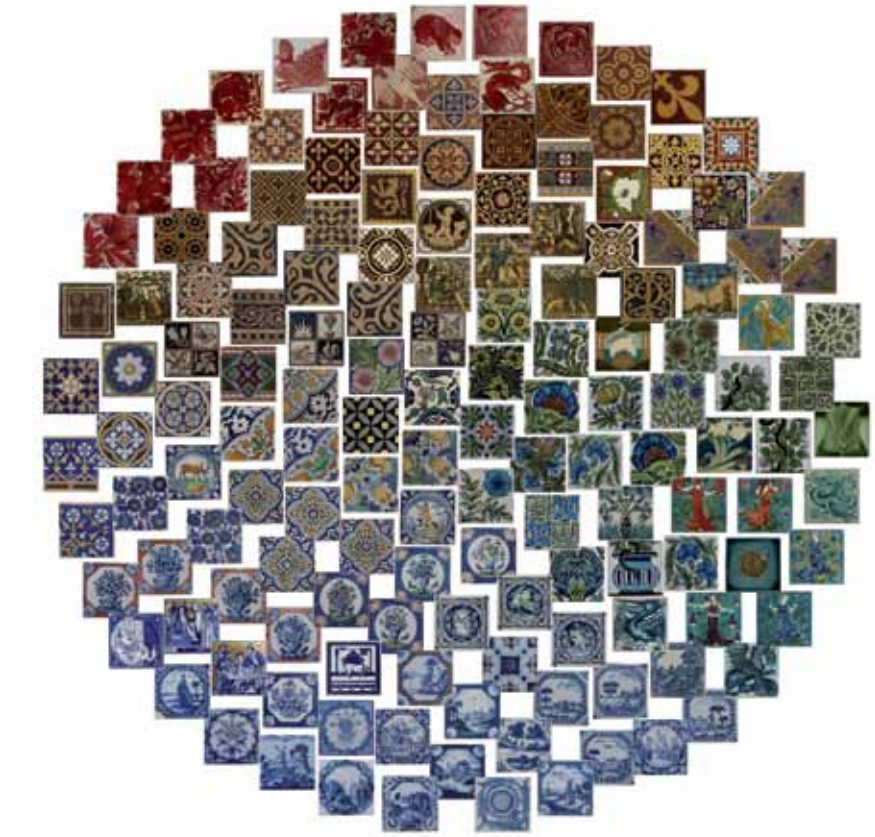


Image generated automatically through software (University of Dundee patent applied for) created in the FABRIC collaborative R&D project, partnered by University of Dundee, Liberty Art Fabrics, System Simulation and Victoria & Albert Museum. [Copyright University of Dundee and Victoria & Albert Museum].

Source: Technology Strategy Board.

2.12 The creative industries bring together many of the key elements of this Strategy: new technologies (especially in the digital arena), interdisciplinary innovation (for example, between engineers and artists), the critical importance of design, the interaction between cutting-edge research and business innovation, and the challenge presented to traditional frameworks of IP, copyright and regulation.

2.13 The Arts and Humanities Research Council will continue to promote interactions between research and business in this area, through establishing a cross-organisational centre for the understanding of Copyright and New Business Models

in the Digital Age. The Research Councils and the Technology Strategy Board are also investing in four Creative Economy Hubs for Knowledge Exchange, and \Digital Economy Hubs supporting collaboration between Research Councils.

Catapults

2.14 Technology-based sectors are characterised by a high level of R&D intensity, close links between companies and the knowledge base, and in some sectors, long or closely integrated supply and value chains, which use a range of technologies and processes. Supporting technology based sectors requires an integrated approach that bridges the gap between the research base and business, and provides resources of capital, expertise or equipment.

The High Value Manufacturing Catapult Centre includes the Advanced Manufacturing Research Centre (AMRC), University of Sheffield. This illustrates machining an engine rotor on a Mori Seiki CNC mill-turn machine at the AMRC's Rolls-Royce Factory of the Future.

2.15 **We are establishing an elite national network of technology and innovation centres, operating under the brand name of Catapult centres**. These will provide comprehensive access to specialist capability and expertise, to transform innovative ideas and technologies rapidly into valuable products, processes and systems. The capability to use design to commercialise technology will be integrated within the Catapults. The Technology Strategy Board will invest over £200 million in six centres, with the network completed in 2013. Their role will be to:

- create a critical mass for business innovation, in technology areas where there is strong UK capability to exploit global markets worth billions of pounds each year;
- strengthen and embed supply chains within the UK;
- provide open access for business to equipment and technology expertise that would otherwise be inaccessible;
- conduct applied research collaboratively with business, and under contract;
- act as the hubs of clusters and networks, facilitate open innovation through the development of new collaborations between businesses and external partners;
- support the training and development of applied engineering skills and facilitate the movement of skilled individuals between the knowledge base and business;
- encourage the diffusion of knowledge and techniques between different sectors; and
- help businesses access new funding streams, including through European funding programmes, and attract inward investment through promoting UK capabilities and the Catapult brand.

2.16 The first centre, the High Value Manufacturing Catapult, was opened for business in October 2011, and Catapults in Cell Therapy and Offshore Renewable Energy, will be launched in 2012. The technology areas for the final three Catapults will be announced in early 2012, with all six centres being operational by 2013. In more detail, the focus of the first three centres will be:

- **High Value Manufacturing Catapult:** a consortium of seven centres based across the UK, with expertise including, design and manufacturing technologies for metals, composites and hybrids; for plastic electronics; for the process industries; and automation, control and simulation/modelling technologies. This supports key manufacturing sectors including aerospace, automotive, industrial biotechnology, chemicals, food and drink and microelectronics. The Technology Strategy Board will invest more than £140 million in this Catapult during the next six years;
- **Cell Therapy Catapult:** will be based in London and will focus on the development and commercialisation of new treatments for diseases, as well as the underpinning technologies for manufacturing, quality control, safety and efficacy challenges for these new treatments. The Technology Strategy Board will invest up to £50 million over five years; and

- **Offshore Renewable Energy Catapult:** will focus on commercialising technologies for offshore wind, wave and tidal power. It will aid the development and transfer of knowledge from established engineering industries into areas such as foundations, installation, connection, operations and maintenance but also work with researchers and SMEs to evaluate and develop novel subsystems and components

Emerging Technologies

2.17 As well as investing in areas of existing technology strength, we need to position ourselves to exploit new technologies emerging from the knowledge base. As the speed with which technologies are commercialised increases, the UK's competitiveness will depend on our ability to identify new opportunities at an early stage and mobilise resources of skilled people and investment capital to exploit them. Whilst the UK cannot develop all emerging technologies, we can and should invest in those where we have the research and business capability to accelerate their commercialisation, and build value chains in the UK.

2.18 General purpose technologies, which have wide application across business sectors, are the key emerging technologies. These technologies require a broad capability to commercialise, beyond research and technology development. UK strengths in design, social and behavioural science can develop the products and business models that exploit their potential.

2.19 Commercialising these technologies requires investment in facilities, research programmes, testing procedures and the development of applications over the long term. The public sector can play a key role in this, in the same way that it pioneered developments in computing, microelectronics, mobile telephony, satellite communications, radar, large commercial aircraft, modern pharmaceuticals, global positioning systems, and many other technologies.

2.20 The UK does not have the capability or the resources to succeed in every emerging technology. Therefore, it is essential to prioritise our investments into those emerging technologies which offer the greatest potential return. A robust analytical framework, drawing on expertise in business, the Technology Strategy Board, the Research Councils, Public Sector Research Establishments, universities, and infrastructural organisations has been used to evaluate technologies against key criteria:

- the potential size of the global market, and its rate of growth (greater than £10 billion per annum);
- the range of applications for the technology across a number of economic sectors (over four);

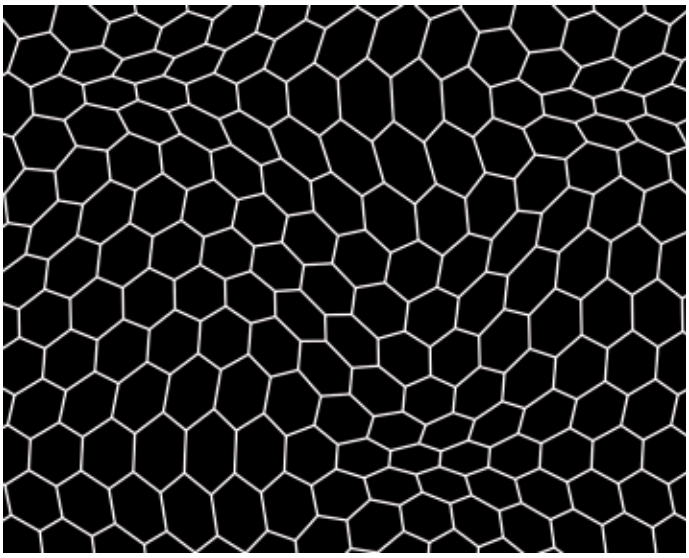
- the capability of the research base to develop these technologies (number of published papers, active research projects);
- number and strength of UK companies and their supply chains relative to international competitors, and their ability to adopt and exploit the technologies; and
- our ability to capture and protect the value we create (patenting, embedding and exploiting intellectual property (IP)).

2.21 Using this approach, four technology areas have been prioritised for investment. This will offer UK businesses the opportunity to develop the industries of the future. The Technology Strategy Board will focus on synthetic biology, energy efficient computing and energy harvesting. Other emerging technologies will be supported through a range of Technology Strategy Board and Research Council activities, including investing in the commercialisation of graphene.

- **Synthetic Biology:** is the design and engineering of novel biologically-based parts, devices and systems, or the redesign of existing biological systems for useful purposes. Estimates put the world market at around $100 billion by 2020. The UK produced 14% of all global research papers between 2005 and 2010. The potential applications include bacteria that feed on pollutants, new biofuels, drought and disease resistant crops. The UK has leading companies in these sectors.
- **Energy-Efficient Computing:** is the design of hardware and software to reduce energy consumption through reducing the power needed or operating time. The global market could be $50 billion in 2020. The UK produces around 7% of global research papers, and 1.6% of global patents. Almost a third of European chip design companies are based in the UK and there are strong hardware and software sectors.
- **Energy Harvesting:** is the use of low levels of energy obtained from the environment, from temperature, movement or pressure, enabling electronic devices to power themselves independently. Markets include wireless sensors, building controls and consumer devices. The global market for energy harvesting could grow to $4.4 billion by 2020. The UK has capability in the sensors and instrumentation, electronics and design to exploit these technologies.
- **Graphene:** the thinnest possible material, yet impermeable to gases or liquids. It is the strongest material ever measured; around 200 times stronger then structural steel and a record conductor of heat and electricity. Potential applications include ultrafast transistors, to high-performance materials that are used to build aircraft; and it could potentially revolutionise the semi-conductor industry by replacing silicon.

Graphene Global Research and Technology Hub

2.22 The UK is the global leader in graphene, discovered in Manchester in 2001 by 2010 Nobel Physics Laureates Andre Geim and Konstantin Novoselov. **We are investing £50 million in the development of a Graphene Global Research and Technology Hub**, which will accelerate the development of commercial applications for graphene. The Hub will connect UK researchers and businesses, and provide specialist equipment and expertise. The Hub will also develop a graphene strategy to embed a significant proportion of the value chain in the UK and build sustainable competitive advantage. It will work with universities and further education providers to ensure the UK develops the skills needed to support a growing graphene-based sector.



Representation of Graphene under strain.

Picture: University of Manchester.

Summary of Actions

Since May 2010, the Government has:

- **protected the science and research budget and committed to investing over £20 billion by 2015**
- **allocated an additional £495 million of capital investment since the Spending Review in 2010**
- **committed to establishing an elite national network of Catapults, investing over £200 million between 2011-15**

To take this further, we are now:

- **investing £50 million in the development of a Graphene Global Research and Technology Hub.**
- **investing £21 million to enable the UK to become the world leader in the next generation of satellite-based sensing services.**
- **Investing £180 million in an Integrated Translation Programme to support the commercialisation of innovations in the life sciences sector.**

3 Innovative Businesses

Businesses are key innovators in the UK. Through innovation, they drive productivity improvements and economic growth. Businesses of all sizes and in all sectors innovate. Technology-based businesses and sectors are important, and perform as well as their international competitors. However, future economic growth also depends on businesses across the economy adopting technologies and investing in their own complementary forms of innovation. Design, managerial and organisational competencies, human resources and intellectual property are increasingly important forms of innovation.

Businesses also benefit from partnering with universities. They are more likely to improve the quality of their goods and services, improve their labour productivity, increase their range of goods and services and more than twice as likely to open new markets or increase their market share compared to those businesses that don't interact with HEIs.[8]

To achieve strong, balanced and sustainable growth we need to find new ways of stimulating investment in innovation across the economy. It is paramount that in a time of scarce resources, Government helps innovative businesses to access the finance and support they need to generate wealth and create new jobs.

Investing in Innovation

3.1 Research from NESTA shows that about 6% of innovative, high-growth companies created 40% of new private sector jobs[9]. The Government is committed to enabling such businesses to access more diverse sources of finance, including debt and equity, as well as providing support through the tax system.

Research and Development (R&D) Tax Credits

3.2 The Government recognises the value of R&D Tax Credits to innovative companies. R&D Tax Credits offer relief from Corporation Tax and provide the single biggest government incentive for business R&D. They incentivise companies in all sectors,

8 Lambert Review of Business-University Collaboration (2003), HMT

9 'The vital 6 per cent' (2009), NESTA.

from new innovative start-ups through to large multinational companies, to undertake more R&D. In the financial year ending 31 March 2010, company claims totalled over £1 billion, enabling over £11 billion of R&D investment by business.

3.3 In the March 2011 Budget, the Government made significant changes to the SME R&D Tax Credit (for companies with fewer than 500 employees). We raised the rate of tax relief to 200% of qualifying expenditure from 1 April 2011 and will increase it to 225% from 1 April 2012. This makes the UK SME R&D Tax Credit amongst the most competitive regimes in the world. We also recognise the importance to small companies of a simplified tax regime and we have made it easier for small companies to claim the R&D Tax Credit.

3.4 The Government announced in its Autumn Statement 2011 its intention to introduce an "above the line" Research and Development Tax Credit and will consult on the details at Budget 2012. The Credit will be effective from April 2013 and will provide greater visibility for the tax incentive and greater certainty for large company investors. The Government will use the consultation process to ensure that SMEs' R&D incentives are not reduced as a result of the introduction of "above the line"[10].

3.5 To increase usage of the R&D Tax Credit we will:

- Work with HM Treasury, HM Revenue and Customs and the Devolved Administrations to increase awareness and take-up of the SME scheme;
- Work with the Design sector to raise awareness of how the Scheme can help support design-led research and development; and
- Further simplify the scheme piloting a pre-approval mechanism for smaller companies.

Support for Venture Capital

3.6 Investment and fundraising in the UK and Europe has suffered as a result of the crisis in financial markets. The US and European venture capital markets are volatile and subject to large uncertainties. The Government is committed to making the UK the best place in Europe to grow and finance a business. We have:

- Increased the amount government committed to the Enterprise Capital Funds programme by £200 million over the Spending Review period;
- Backed business angels with the £50 million Co-Investment Fund funded through the Regional Growth Fund;

10 The current R&D Tax Credit reduces the profits that R&D companies have to pay corporation tax on. An "above the line" tax credit is calculated as a percentage of the company's R&D spend. It is first offset against the company's corporation tax bill and if there is any unused credit (e.g. if the company is loss-making) the credit is payable to the company. The fact that the company gets the benefit of the credit, whatever its tax status, means that it can be accounted for as a reduction in R&D spending – 'above the tax line' in the accounts.

- Reformed investor tax reliefs, including increasing the rate of income tax relief for the Enterprise Investment Scheme to 30% and doubling the investor limits to £1 million per annum from April 2012. Work is ongoing to secure State Aid approval for remaining reforms;
- Continued to support the UK Innovation Investment Fund, one of Europe's largest technology funds that is investing in life sciences, digital, advanced manufacturing and clean tech companies;
- Spurred the five main banks to set up a Business Growth Fund worth £2.5 billion. It provides £2 million – £10 million to companies with high-growth trajectories.
- Encourage investment into new early stage companies through the Seed Enterprise Investment Scheme (SEIS) by providing a higher rate of income tax relief of 50% for individuals who invest in qualifying seed companies. To kick start the scheme the Government is offering a Capital Gains Tax exemption on any gains realised in 2012-13 that are invested through SEIS in the same year.

3.7 During President Obama's state visit to the UK in May 2011, the President and the Prime Minister announced their intention to strengthen links between our respective venture capital sectors. We will hold a major Anglo-US Financing Innovation symposium in London 2012, linked to the Olympic Games, with the British and US Venture Capital Associations. We will bring together UK and US investors and fund managers to enable strategic partnerships to be developed and to showcase and secure investment for some of the UK's leading innovative companies.

Technology Strategy Board

3.8 The Coalition Government has made the Technology Strategy Board the prime channel for supporting business-led technology innovation. The Government recognises the business leadership of the Technology Strategy Board and simplifies what was previously a complex landscape through which businesses sought and received support. The Technology Strategy Board as the UK innovation agency targets support more effectively towards those areas of investment that will have the greatest impact on growth, and leverage additional private sector investment.

3.9 The Technology Strategy Board develops technology strategies and makes choices on the allocation of funding to particular sectors markets and challenges, as well as to emerging technologies, by taking a strategic view of where UK capability exists and where future opportunities may emerge. Its ability to operate effectively relies on its access to significant technological and business expertise. It creates incentives for business R&D which are provided through several methods, including:

- **Collaborative R&D**: provides funding to enable business and research communities to work together on R&D projects from which successful new products, processes and services can emerge. Over £150 million will be invested in 2011-12 to enable research such as an £800,000 grant to develop Aquamarine Power's Oyster®, a hydro-electric wave energy converter;
- **Knowledge Transfer Networks (KTNs)**: providing over £15 million in 2011-12 for 15 KTNs, which have over 38,000 members through the Connect web platform makes the necessary connections between the various players, helping industry access knowledge and information to support growth;
- **Knowledge Transfer Partnerships (KTPs)**: over £30 million in 2011-12 to stimulate innovation by facilitating the transfer of knowledge and the spread of technical and business skills through 1000 live projects per annum undertaken by high calibre, recently qualified graduates. This year's award for best KTP went to a partnership between Queen's University Belfast and Cherry Pipes of Dungannon;
- **Small Business Research Initiative**: investing over £5 million in 2011-12 to enable innovative companies to solve challenges for Government departments. For example a recent competition with the Department of Health provided solutions that enabled diagnosis of asthma in babies, or others, who cannot blow into a conventional spirometer; and
- **Grant for Research and Development**: approximately £20 million of funding in 2011-12 to address the finance market failure for high-risk and potentially high-reward technologically innovative projects carried out by SMEs. The funding supports Proof of Concept and Proof of Market analyses, and the development of prototype products. Previous beneficiaries include Optos, based in Dunfermline, an innovative retinal imaging company with revenues worth over £100 million in 2010.

Increasing SME Innovation Support

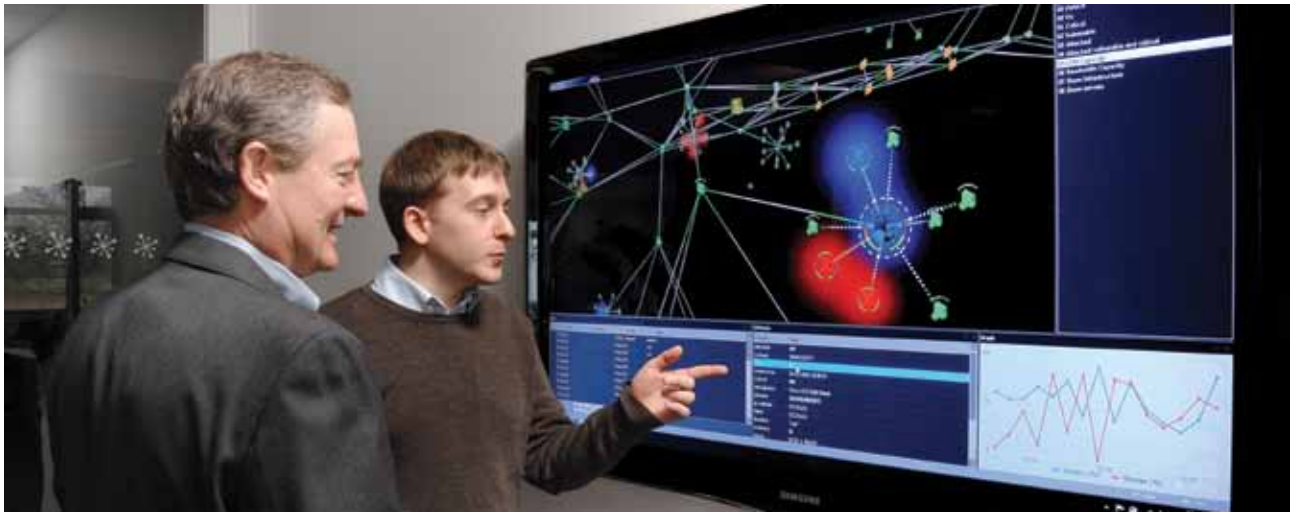
3.10 As part of an SME Innovation Package announced in the 2011 Autumn Statement, the Government will invest an additional £75 million over three years through the Technology Strategy Board to support innovative small businesses. **We are also rebranding Grant for R&D back to its original and popular brand name of Smart.** Smart was introduced in 1988 and was a long-running programme that corrected the recognised market failure around private finance for high-risk and potentially high-reward technologically innovative projects carried out by SMEs. This new funding package for Smart enables the Technology Strategy Board to expand support for innovative technology SMEs across the whole of the UK.

Design for Innovation

3.11 Design can be transformative for companies, through leading or supporting product and process innovation, for managing the innovation process itself, for the commercialisation of science, and the delivery of public services.

3.12 Research has consistently shown a link between the use of design and improved business performance across key measures including turnover, profit and market share[11]. Over a ten year period, the Design Council tracked publicly quoted firms that use design intensively and compared them to less intensive design users. Between 1995 and 2004, the share prices of design-conscious companies outperformed other firms by 200%. The Design Council's 2007 Value of Design Survey of over 500 businesses found that for every £100 a design-alert business spends on design, turnover increases by £225.

3.13 Most successful high-tech businesses are design and technology-driven. However, there are parts of the economy where design awareness remains low, including amongst SMEs, scientists seeking to commercialise new ideas and the public sector. This lack of awareness and use of design is compounded by the fact that the UK design sector, while boasting a worldwide reputation for creativity and innovation, is complex to navigate. We continue to support the Design Council's activities to connect both the private and public sectors to design. The Design Council will work with the Arts and Humanities Research Council and other partners on a design research programme to measure the impact of design on economic performance and social value creation.



HyperGlance draws on computer games technology to model complete IT applications and infrastructures in 3D, so customers can make decisions based on understanding the business impact of problems and vulnerabilities.

Source: Technology Strategy Board

11 Evaluation of Designing Demand – Eden Partners, 2011.

Design Support for Innovative Business

3.14 The Design Council is delivering Designing Demand, a BIS-funded mentoring programme to build greater design capability and understanding among SMEs. The resulting design projects often deliver new or improved products, services, systems and/or brands that improve business growth potential and success. The average return on investment for every £1 invested in design by business is over £25 and it is estimated that over £12 Gross Value Added (GVA) has been returned for every £1 of public funding invested in Designing Demand[12]. Building on this success we will increase our funding of Designing Demand to £1.3 million per annum.

Gripple

In 2007 when the Sheffield-based company took part in Designing Demand, it had an £18 million turnover from manufacturing wire joining and tensioning devices. Today, new products are being brought to market faster and productivity has been improved as a result of the design support it received. Gripple now sell over 30 million products every year to over 80 countries, designed to suit a whole range of applications across the agricultural and construction markets. Turnover is growing and increased to £25 million in 2009. Over 20% of the firm's turnover is generated from new products launched in the last three years.

"The Designing Demand framework has really raised the profile and importance of innovation at all levels within the business," Gripple's Special Projects Manager Gordon Macrae

3.15 Business Coaching for Growth is a new programme to help up to 10,000 SMEs a year overcome the barriers they face in achieving high-growth potential. Specialist coaches will work with senior management teams to develop business strategies, raise external finance, and develop the skills they need to implement their strategies. The programme will include help to commercially exploit innovation, build a culture of innovation within the business, and identify and protect intellectual property and copyright. There will be strong links between Business Coaching for Growth, and the support provided by the IPO, Technology Strategy Board, The Design Council and Catapult Centres.

Maximising Investment

3.16 In the current economic climate, it is vital that we use public funding to leverage investment from other sources. This is particularly true in those areas of the UK that do not receive high levels of funding from national funding programmes for research and innovation, or significant levels of business investment. We are committed to

12 'The Value of Design Factfinder Report' (2007), The Design Council.

ensuring that we exploit every opportunity that exists to raise the level of investment in innovation across the UK, and to exploiting available sources of investment such as the European Regional Development Fund (ERDF).

3.17 Working with innovation infrastructure organisations, Local Enterprise Partnerships (LEPs) and other parts of the innovation ecosystem we are investing in a capability that enables us to make maximum use of European Union (EU) funding to support our investments. This will be based in the Technology Strategy Board, but will work with innovation organisations and local partners to provide support for innovation at the local level. We will use this additional European funding to:

- **Increase the scale and reach of our innovation infrastructure** such as Catapult Centres, through expanding their capability;
- **Support innovative collaborations** between business and the knowledge base, through innovation vouchers and increased numbers of Knowledge Transfer Partnerships;
- **Improve the competitiveness of businesses and their products and services through design**, expanding the Designing Demand programme; and
- **Supporting companies to access additional investment** through the Technology Strategy Board's Launchpad programme.

Intellectual Property

3.18 Intellectual Property (IP) is a significant factor for growth for many companies; innovative companies that use intellectual property rights are associated with significantly better chances of firm survival[13] and company growth[14]. Evidence shows that use of patents is associated with greater knowledge creation, better use of knowledge within firms[15] and higher transfer rates of knowledge between firms and universities[16]. Trade mark use is similarly associated with higher firm productivity and innovation[17]. However, in protecting their innovation, SMEs lag behind large firms. While 13% of large firms seek to protect their intellectual property through patents, only 6% of SMEs do so and therefore may miss opportunities to seize the full value of their ideas[18]. This is often because smaller firms do not always understand the

13 Helmers and Rogers, 'Innovation and Survival of New Firms across British Regions' (2008), Economics Series Working Papers 416, University of Oxford, Department of Economics, 2008
14 Greenhalgh and Rogers, 'The Value of Intellectual Property Rights to Firms' (2007), Economics Series Working Papers 319, University of Oxford, 2007
15 Criscuolo, Haskel and Slaughter, 'Global engagement and the innovation activities of firms' (2006), NBER Working Papers 11479, National Bureau of Economic Research, Inc, 2006
16 Crespi, Criscuolo, Haskel and Slaughter,,'Productivity growth, knowledge flows and spillovers' (2007), Centre for Economic Performance, LSE, 2007
17 Greenhalgh and Rogers, 'Trade Marks and Productivity in UK firms' (2005), Economics Series Working Papers 300, University of Oxford, Department of Economics, 2005
18 Hughes and Mina, 'The Impact of the Patent System on SMEs' (2010), CEBR

value of their IP and are unlikely to seek specific IP advice unless prompted to do so within wider business advisory discussions.

3.19 In November 2010 the Government announced an independent review of IP and growth to be carried out by Professor Ian Hargreaves. This review published its findings in May 2011, setting out the main concerns for businesses, particularly SMEs, in accessing the right advice to allow them to use their IP to maximum effect[19]. These activities will further build on initiatives such as the Intellectual Property Office's (IPO) Ipsum service, which enables businesses to have up to date information, in real time, saving them time and money as they progress patent applications.

3.20 As part of the implementation of the Government's response to the Hargreaves Review, the Intellectual Property Office (IPO) has undertaken a programme of work designed to improve the offering to business in this area.

Raising IP Capability for Business Advisors

3.21 The IPO offers a range of support tools to businesses. However, we recognise the importance of equipping those who advise businesses direct with the skills and knowledge to offer IP advice. The IPO currently runs Masterclass training courses for advisors. They will adapt this training into modules to make it accessible for a wider range of business advisors. To maximise its reach, the IPO will also develop an online business advisor training tool to provide advisors with the skills to advise businesses on the value of their IP, how to maximise this value and also to be able to direct businesses to other sources of advice when necessary

3.22 The PatLib network operates around the country, with 13 regional locations across the UK, including the Business and IP Centre based in the British Library in London. The service provision varies across the network; all provide access to literature on IP, but some are able to offer free sessions with advisors, support on patent and trade mark searching and commercial IP services. The IPO will work with the PatLib network to improve the wider offering of the entire network.

Register of Advisors

3.23 The Hargreaves Review found that the extent of information available on IP can actually act as a significant barrier to SMEs. The IPO is aware that this is an area of real concern for SMEs and has taken steps to address this. In March, the British Standards Institution (BSI) published a standard, supported by the IPO, for those wishing to offer commercial advice on IP. To reinforce this, the IPO will investigate improving access to IP advisors, through providing an online register of IP advisors, who have the recognised BSI standard for providing advice, and also recognises

19 Hargreaves, 'Digital Opportunity: A Review of Intellectual Property and Growth' (2011), IPO, 2011

those who have undertaken specific training or ongoing professional development. The IPO will further consult businesses, business advisors and IP specialists on providing additional specific lower cost legal advice at a 'paralegal' level.

IP Audits

3.24 In addition to training business advisors and highlighting the work of advisors, the IPO also recognises the need to build capability within businesses to manage their own IP. To support this business capability building the IPO will offer sponsored IP audits for a number of companies. An IP audit allows a company to gain a clear picture of their intellectual assets and helps to develop an effective management plan or IP strategy. In 2011 the IPO ran a pilot programme in conjunction with the Technology Strategy Board; feedback from participants has demonstrated that this was highly valued.

Dispute Resolution

3.25 For many companies, the costs and time involved in resolving a dispute is a real barrier to maximising the value of their IP. Recent changes to the Patents County Court have helped, streamlining the procedures and limiting the damages that can be claimed.

3.26 The IPO's Patent Opinions service allows individuals or companies to request an opinion on the validity or infringement of a patent and is well used. The opinion is not binding but is low cost and gives an authoritative opinion on an issue before entering legal proceedings or as a precursor to mediation. In contrast, the IPO's mediation service is only used infrequently. The IPO would like to support alternative dispute resolution but it is clear that the current service is not meeting business needs. The IPO will therefore provide a more customer-focused dispute resolution service and will consult businesses to determine what is needed during 2012.

Human Capital

Employers Benefit from the Skills Graduates Bring

3.27 Innovation-active enterprises have more than double the share of employees educated at degree level in science or other subjects than their non-innovative equivalents. Graduates provide added-value to the employer[20]. Employers value graduates because they challenge how things are done and question the status quo, bring new ideas and energy, use their initiative and act without waiting for instruction. They are also seen as being flexible, assimilating things quickly and coming at things from a different perspective. Recent research indicates 85% of

20 Employer and university engagement in the use and development of graduate level skills (2007), DfES research report (2007)

employers thought their recent young graduate recruits were well or very well prepared for work.[21]

3.28 Research estimates that a one percentage point increase in the proportion of the workforce with a degree, instead of A levels or equivalent qualifications, leads to an increase in productivity of 0.5%[22]. Productivity is 30% higher if the company's entire workforce has a degree than if none do[23].

Shares of employees that hold a degree in science or other subjects by business size

	Science graduates			Other graduates		
Firm size	**Innovation active**	**Not innovation active**	**All**	**Innovation active**	**Not innovation active**	**All**
Small	5.7	1.6	4.1	9.4	3.6	7.2
Medium	4.7	2.6	4.1	7.8	5.2	7.1
Large	5.3	0.9	3.4	8.1	2.3	5.7
All	5.2	1.4	3.8	8.3	3.2	6.4

Investing in Researchers

3.29 Working with the Research Councils we will continue to develop highly skilled researchers to achieve impact across the whole economy, as well as developing the next generation of researchers to maintain national capability. In future, Research Councils are preferentially investing training resources in centres or clusters of excellence which provide the highest quality research training experience, facilities and development opportunities. Increasing investment in collaborative research training with private, public and third sector research partners, such as CASE awards which provide research training in partnership between an eligible academic institution and partner company.

3.30 Our aim is to enhance the quality of research training and the employability of early stage researchers. Institutions should take responsibility for delivering and resourcing transferable skills and career development post 'Roberts'.[24] This will be informed by the 'Independent Review Panel' report (the Hodge Report on progress implementing recommendations on employability and career development[25]), statements of expectations from RCUK, and build on the experience of the development of

21 National Employer Skills Survey 2009 (2010), UCKES, (2010)

22 S Machin, A Vignoles & F Galindo-Rueda, 'Sectoral and Area Analysis of the Economic Effects of Qualifications and Basic Skills' (2003), DfES.

23 Haskel & Galindo-Rueda, 'Skills, Workforce Characteristics and Firm-level Productivity in England' (2005), CEPR .

24 Review of progress in implementing the recommendations of Sir Gareth Roberts (2011), RCUK, available at http://www.rcuk.ac.uk/documents/researchcareers/RobertReport2011.pdf

25 http://www.rcuk.ac.uk/Publications/policy/Pages/hodge.aspx

Doctoral Training centres. We are working with Research Councils UK, HEIs and UK HE funding bodies to improve the reporting of indicators of training quality and outcomes.

3.31 We are providing the Royal Society, the Royal Academy of Engineering and the British Academy with grant funding for a portfolio of prestigious early-career post-doctoral research fellowships, which allow our most capable academics to work full-time on research. This helps to maintain excellence in the UK's research base and secures future economic returns from our investment in science.

3.32 By supporting our most talented biomedical researchers – through our grant to the Royal Society – we are helping to keep the UK at the very forefront of biomedical research. On 25 October 2011, the Royal Society and the Wellcome Trust announced the Sir Henry Dale Fellowships, a major new joint scheme offering grants of up to £1 million each to the best young biomedical researchers to pursue research in Britain into some of the most important diseases affecting the world today, including cancer, heart disease and Alzheimer's. The new scheme will provide support for outstanding post-doctoral scientists working in this area and wishing to build their own independent research career.

A Skilled Workforce

3.33 Turning creative ideas into new products or affordable production processes requires practical and higher level skills. Our skills system has been reformed to enable a much greater degree of responsiveness and employers are already arranging training that meets their specific needs. The Growth Review on education and skills has explored how we take this further by looking at how we focus our Apprenticeships programme on the areas that reap the greatest returns on investment. We are also committed to exploring how business can have greater ownership of the skills agenda.

3.34 We are creating conditions for Further Education colleges to innovate, as enterprises as well as learning providers. Our reforms will give more freedom and flexibility to decide how best to respond to employer and learner demand whether in their local communities or the global market.

Increasing Levels of Innovation in Economically Important Sectors

3.35 Through the Growth and Innovation Fund (GIF) we are helping business to make the most of how skills can promote enterprise, innovation, productivity and growth. We want to encourage employers to bring forward new ideas that will contribute to driving economic growth and could include additional investment in apprenticeships, addressing leadership and management skills or investing in skills to support supply chains or geographical clusters.

3.36 The UK is already a world leader in clean technologies. We have a growing number of SMEs with innovative technology offerings. Thanks to the strong offshore renewables policy in the UK and the associated market, major global companies have turned their attention to setting up manufacturing facilities in the UK for offshore wind turbines. The UK is also currently leading the world in terms of marine energy device and installation development; approximately one third of tidal device developers and around a quarter of wave device developers are UK companies. In low carbon vehicle technology, we have global companies such as Nissan making the LEAF car in the North East of England, BMW investing in a 'green' Mini in Oxfordshire, and the industry is supported by a dynamic supply chain.

3.37 To help companies working in key technologies to commercialise new ideas, **we will invest £25 million in enabling large-scale demonstrators** in technologies such as integrated systems for cities. These will demonstrate innovation at scale and critical mass in "living lab" environments.

Picture: with acknowledgements to Nissan.

The UK is to become the home to the world's first mass market 100% electric vehicle in the shape of the Nissan LEAF, deliveries of which began in March 2011 and which will go into production at Nissan's Sunderland plant in 2013. Nissan is also building an advanced lithium-ion battery plant in Sunderland, which will be Europe's first to produce batteries for electric vehicles in significant quantities. This is one of a series of major new low carbon investments here by global car companies such as Ford, Toyota and Jaguar Land Rover. These investments are being made in parallel with UK infrastructure roll out and vehicle demonstration projects, which are seeing the UK pioneering the transition to low and ultra-low carbon vehicles with the active support of the Industry-Government Automotive Council, which is working to deliver a range of new low carbon technologies and supply chain opportunities in the UK.

3.38 The UK also has strong capabilities in bioscience through a combination of world-class academic research and a vibrant mix of small and medium-sized companies operating in the industrial biotechnology arena. The challenge of climate change and the need for renewable fuel and feedstocks are global and, as a result, offer UK

organisations significant market opportunities in areas such as improved/next generation biofuels, new crop varieties, biocatalysts and biorefinery design.

Utilities

3.39 The energy and water industries make an important contribution to the UK economy. In 2009 the UK water market contributed £15 billion[26] of UK GVA, whilst the energy industries (electricity and gas) contribution was around £21 billion, with over 150,000 people employed across both industries. The emergence of new markets both domestically and internationally coupled to a strong research base in engineering, environmental and social sciences, means that it is of strategic importance for the UK growth agenda.

Agri-food and Utilities

3.40 The agri-food sector includes all industries that are involved in the production, processing and inspection of food. Agri-food makes a significant contribution to the national economy and is the largest manufacturing sector in the UK. It has an annual output of £129 billion, and employs around 3.7 million people. The global market in agriculture and agricultural supply, food production, distribution and retail exceeds US $1 trillion. In 2010 UK agri-food exports were worth £16.1 billion, which was an increase of 36% on 2007[27].

3.41 We will work with businesses, universities, the research base, and the wider innovation ecosystem, including the Devolved Administrations, to address the innovation barriers that the agrifood and utilities sectors face and will enable greater levels of innovation and growth across both sectors. Our actions will focus on:

- Working with the Sector Skills Councils to improve skill levels including management and leadership skills;
- Ensure co-ordination of activity with the Technology Strategy Board's Sustainable Agriculture and Food Innovation Platform
- Driving innovation in power distribution working with the Technology Strategy Board, business and the knowledge base;
- Increasing exports from the UK water industry through the Technology Strategy Board, business and the knowledge base;
- Strengthening links with universities, Research Councils and PSREs;
- Increasing levels of innovation including the commercialisation of R&D, technology transfer and diffusion and adoption of innovation; and

26 UK National Accounts, 2011.

27 United Kingdom Food Supply Chain – Improve et al, 2011 http://improveltd.co.uk/industry-report/uk-food-supply-chain

- Targeting support from the innovation infrastructure to ensure that agri-food and utilities businesses are able to access Government support including raising awareness of support from the Technology Strategy Board and the R&D Tax Credit.

3.42 On 15th November, 2011, the Government launched the **Make it in Great Britain** campaign, a major new initiative to highlight and celebrate the UK's world class manufacturers. The campaign aims to transform outdated views of UK manufacturing among investors and young people. **Make it in Great Britain** will culminate in an exhibition of the best of innovative UK manufacturing to be held at the Science Museum to coincide with the 2012 Olympic and Paralympic Games. It will also include a Make it in Great Britain Challenge, a national competition to find the most promising and cutting edge, pre-market products or processes.

Summary of Actions

Since May 2010, the Government has:

- **Raised the rate of the SME R&D Tax Credit relief to 200% of qualifying expenditure;**
- **Increased the amount of government investment to the Enterprise Capital Fund Programme by £200 million over the Spending Review period;**
- **Backed business angels with a £50 million co-investment fund;**
- **Reformed investor tax reliefs, including increasing the rate of income tax relief for Enterprise Investment Scheme to 30%;**
- **Simplified the innovation support landscape and made the Technology Strategy Board the prime channel for supporting business-led technology innovation; and**
- **Undertaken an independent review of Intellectual Property, led by Professor Ian Hargreaves.**

To take this further we will:

- **Increase the SME R&D Tax Credit relief to 225% from April 2012. We will further simplify the scheme and actively promote its uptake amongst SMEs. We will also implement an "above the line" R&D Tax Credit from April 2013;**

- **Work with the Design sector to raise awareness of the R&D Tax Credit and will increase our funding of Designing Demand to £1.3 million per annum;**
- **Work with the US Government and the US and UK VC sectors to increase investment for the UK's innovative businesses;**
- **Provide the Technology Strategy Board with additional staff resources to leverage European Funding that can be matched against UK innovation and research budgets;**
- **Increase the support available from the Intellectual Property Office;As part of the extra £495m extra capital investment, invest £25 million in large scale demonstrators; and**
- **Starting with agri-food and utilities, we will work to enable economically important sectors to increase their levels of innovation.**

4 Knowledge and Innovation

The UK has an innovation ecosystem of institutions with a worldwide reputation, and which is a source of competitive advantage internationally. Through collaboration with business and with each other, these institutions develop innovation networks which increase the impact of their work. At their best, these networks develop into clusters of innovative, high productivity businesses which drive economic growth. The Government recognises the role of the innovation ecosystem in growing our knowledge economy and is committed to maximising its value. It will provide incentives to greater collaboration between businesses and universities, remove barriers to cluster development and strengthen essential parts of the infrastructure.

Innovation and Research Institutions

4.1 The UK innovation ecosystem contains deep and varied capabilities in science and technology, creativity and design, intellectual property and metrology. It includes a broad base of research active universities, the Technology Strategy Board, the UK Intellectual Property Office, and the Design Council (as described in previous chapters). It also embraces:

- Research institutes, like the Laboratory of Molecular Biology, whose scientists have won 13 Nobel prizes since it was established (in addition to a further 8 Nobel prize winners among its alumni);
- Research and innovation campuses such as those at Daresbury, Harwell and Babraham, which provide access to advanced facilities and expertise, provide homes to high-tech companies and are magnets for investment;
- Innovation infrastructure organisations, including the National Measurement Office, National Physical Laboratory, British Standards Institution and UK Accreditation Service;
- Public and third sector bodies providing specialist support, like the Design Council and the National Endowment for Science, Technology and the Arts (NESTA);
- Private sector research and technology organisations, like QinetiQ and LGC, which conduct research and support its commercialisation; and

- Public Sector Research Establishments (PSREs): a diverse collection of public bodies typically engaged in translational research, making it easier for research to be exploited in innovative products, services and processes – either on behalf of government or the NHS or as part of arts and heritage organisations.

4.2 This ecosystem is a network of diverse and complementary organisations, evolving and adapting to changing demands. It is Government's responsibility to maximise the impact of the public money invested in the ecosystem, but not to attempt to direct the institutions or researchers within it. We need to harness the capabilities of the organisations involved, so that the ecosystem supports all stages of innovation and research, and contributes more to economic growth.

4.3 This ecosystem includes the most efficient research base in the world, with strong connectivity to the industrial base, regional, national and global – the maintenance of which requires excellent research infrastructure. In addition to £1.9 billion capital investment announced in the Spending Review, Government has since committed a further £495 million capital investment. As well as large capital investments this extra investment includes £61 million committed on 29 November 2011 for a range of essential science base infrastructure capital projects – to help ensure our investments in science capital projects deliver maximum value for money and economic impact.

The Role of Universities in the Innovation Ecosystem

4.4 Universities are one of the major sources of knowledge generation in the UK. They have a fundamental value in the creation and transmission of knowledge for its own sake, as well as being a national and local asset supporting innovation and growth. They are often at the centre of dynamic local economies and innovation and research systems, acting as the hubs of networks that link businesses with the research base and with the wider innovation ecosystem. Universities are often among a region's biggest employers, attracting thousands of international students and visitors, and academics working with every sector of society. The delivery of thousands of skilled people to the workforce is a major contribution to this country's innovation capacity.

Interface provides a free impartial brokerage service to companies regarding the specialist expertise that is available in the Scottish academic community; including research and technology capabilities, consultancy, industrial placements and access to equipment and facilities. It matches business need to academic expertise and provides support to facilitate productive collaborations for businesses. Interface is a unique model that offers businesses the impartiality of understanding the academic capability and capacity without having to individually contact each of the many different research groups that may appear relevant to their R&D requirements.

Now in its seventh year of operations, Interface has supported over 1000 companies, identified around 1,400 opportunities and brokered over 450 business led collaborative projects with Scotland's academic institutions.

4.5 The universities' knowledge-based services to business and other partners are now valued at over £3 billion and have been growing at 4% per annum in recent years[28]. In 2009-10, university spin-off businesses based on leading edge research from UK universities turned over nearly £1.8 billion and employed around 17,000 people. Our universities draw researchers and innovators to this country, and form the basis for UK entry to global knowledge networks.

4.6 Higher Education Innovation Funding (HEIF) provides incentives to strengthen connections between universities and businesses to ensure that businesses benefit from a more integrated ecosystem. HEIF will continue to invest £150 million a year in universities in England, with a formula-based funding allocation focusing on those institutions most effective at generating external income from collaborations with business and other users. Over the next four years, universities will use HEIF to invest in areas including the commercialisation of research and technology with increased focus on the private sector, the development of human capital and skills, entrepreneurship and knowledge networks.

4.7 We welcome the Confederation of British Industry's rallying call to the business community to offer relevant work experience, and where appropriate, work with universities to develop courses that lead to attractive employment for graduates. We want more employers to sponsor students and provide relevant work placements. Sir Tim Wilson is considering some of these issues in his review of university and business links, and **will bring forward recommendations for improving these in Spring 2012**.

28 Higher education-business and community interaction survey (2009-10), HE-BCI

Strengthening Connections between Universities and our Wider Innovation Infrastructure

4.8 The Design Council's Innovate for Universities programme is helping promote a greater understanding of how design can help university Technology Transfer Offices (TTOs) to commercialise academic research, identifying market needs, making new concepts viable and appealing, attracting new investment and reducing risk in the commercialisation process. BIS funding is allowing a further seven university TTOs around the UK to benefit from the mentoring programme in 2011-12.

Pictures: Navetas Energy Management Ltd.

Geni-e Smart Meter

In 2007, Dr. Malcolm McCulloch of University of Oxford invented a process for measuring electricity usage using complex algorithms and artificial intelligence techniques to identify the appliance using the electricity by monitoring current and voltage variations in real time. He hoped to develop this into a smart electric meter that would enable users to view and control individual energy use of each appliance in their home. With access to better data, he believed up to 20% less energy could be used.

Through the design mentoring provided by a pilot of the Design Council's Innovate for Universities programme, the team realised that they needed to research issues such as how the meter would be manufactured and installed and how it would present data to users. They commissioned visualisations to show the meter in different user scenarios to ensure would-be investors understood the concept and the investment opportunity. The visualisations also helped with market research with potential users.

The design work was instrumental in the team securing £900,000 of seed funding to set up a spin-out company. '*We thought we would get support developing a prototype*' says David Baghurst, Head of Isis Enterprise, '*but we got something much more valuable – a lot of customer and investor interest for a very small amount of money.*'

Four years on, the original spin-out is now wholly owned by **Navetas Energy Management Ltd** and second round funding of £4 million has enabled the company to further develop the product and run national trials with a major UK energy company. It currently employs 20 people and has plans for growth once the trials have been completed.

Innovation Vouchers

4.9 Innovation voucher programmes support SMEs to collaborate with knowledge based institutions across the public or private sectors. These can be an effective means of building innovation capability in SMEs. Recent voucher programmes in the UK, run in a number of regions or by NESTA, have shown the positive impacts innovation vouchers can have for SMEs. Innovation vouchers:

- Encourage first contact between SMEs and the knowledge base;
- Introduce innovation processes into businesses;
- Raise awareness and recognition within SMEs of the services the knowledge base can provide; and
- Encourage ongoing collaboration with the knowledge base beyond the expiry of the voucher, generated by satisfaction with project outcomes and services provided by the knowledge base.

4.10 Working in partnership with business, the Technology Strategy Board and Local Enterprise Partnerships, we will implement a new innovation voucher programme in 2012-13 to support SMEs in working with external knowledge providers. The programme will initially focus on geographical areas and sectors which to date have had relatively low levels of private sector innovation and growth.

The Role of Research and Innovation Campuses

4.11 Research and Innovation Campuses provide thriving environments for businesses, industry, universities and researchers, enabling innovation and delivering impact from research investment. Campuses like this in the UK support innovation in areas including life sciences and biomedical research, energy, security, climate and the environment. They provide access to advanced world-leading facilities; scientific services; a unique training environment and world-leading expertise. They foster a culture of collaboration and innovation to support the creation and growth of new and existing business.

4.12 UK facilities act as magnets for domestic and overseas investment by high-tech companies, and they give UK researchers sought after expertise in international collaborations. This allows the UK to participate in major international research infrastructure projects that are too expensive and complex for any one country to develop in isolation.

- **Harwell Science and Innovation Campus (Harwell Oxford)** is a joint venture between the Science and Technology Facilities Council (STFC), the United Kingdom Atomic Energy Authority and the property developer Goodman International. More than 145 organisations are already located on the Harwell Campus, including start-ups, multi-national businesses, the Ministry of Defence Centre for Defence Enterprise and the European Space Agency's new UK centre, specialising in space robotics and climate change research.
- **Babraham Research Campus** is a key component of the Cambridge science and innovation cluster, with a strong track record in supporting innovation through the nurturing of biotech start-ups and SMEs. It provides a unique combination of physical location; excellent science facilities; company incubator space; a successful research institute; the presence of small, innovative companies (currently 30); and effective networks across the Cambridge area.
- **NRP (the Norwich Research Park)** is a successful science and innovation park that involves a unique collection of partners (the John Innes Centre, Sainsbury Laboratory, Institute of Food Research, The Genome Analysis Centre, University of East Anglia, Norfolk and Norwich University Hospital). Together, these partners have a shared vision for the NRP, supported by the Biotechnology and Biological Sciences Research Council, for the NRP to be a world centre for environmental and life sciences, renowned for the generation of new industries and services spawned by the ecological, climate, sustainability and healthy ageing drivers.
- **Daresbury Science and Innovation Campus (DSIC)** is a world-class location for high-tech businesses and leading edge scientific research, innovative technology development and entrepreneurial collaboration. It is already home to 100 high-tech companies which employ over 300 people and have developed over 150 new products and services. The 20-year joint venture between the public and private sectors has ambitions to bring more than 6,000 jobs to the area during its lifetime, attracting further domestic and international positive inward investment in world class scientific research and innovation.

4.13 In August 2011 the Prime Minister announced that the campuses at Harwell and Daresbury would be within new Enterprise Zones. The Zones benefit from over £150 million in tax breaks over 4 years, new superfast broadband, lower levels of planning control and the potential to use enhanced capital allowances.

Daresbury International Centre of Excellence in Computational Science and Engineering

As part of the extra £495 million capital investment in the research base made since January 2011, in October 2011 the Government announced £145 million of capital investment in e-infrastructure (High Performance Computing, software, networks, data storage, security, people and skills). £30 million of this money is earmarked for the Daresbury International Centre of Excellence in Computational Science and Engineering (ICE-CSE).

As part of the extra £495 million capital investment we will also make a further £13 million investment in ARCHER. This is the next phase of development of the next generation UK high performance computer, ensuring that the UK has world-leading High Performance Computing capacity.

Research Councils, industry and Government recognise that we are experiencing a paradigm shift in which the scientific process and innovation are beginning in the virtual world of modelling and simulation before moving to the real world of the laboratory. Sophisticated analysis and visualisation software are being used to mine massive amounts of experimental data from the life and environmental sciences to uncover new hypotheses and trends. To exploit this revolution we need a fresh, collaborative approach to software development to bring scientific, industrial and public sector users, hardware and software developers and vendors closer together. This means that the advanced computational capacity of the UK needs to be addressed as a system – an e-infrastructure.

Research Councils and industry highlight the importance of digital infrastructures and their positive impact both on economic growth and employment. With the right e-infrastructure, Government can make the UK a better place to live and do business by:

- enabling improvements in scientific and business productivity through more efficient ways of working, and more efficient communication and exchange of information with peers, customers and suppliers;
- accelerating skilled job creation through new business formation and growth in the technology sector;
- driving up skills by offering leading edge e-infrastructure; and
- supporting better and more efficient ways of delivering public services.

The Government **will soon publish a Strategic Vision for UK e-Infrastructure**. By investing in research and e-infrastructures the Government is also further increasing the attractiveness of the UK for inward investment, as set out in the UKTI Strategy "Britain Open for Business."

4.14 In addition, subject to business case, and as part of the extra £495m capital investment in the research base made since January 2011, **we will invest £80 million in the Institute for Animal Health**, which will (as well as supporting the rural economy and in particular the poultry breeding industry where the UK is the world leader) create the basis for a new research and innovation campus in Surrey. The vision of a single site at Pirbright allows the science strategy to be realised as an integrated Pirbright animal health innovation campus and a world class National Centre for Virology research.

Innovation, Research and Clusters

4.15 Clusters are geographic concentrations of interconnected businesses, knowledge base organisations and suppliers. They exhibit high levels of innovation and collaboration, often involving direct business interactions with the local research base and the application and commercial exploitation of knowledge and Intellectual Property it has generated. Clusters reduce the risks associated with developing and commercialising new and emerging technologies, and supporting wider adoption and diffusion.

4.16 Networks develop around clusters involving academics, technologists, skilled workers and investors who develop knowledge and expertise on the strengths and opportunities of new technologies, and on possible risks.

4.17 Research undertaken by the European Commission has identified that clusters and regional specialisation are associated with higher levels of innovation and prosperity[29]. The UK is home to world-leading clusters such as one around Cambridge, which is focused on IT and life sciences and has produced significant companies such as ARM Holdings, Autonomy, Cambridge Silicon Radio, as well as many innovative start-ups and early development companies. It also attracts inward investment from companies like Takeda and Pfizer.

29 Innovation clusters in Europe: A statistical analysis and overview of current policy support (2007), European Commission,

N8

The N8, established in 2007, is a partnership of the eight research intensive universities in the North of England: Durham, Lancaster, Leeds, Liverpool, Manchester, Newcastle, Sheffield and York with access to over 18,000 academic staff and 51,000 postgraduate students.

The N8 has established virtual research centres in Regenerative Medicine and Molecular Engineering, combining "best with best" expertise across disciplines to work with SMEs, develop supply chains and connect to large industry players. The N8 is now bringing together a powerful network of research intensive universities, SMEs and global firms involved in R&D, such as AstraZeneca, Croda, National Nuclear Laboratory, Procter and Gamble, Reckitt Benckiser, Siemens, Smith & Nephew and Unilever. Working with the Technology Strategy Board, N8 will pilot new approaches to engaging with business and in promoting and encouraging open innovation in specific technology priority areas.

This experience of collaborative working is also being applied to support the research and intelligence needs of Local Enterprise Partnerships and Local Authorities, for example in maximising the economic opportunities of an ageing population.

4.18 The Government has an important role in removing barriers to the emergence of new clusters and the growth of existing clusters, for example by addressing restrictive planning laws, ensuring a modern infrastructure, the supply of highly skilled workers and addressing barriers to capital.

4.19 We believe that funding mechanisms for research and innovation should recognise the value of collaborations between organisations. Consortia can tackle large-scale and ground-breaking new research beyond the capabilities of a single institution; they may involve a range of partners, including collaboration internationally and with business. To make clear that such approaches are welcomed, **Research Councils UK, working with UK HE funding bodies, and in discussion with individual universities and consortia, will establish a principles-based framework for treatment and submission of multi-institutional funding bids.**

4.20 The current Research Council funding rules can preclude some small 'state of the art' technology facilities from bidding for funding, where they lack a 'critical mass' of researchers. **We will enable small 'state of the art' research facilities to secure recognition to apply for Research Council funding.** This will give greater funding opportunities to non-commercial organisations providing research facilities, around which clusters can develop.

4.21 The Coalition Government has also put in place a number of measures that will actively support the rebalancing of the economy, empower local communities and

address barriers to growth. These measures include the establishment of business-led LEPs that will support economic growth, including those around the Research Campuses of Harwell and Daresbury. Other measures include:

- **Planning**: The Government is currently consulting on proposed changes to the current planning legislation with a new emphasis on supporting economic growth;
- **Infrastructure**: The Government has published its plans in the National Infrastructure Plan 2011.[30] We are investing in improved transport links and a modern digital infrastructure;
- **Skills**: We will make the skills system more business driven and locally responsive. This will ensure that employers can access the skills they need to support the growth of their business and the wider cluster;
- **Fiscal**: We will ensure that that the UK has the most competitive Corporate Tax Regime in the G20. We have put forward a range of measures to develop Enterprise Zones and make them attractive places to do business;
- **VAT**: The Government announced on 29 November 2011 that the EU VAT cost-sharing exemption will be introduced in Finance Bill 2012. Currently a VAT cost arises if organisations such as charities and universities want to make efficiencies by working together to share services. This cost can be a barrier which the exemption could remove. Universities have estimated that efficiency savings of 15-30% could be achieved if they were to share services; and
- **Launchpad:** We will extend Launchpad to support new and emerging clusters in other parts of the UK.

4.22 The Technology Strategy Board successfully supported the development of the London Tech City cluster through a £2 million investment in Launchpad. This investment helps small businesses finance developing digital products or services from proof of concept to user facing trials and to leverage in private sector finance. Launchpad competitions can be used to focus on a specific sectoral cluster in one geographical region, and fund higher risk research projects, between SMEs and micro companies aimed at developing a product or service to proof-of-concept and/or a user-facing trial. The competitions are designed to strengthen clusters through facilitating co-operation and networking within them. Launchpad is also designed so that applicants can use the endorsement of Technology Strategy Board assessment to secure funding from outside their business if required, either from new business partners or from angel or venture capital investors.

30 http://www.hm-treasury.gov.uk/national_infrastructure_plan2011.htm

Tech City in East London.

Picture: UK Trade & Investment.

4.23 The Tech City Launchpad initiative attracted over 200 high quality proposals, with over 80% from new, small, early stage companies with nearly all in, or intending to move to Tech City. Many were also new to the Technology Strategy Board, and the end outcome saw the Technology Strategy Board increase funding and support 18 projects.

4.24 Launchpad has been a success, and we will invest to extend it to support new and emerging clusters in other parts of the UK. The Technology Strategy Board is currently assessing the case for running further competitions in other geographic areas including Bristol (media), Manchester (media), Edinburgh (software), the North-East (renewable energy), Cambridge (med-tech), Southampton (photonics and software) and the Midlands (light engineering).

The Role of Research and Technology Organisations in the Innovation Ecosystem

4.25 Research and Technology Organisations (RTOs) are positioned between academia and business users of technology. They are a range of companies and organisations whose activities bridge gaps in the process of converting research outcomes into innovation and new technologies for use. Examples include QinetiQ Group plc, providing technology-based services in the defence and security markets, BSRIA (the Building Services Research and Information Association), focusing on construction and building services, and the National Physical Laboratory providing knowledge-

based services to support the application of science and technology through better measurement. This intermediate sector is an important part of the innovation system, and is estimated to contribute £3 billion annually to UK GDP, and support over 60,000 jobs[31].

4.26 We believe that the intermediate sector is an under-used asset. It provides expert technical advice in many sectors, including agri-food and water where we are seeking to encourage higher levels of investment in innovation. We will work with RTOs to develop a strategy for using their experience and expertise as part of the innovation ecosystem.

Summary of Actions

Since May 2010, the Government has:

- **Strengthened the excellence of our research base, through maintaining the £4.6 billion budget for science and research programmes in cash terms for each of the next four years, including an extra £495 million capital investment announced since the conclusion of the Spending Review.**
- **Provided incentives to universities and business to continue to work more closely together – HEFCE will maintain Higher Education Innovation Funding (HEIF) at £150 million p.a. for 2011-15. HEFCE has changed the way in which HEIF is allocated, to incentivise higher education institutions to increase their interaction with business and other users of research.**

To take this further we are now:

- **As part of the extra £495 million extra capital investment, investing £145 million to boost Britain's e-infrastructure and make the UK a world leader in scientific and business use of supercomputing; as well as investing a further £13 million in ARCHER Phase 2 – the next phase of development of the next generation UK high performance computer**
- **As part of the extra £495 million extra capital investment, committing £61 million for a range of essential science base infrastructure capital projects**
- **As part of the extra £495 million extra capital investment, investing £80 million in the Institute for Animal Health**
- **Implementing a new innovation voucher programme to support collaboration between SMEs and external knowledge providers; and**

31 Study of the Impact of the Intermediate Research and Technology Sector on the UK Economy (2008), Oxford Economics.

- **Tackling barriers to the growth of clusters around our innovation institutions, including through work by Research Councils UK to establish a principles-based framework for treatment and submission of multi-institutional research funding bids**
- **Extending the Launchpad initiative to run up to three further competitions**
- **Introducing the EU VAT cost-sharing exemption to enable universities and charities to ensure that a VAT cost isn't incurred when services are shared.**

5 Global Collaboration

Innovation and research are now increasingly international endeavours. Most innovations originate from multiple countries, with a great many drawing in components or technologies developed in multiple locations with the high growth economies playing an increasingly important part in this. The UK can contribute in many different ways, allowing us to attract investment and succeed in growing markets.

We will develop and support new forms of international partnership and collaboration, with the Government taking an active role in promoting UK expertise around the world.

The New Geography of Innovation and Research

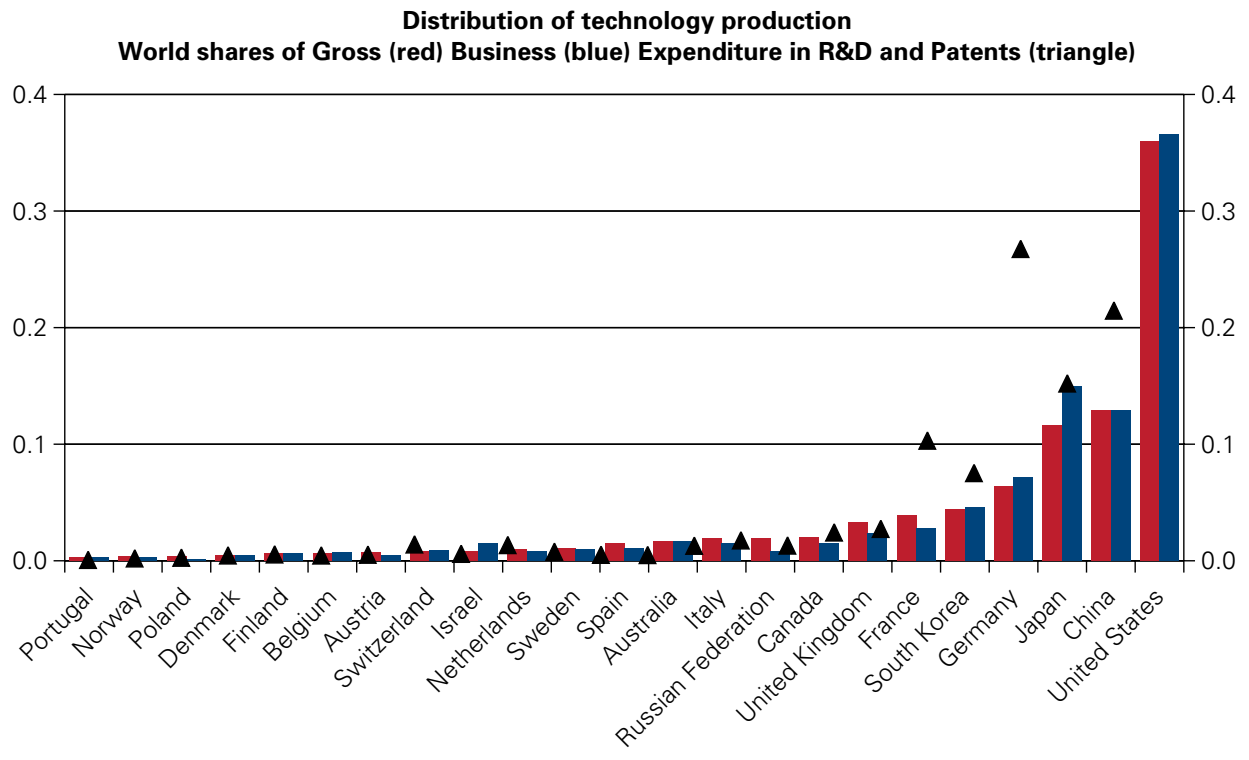
David Willetts, the UK Minister for Science and Universities visiting India.

5.1 The new geography of innovation and research means we are no longer in a world where all leading research and innovation activity is undertaken in the USA, Europe or Japan.

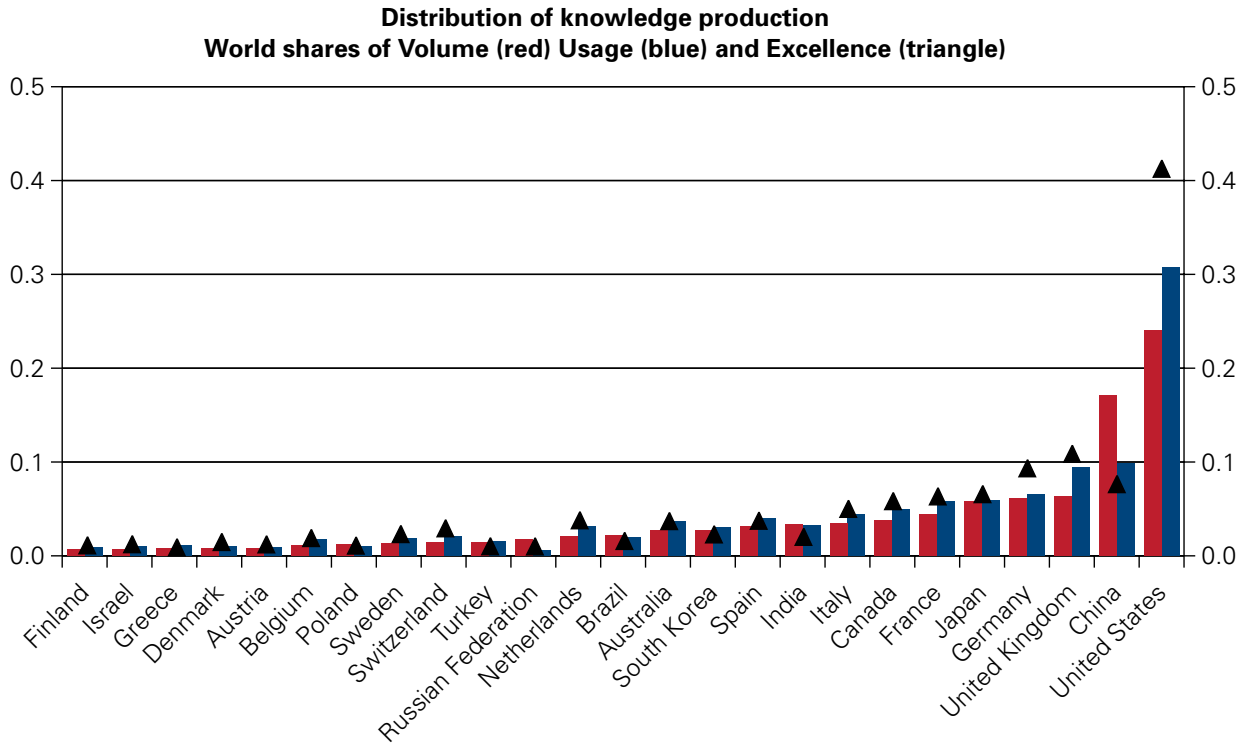
5.2 The scientific and technological capability of the UK and most other developed nations was established over centuries. The advance of countries such as China and India to the frontiers of science and technology has occurred in little more than a decade. High growth economies are focusing on moving up value chains – making significant investments in the process. Their strong, long-term growth also makes them of increasing importance to UK businesses looking for new markets.

5.3 Much innovation activity occurs in "hotspots": cities or regions where companies research expertise, other resources such as capital and a skilled workforce have concentrated. The pattern of development that has characterised the ICT sector in Silicon Valley and the electronics and biotechnology sector in Cambridge are now emerging in other countries. For instance, Biopolis in Singapore is a biomedical research facility covering over 7 square miles and Nanjing Science Park covers 93 square miles.

International Patents



1: The series of patent shares is not always and everywhere above the spending bars indicating some countries manage their technological resources more efficiently than others.



2: The excellence shares do not lie above the quantity bars for all countries indicating that some countries manage their knowledge resources to concentrate in excellence more efficiently than others.

Shifts in Global Value Chains

5.4 Supply and value chains now extend around the world with an increasing proportion of the value chains associated with common products or services involving links in multiple countries[32]. The key trends shaping this internationalisation are:

- **Multi-National Enterprises** (MNEs) taking a global perspective to find the best locations for their R&D. These decisions reflect a range of factors, including the ability to gain access to specific expertise or suppliers within a cluster, access to technological skills that exist in a local workforce, to gain local market knowledge and improved access to customers, enabling the company to identify new market opportunities[33]. Corporate venturing, where large businesses invest in smaller ones, is also expanding in sectors such as microelectronics and the life sciences.

- Innovative **Small and Medium Enterprises** (SMEs) looking to capitalise their intellectual property, increasingly seek overseas partners that can provide technical expertise, funding, or access to wider markets.

32 Global Value Chains: Preliminary evidence and policy issues (2011), OECD, DSTI-IND.

33 Pietro Moncada-Paterno-Castello & Peter Voigt & Marco Vivarelli, "Evolution of Globalised business R&D: Features, drivers, impacts," (2011), Institute for Prospective and Technological Studies, Joint Research Centre.

- **Research institutions** focusing on international partnerships to improve the quality of their research, recruit researchers and students and enable access to wider funding sources. International collaboration is pervasive in the UK and of the highest quality.
- **Governments** are increasingly seeking ways to attract high-value business investment, and creating incentives to achieve this objective.

A Strategic Approach to International Innovation and Research for the UK

5.5 International collaboration increases citation impact by a twofold factor over national collaboration[34]. Working with other countries gives researchers and businesses access to complementary knowledge, new technologies, facilities and new markets. Taking new products and services overseas can drive innovative new solutions and create a virtuous cycle of growth, capability and increase in market share[35].

5.6 The UK's position as a global leader in innovation and research depends on an internationally mobile and highly collaborative research workforce. We need to maintain the focus on excellence within our research collaboration and increase the level of businesses' international engagement. The UK innovation and research infrastructure will support the international engagement of businesses and knowledge base institutions with international partners. Our strategic approach to international engagement consists of five pillars:

- Promoting the UK's research and high technology sectors overseas;
- Supporting UK businesses' and researchers' access to international markets and collaboration;
- Ensuring the UK continues to attract globally mobile capital, technology and highly-skilled people;
- Strengthening our engagement with initiatives within the European Single Market; and
- Building strategic links with high growth economies.

Promoting the UK's Research and High Technology Sectors

5.7 The UK's research base and its highly developed infrastructure are particularly important in attracting and embedding high quality inward investment in the UK – 15% of all foreign direct investment projects in the UK during 2010/11 were related

34 International Comparative Performance of the UK Research Base (2011), Elsevier on behalf of BIS.2011.

35 In 2010, UK Trade & Investment (UKTI) assisted nearly 25,000 businesses, and over 80% of its clients are innovative. Source: UKTI Annual Report and Accounts 2010-11.

to Research & Development[36]. These investments can anchor the position of the UK within global value chains and introduce new technologies and ways of working. UKTI has significant impact on nearly 50% of inward investment projects[37]. UKTI also promotes UK innovation capability when maximising the UK share of overseas supply chains as part of its High Value Opportunities Programme, focused on winning major overseas trade opportunities that are worth at least £250 million.

5.8 The UK needs to make best use of our innovation assets and its network of diplomatic posts, which possess commercial, scientific and technological and IP expertise:

- UKTI, the Science and Innovation Network (SIN) and the network of IP attachés will focus particular support on helping innovative UK businesses to take advantage of commercial opportunities and build successful international collaborations in **innovation hotspots**.
- The Technology Strategy Board and the Research Councils will create **a regular pipeline of the best examples** of UK research and innovation capability to colleagues in posts overseas to create stronger awareness of this.
- The **Catapult centres** will all have a focus on international engagement, varying according to where the best opportunities exist.
- We will use the backdrop of the London 2012 **Olympic and Paralympic Games** to provide a showcase of UK business and research capability in front of an international audience under the GREAT brand.
- The **Design Council will work with UKTI** to promote the use of the UK's design strengths to support UK business and to attract inward investment.
- The National Measurement Office, National Physical Laboratory and the British Standards Institution will work with international measurement and standards bodies and committees to **promote the UK's strengths in measurements and standards** and of the UK businesses associated with them.

36 UKTI Inward Investment Report 2010/11.
37 UKTI strategy document – Britain Open for Business (2011).

Tech City

In July 2008, East London was home to some 15 high-tech companies: today it hosts over 600[36] including:

Songkick provides a site for fans of live music to get alerted when bands they listen to come to town. Songkick has aggregated the largest database of concert information worldwide with over 2 million concerts from 1960 to the present day.

Mind Candy achieved global success with MoshiMonsters.com, which now has over 50 million registered users worldwide. The company has now expanded offline with the recent launch of Moshi products at retail within the UK, US and Australia. The company aims to become one of the first billion-dollar businesses to emerge out of Tech City.

The impressive growth of Tech City is helping to sustain the UK's position as foremost technology hub in Europe, and the location of choice for technology-based companies right across the value chain. The international promotion of the ecosystem there will have significant benefit to the whole of UK innovation by, for example, attracting venture capital and angel investment from overseas.

Support for Access to International Markets and Collaboration

5.9 Over a quarter of UK innovative businesses have co-operation agreements with foreign partners. The UK also has a strong reputation as a location for high-value business R&D activities, with 23% of R&D funded from overseas (highest of any OECD nation). The UK academic community is currently the most successful in winning support from the EU's Framework Programme for research[39], and is also a key partner for non-EU countries wishing to participate. As part of strengthening growth within the UK, we need to increase the number of exporting companies and position these to exploit high growth markets, and support research teams that collaborate internationally.

5.10 Research Councils are already extremely active in supporting international collaboration within the research community, as is UKTI for businesses. A variety of new measures will further support UK companies to internationalise, including:

38 Digital Shoreditch survey Summer 2011 of technology, digital and creative businesses in Shoreditch. See www.techcitymap.com.

39 UK HEIs received 10.17% (€2,255 million) of all FP7 funding to date compared with 5.96% (€1,322 million) by DE HEIs. Source: FP7 grant agreements and participants' database, European Commission, 2011.

- UK companies going overseas can benefit from sharing intelligence about market value and means of entry. As part of the recently announced Exporting for Growth package, UKTI is working with Yell Group plc to create a **collaborative online platform** called "Open to Export" which will launch in 2012, enabling innovative companies and service providers to support one another.
- The new UKTI Venture Capital team, working with partners, such as the Technology Strategy Board, will deliver a package of measures to assist innovative UK SMEs with the capacity for high growth to **connect with overseas finance** so that they can access the capital that they need to grow their business and will run **competitive processes** to identify and actively support a number of investor-ready UK SMEs.
- The **Intellectual Property Office will expand the help it offers** UK businesses to better exploit their IP potential in key global markets.

Benefiting from Globally Mobile Innovation and Research Resources

5.11 If the UK is to compete effectively in the global economy, it must continue to attract entrepreneurs and researchers, and to enable companies to recruit skilled employees.

5.12 The excellent nature of UK research is underpinned by its ability to attract highly productive and internationally mobile researchers. A recent study[40] found that short-term visitors to the UK were 35% more productive than the average national researcher while UK researchers who spent at least two years abroad and returned were 66% more productive than the average. British undergraduate students are less likely to study abroad than their mainland European counterparts, for reasons such as lack of foreign language skills or the relative inflexibility of courses. However, international exposure while at university provides students with skills that employers have said are in short supply. Surveys consistently show that international students who come to the UK gain considerably from their time here.

Support for Academic Mobility

5.13 We continue to support outward mobility and are keen that study abroad becomes an integral and accredited part of a wider range of courses, and to increase student mobility. We are working to ensure the recognition of study and qualifications undertaken overseas. We are also working with the higher education sector to encourage universities to credit other mobility activity so that overseas activity contributes to their degree.

40 International Comparative Performance of the UK Research Base (2011), Elsevier on behalf of BIS, 2011.

5.14 The European Research Area aims to create a 'single market' for research and innovation across the EU with a focus on researcher mobility and careers, knowledge transfer, research infrastructures, cross-border co-operation of research funding agencies and the international dimension. We also support the European Commission's Erasmus Programme which facilitates student and staff exchanges within the EU and now provides work placement opportunities for students. We play a leading role in the development of the European Higher Education Area to ensure that facilitating the mobility of students, researchers and academics remains central and the Higher Education Funding Council for England provides financial support to encourage universities and schools to work together to excite demand for language learning. New developments include:

- The British Council will create a dedicated **web-portal** for UK students and academics seeking mobility opportunities; and
- The Funding and Research Councils will support our **knowledge base in languages** crucial to the UK's economic and security interests.

Visa System

5.15 A range of changes were made to the points based visa system in April 2010 that aim to ensure the UK can attract and retain the talent it needs:

- The new Entrepreneurs Visa has allowed prospective foreign entrepreneurs to seek funding in the UK. In recognition of the contribution entrepreneurs make to growth, if after three years an entrepreneur builds a business with a turnover of £5 million or creates 10 jobs, they can apply for accelerated indefinite leave to remain;
- The truly world-class, even without a job offer, can come through the Exceptional Talent route in Tier 1;
- Other scientists with a job offer can apply through the Tier 2 visa route – if the monthly visa allocation limit is reached, PhD level jobs are awarded additional points to recognise the high level of qualification required by these jobs; and
- We have made progress on tackling the hurdles that institutions can face in bringing foreign academics over as guest lecturers and external examiners – by expanding the terms of the Tier 5 Government Authorised Exchange Scheme.

Strengthening Engagement in European Programmes

5.16 The EU Single Market is the largest market in the world and gives us a significant competitive advantage. However, only 12% of EU online trade is cross-border[41]. The Government sees the Single Market as a cornerstone of UK growth. However, there

41 Based on each Member State's Digital Scorecard for cross-border trade – 12% is the EU average.

are improvements needed to strengthen the Single Market, such as the urgent need to deliver a business-friendly EU Patent, modernise regulations and improving the operation of EU funding programmes.

5.17 Our connections with Europe on research and innovation provide us with potential partners and markets. UK institutions are partners of choice for collaboration within the European funding programmes for innovation and research. European programmes provide the opportunity to undertake R&D&I activities that will ultimately lead to new products and processes. Moreover the collaboration programmes encourage also generate significant benefits for UK companies[42], through improved relationships and networks, access to new or significantly improved tools or methodologies and other forms of intellectual property. Research infrastructures have an important part to play in advancing scientific knowledge and provide unique research facilities, tools and services to users from different countries.

5.18 The Europe 2020 and Innovation Union Strategies have highlighted the need to strengthen links between higher education, business and research (the 'knowledge triangle'). The recently published proposals for the Horizon 2020 programme aim to do this as well as addressing a wider range of barriers to innovation.[43] The European Institute of Innovation and Technology (EIT) contributes to this through its Knowledge and Innovation Communities (KICs) – autonomous pan-European partnerships comprising education, research and business organisations. Recognising all this we will:

- Improve the support to UK companies intending to participate in the **Horizon 2020 Framework Programme** of the European Union for funding research and technological development by working with the the Technology Strategy Board to improve the co-ordination of all parties involved;
- Drive agreement on a business-friendly **EU Patent**, to reduce the costs and administrative burden of protecting intellectual property within the EU;
- Support the creation of a **digital single market**, which could add €800 billion more to the EU economy;[44]
- Support EU funding for the preparatory phase of **major EU-wide research infrastructures** that has clear EU added value and should be continued; and

42 Simonds, P., Stroyan, J., Brown, N. and Horvath, A.: The impact of the EU RTD Framework Programme on the UK (2011), Technopolis Report.

43 http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020-documents

44 M. Monti, A New Strategy for the Single Market. At the Service of Europe's Economy and Society, Report to the President of the European Commission José Manuel Barroso, May 2010.

- With our partner organisations (principally the Technology Strategy Board and Research Councils) we will take a more active role in assisting potential **UK participants in KICs**.

Building Strategic Links with High Growth Economies

5.19 Future success will depend on the UK's ability not only to continue collaborating with excellent research and innovation in traditional partner countries but also to recognise and to exploit opportunities created by the high growth in countries such as the BRIICS. Whilst high growth economies offer many opportunities right now, the value of these opportunities will continue to increase. Our strategy has to be a long term one, and focused on ensuring the UK is a partner of choice for high growth economies in 2020 and beyond. The UK should build on the positive reputation it has amongst these countries, notably China and India, as these economies grow, to stimulate demand for products in high tech sectors where the UK is strong. We will extend this, over time and as resources allow, to Brazil, Indonesia and other high growth economies, drawing on models of effective collaboration that we develop. In particular, building strategic links with the institutions and companies engaged in key hotspots in the relevant countries will be vital if the UK is to position itself to succeed in the global economy.

5.20 **We will develop our capability to do this through a new approach to horizon scanning for strategic opportunities in high growth economies. This will identify complementary strengths and areas of joint interest, and opportunities for the UK to embed itself as a key partner**. This will be co-ordinated by the Technology Strategy Board working alongside UKTI, Research Councils UK and the Science and Innovation Network with strong business involvement. This analysis will lead to targeted, co-ordinated action combining Government-to-Government collaboration with support for the businesses and research communities.

China

China is predicted to overtake the US as the world's largest economy by 2016. Its research spend has trebled since 2005 to £70 billion and spending is planned to increase further to 2.2% of GDP by 2015. UK organisations have a high quality and broadening range of science and innovation relationships with China.

However, urgent action is needed to achieve more strategic engagement, aiming for a step change in our engagement with China's science and innovation systems by 2020. In support of this objective:

- We will encourage the new Catapult Centres to build relationships with the Chinese 'TORCH' innovation centres for mutual benefit, as they become established.
- UKTI's Enabling Innovation UK–China Partnership in ICT is a strategic initiative promoting the UK's ICT sector in China with an intention to grow this substantially over the next 3 years through partnerships with UK companies providing innovative embedded solutions within the products of some of China's largest and fastest growing companies.
- The Intellectual Property Office has placed its first overseas representative in Beijing to help UK businesses gain the knowledge they need to operate in the Chinese IP environment and to press for further improvements.

We will extend our relationship with China to engagement with the Chinese Ministry of Science and Technology in a jointly funded pilot initiative to support bilateral research projects in key areas of mutual interest, aiming to develop mechanisms to support larger and long term research partnerships. At the government level we will continue to seek measures that can facilitate businesses' and institutions' ability to collaborate with the Chinese, recognising their growing importance in the global markets.

Source: IMF (2011), World Economic Outlook, April.
Source: As announced by the Chinese Government at the Fourth Session of the 11th National People's Congress on 5 March 2011.

India

We have a considerable history of collaboration with India. The UK has developed over £90 million of jointly funded research with India since Research Councils UK established their in-country presence three years ago. Ministerial visits have supported the research relationship. The jointly funded UK India Education and Research Initiative supports collaborative research, links with the Indian Innovation Universities and the development of innovative models of delivery of vocational education achieved through new forms of partnership between UK and Indian training organisations.

We will work with UKTI, Research Council UK, NESTA and Technology Strategy Board to conduct a renewed assessment of the collaboration opportunities afforded by India's growth and increased confidence and interest in innovation and expect to be announcing a set of measures that establish a co-ordinated approach to supporting collaboration on innovation as part of the UK-Indian Ministerial Science and Innovation Council which will take place in London in February 2012.

Brazil

Brazil's Ministry of Science, Technology and Innovation has plans to invest 1.5% of its GDP on R&D by 2012 and their aim is to achieve 2% before 2020. UK-Brazil collaborations in research and innovation continue to expand significantly and there are opportunities to further develop this relationship. Key recent developments include:

- Vince Cable meeting with his Brazilian opposite number, Fernando Pimentel, at the Joint Economic and Trade Committee in November 2011 made clear his desire to deepen the UK-Brazil partnership particularly in innovation;
- A joint statement signed by David Willetts, Minister of State for Universities and Science, with the Brazilian Science Minister, Aloizio Mercadante, in June 2011 on increasing science co-operation between our two countries; and
- The announcement from Universities UK on the UK's participation in President Dilma Rousseff's flagship programme, "Science Without Borders", where up to 10,000 Brazilian students will receive Brazilian Government scholarships to study in the UK.

Source: Ministry of Science, Technology and Innovation
http://www.mct.gov.br/index.php/content/view/328091.html

Summary of Actions

In conclusion, the UK fully recognises that innovation and research is increasingly an international issue and the Government will work with its partners to build a strategic approach to supporting international collaboration.

Since May 2010, the Government has:

- **Established a High Value Opportunities Programme focused on winning major overseas trade opportunities;**
- **Reformed the visa system to put in place specific entry routes for those with the greatest potential to contribute to the UK's research and innovation capability;**
- **Worked with the HE sector and the EU to encourage mobility of academics and students;**
- **The Government will open up access to core public datasets on transport, weather and health, including giving individuals access to their online GP records by the end of this Parliament;**
- **The Government will provide up to £10 million over 5 years to establish an Open Data Institute to help industry exploit the opportunities created through the release of this data. The ODI will be developed by the Technology Strategy Board and will involve business and academic institutions; and**
- **Been building new links with high growth economies while continuing to work with our traditional innovation and research partners.**

To take this further we will now:

- **Promote the UK's research and high technology sectors overseas through a range of measures including using the backdrop of the London 2012 Olympic and Paralympic Games;**
- **Support UK businesses' and researchers' access to international markets and collaboration through UKTI services, including the creation of a collaborative online platform for businesses, and work to link UK SMEs with overseas investors;**
- **Ensure the UK continues to attract globally mobile capital, technology and highly-skilled people through a continued focus on high value foreign direct investment, the promotion of academic mobility and Research Councils support for key languages;**

- **Strengthen our engagement with initiatives within the European Single Market with a focus on improving access by UK companies to EU innovation and research funding programmes, EU Patent, the digital single market and Knowledge and Innovation Communities; and**
- **Establish an agreement with the Chinese Ministry of Science and Technology to fund bilateral research projects in key areas of mutual interest.**

6 New Innovation Challenges

In earlier chapters we looked at how Government can facilitate an innovation ecosystem and invest in the capabilities that support innovators.

In addition to this Government can enable innovation by:

- *Opening up access to data, information and research that is held within the public sector so its economic and social value can be maximised;*
- *Cutting red tape to ensure that rules and regulations do not inhibit new business models;*
- *Mobilising resources and new partnerships around big societal challenges through the use of Inducement Prizes;*
- *Acting as a Lead Customer – as a major and early user of goods and services the public sector is a source of demand for new forms of innovation, especially in areas such as health, transport and urban development and its scale provides an early market to grow new business models, technologies and services; and*
- *Developing, growing and diffusing innovations that deliver better and more efficient public services*

Open Data and Transparency

6.1 The public sector both generates and holds vast quantities of data, through the research it funds and the services it delivers. Recent European Commission analysis suggested that the commercial value of public sector data in the UK could be around £16 billion per annum[45] whilst citizen access to online personal information is expected to be worth up to £20 billion by 2020[46].

45 Review of Recent Studies on PSI Re-Use and Related Market Developments (2011), Graham Vickery for European Union's Directorate-General Information Society.

46 The Rise of Volunteered Information (2008), Ctrl-Shift research.

6.2 Governments around the world are increasingly recognising that making more of this information available will produce value in the wider economy, through:

- **Building data and analytics markets**: releasing data enables organisations specialising in providing analysis to grow, providing a range of intermediary products and services for use by other businesses across a range of sectors;
- **Expanding existing market opportunities**: the insights garnered from a broader analysis of government data allows entrepreneurial organisations to transform current products and services and to target them more effectively to the appropriate audience/market;
- **Helping create new products and services**: as well as producing efficiencies for business in their current markets, analysis of government data allows entrepreneurial organisations to develop new and innovative products, many of which link to one another, creating positive network effects, and support the growth of complementary digital technologies, generating spillover effects across the wider economy; and
- **Driving up standards and transparency in public services**: giving individuals access to the information they need to help them make informed decisions and to ensure public services are accountable to service users and taxpayers.

6.3 We are already making progress on releasing the value of open data for both companies and consumers:

- We recently published an Open Data consultation and in Spring 2012 will publish an Open Data White Paper;
- We have established a Public Sector Transparency Board to support and challenge public sector bodies in the implementation of Open Data standards;
- A new Open Government licence has made it easier for public service providers to publish data;
- On 3 November 2011, we launched MiData which will give consumers greater access to their personal data so that they can gain insights into their own behaviour, make more informed choices about products and services, and manage their lives more efficiently. We will continue to work closely with businesses, consumer bodies and regulators to develop it further; and
- Europe also shares our ambitions in this area. The EU recently announced an Open Data Strategy that will set out measures aimed at increasing government transparency and creating a €32 billion a year market for public data. This will help to create synergies with some of the measures being developed in the UK.

6.4 However, large volumes of data remain unused and its value is untapped. The Office of Fair Trading has noted that key barriers to exploiting the value in public sector data included difficulty of access, charging regimes and a simple failure to exploit it[47]. We believe there is an opportunity for the UK to establish a first mover advantage in open data. We will help to facilitate access to public sector data so that maximum value can be derived.

6.5 The latest phase of the Growth Review included a project looking at the economic growth potential of making access to public data assets possible. The highlights were announced in the Chancellor's Autumn Statement and include:

- **Linking primary and secondary healthcare datasets** – The Government will provide a service to link primary and secondary healthcare datasets from September 2012 to reinforce the UK's position as a global centre for research and analytics and boost UK life sciences;
- **Publishing prescribing data** – The Government will publish further prescribing data by September 2012 and additional health and social care datasets by September 2013 to support health and social care data-based product and analytics markets;
- **Train and bus data** – The Government will work with the transport industry to make available by April 2012 timetable and real-time train and bus information to support the development of innovative applications to improve passenger journeys;
- **Rail fares data** – The Government will consult in early 2012, through the Fares and Ticketing Review, on providing open access to rail fares data, giving passengers and business better information and enabling them to make the most cost-effective travel choices;
- **Civil Aviation Authority** – The Government plans to legislate to give the Civil Aviation Authority the power to publish data on the performance of aviation service providers, to enable users of air freight and passenger services to make the most cost-effective choices;
- **Highways and traffic data** – The Government will release from March 2012 a range of highways and traffic data, including on road works, to help reduce congestion and enable business to make more predictable travel and logistics decisions;
- **Fit note data** – The Government will consult on the content of anonymised fit note data to be published from 2012 to drive innovation in the occupational health sector and improve management of sickness absence;

47 The Commercial Use of Public Information (2006), Office of Fair Trading.

- **Universal Credit data** – The Government will design the Universal Credit ICT system so that aggregate benefits data can be published during the first year of live running of the system;
- **Linking welfare data** – The Government will consider opportunities for linking welfare datasets to other government and commercial datasets to increase their value to industry;
- **Open Data Institute (ODI)** – Government will provide up to £10 million over five years, with match-funding from industry and academia, to establish the world's first Open Data Institute in Shoreditch, East London. The ODI will be developed by the Technology Strategy Board and will involve businesses and academic institutions. It will focus on innovation, commercialisation and the development of web standards to support the Open Data Agenda. It will ensure that Open Data research is transformed into commercial advantage for UK companies, work with academic centres to increase the number of trained personnel with extensive Open Data skills and provide expert advice for government.
- **Releasing reference data** – The Government will establish a Data Strategy Board and a Public Data Group that will maximise the value of the data from the Met Office, Ordnance Survey, the Land Registry and Companies House. It will make available for free a range of core reference datasets from these bodies to support the development of high-value data businesses; and
- **Personal data** – The Government will ensure all NHS patients can access their personal GP records online by the end of this Parliament. The Government will publish a new procurement arrangement for school information and learning services in Spring 2012 to improve parents' and pupils' access to education data and increase competition in provision of learning services.

Expanded Access to Research Publications and Data

6.6 The Government, in line with our overarching commitment to transparency and open data, is committed to ensuring that publicly-funded research should be accessible free of charge. Free and open access to taxpayer-funded research offers significant social and economic benefits by spreading knowledge, raising the prestige of UK research and encouraging technology transfer. At the moment, such research is often difficult to find and expensive to access. This can defeat the original purpose of taxpayer-funded academic research and limits understanding and innovation. We have already committed, in our response to Ian Hargreaves's review of intellectual property, to facilitate data mining of published research. This could have substantial benefits, for example in tackling diseases. But we need to go much further if, as a nation, we are to gain the full potential benefits of publicly-funded research.

6.7 There are many successful international examples of open access research. At Harvard, academics often grant the university a non-exclusive irrevocable right to distribute their scholarly output for non-commercial use. Their articles are than stored, preserved and made freely available through the Digital Access to Scholarship at Harvard (DASH). The UK has various similar examples of good practice:

- many universities and subject communities have their own digital open access repositories;
- the independent Wellcome Trust ensure all research they fund is made freely available in UKPubMed, supported by the Medical Research Council, an online resource; and
- the *British Medical Journal* has been open access since 1998, with authors making a payment to cover the costs of publication, including peer review.

6.8 Government will work with partners, including the publishing industry, to achieve free access to publicly-funded research as soon as possible and will set an example itself.

- We have helped establish **an independent working group chaired by Janet Finch to consider how to improve access to research publications**, including publicly-funded research. This will report in early 2012.
- **The Royal Society is considering how to improve the sharing and disclosing of research data**, both within the research community and beyond. It will report in early 2012.
- **Alan Langlands is chairing a task force to advise on improving the accessibility of data within Government and its agencies**, which will advise on data linkage, conditions of access and data quality. This will report during 2012.

6.9 The Research Councils expect the researchers they fund to deposit published articles or conference proceedings in an open access repository at or around the time of publication. But this practice is unevenly enforced. Therefore, as an immediate step, we have asked the Research Councils to ensure the researchers they fund fulfil the current requirements. Additionally, **the Research Councils have now agreed to invest £2 million in the development, by 2013, of a UK 'Gateway to Research'**. In the first instance this will allow ready access to Research Council funded research information and related data but it will be designed so that it can also include research funded by others in due course. The Research Councils will work with their partners and users to ensure information is presented in a readily reusable form, using common formats and open standards.

6.10 Our goal is a transformation in the accessibility of research and data. As these new initiatives take effect, we will be mindful of the need to protect the national interest – for example, on national security, personal privacy and commercial sensitivity – as well as the reputation of our research base.

Easy Access IP

There are a number of emerging models aimed at speeding up the process of commercialising IP. "Easy Access IP" , developed and launched by the University of Glasgow is one example. Glasgow are now working in partnership with King's College London and the University of Bristol to develop the model further. Easy Access IP universities are making university IP available , where there is not sufficient value to justify upfront university investment, for free, providing *four conditions are met: companies must inform the university how the IP will be used to benefit the economy; ensure it can continue to be used for research purposes; demonstrate that it has been used to add value after three years; and acknowledge the university as the source of the research. To facilitate this, Glasgow and the partnership have developed a streamlined licensing agreement.*

Other universities have also developed approaches to streamline the process of commercialising IP.

Cutting Red Tape

6.11 If we want to encourage new forms of innovation in the economy we need to ensure that rules and regulations do not inhibit new business models, or place them at a disadvantage to incumbents. In particular, a number of businesses who want to use the internet and other new technologies to disrupt the established way of doing things are being held back as their innovations outstrip the regulation that currently exists.

6.12 For example, crowd-funding platforms that enable members of the public to lend to one other, or to small businesses, have found that financial regulations don't easily accommodate their business model because they predate new technologies. Or, in the property sector, a number of businesses have tried providing a platform for customers to sell directly to each other, without needing to work through Estate Agents, at low or no cost. However Estate Agency regulations treat them as if they are traditional Estate Agents, and place burdens upon them that make very low cost internet-enabled business models unviable.

6.13 We are determined to unleash Britain's innovative talents and remove any unnecessary red tape and that's why **the Prime Minister recently launched the**

Disruptive Business Models Red Tape Challenge[48] theme inviting inventors, innovators and entrepreneurs to tell us about the rules and regulations that hinder innovation, new business models or stifle competition.

Innovation Inducement Prizes and Challenges

6.14 While not widely used, inducement prizes have a long history, dating back to the Longtitude prize offered by the British Government in 1714 to the first person who could develop a way to determine a ship's longtitude within half a degree.

6.15 Internationally, both governments and businesses are increasingly seeing the potential of offering prizes as a complement to other ways of supporting innovation. Between 1999-2009[49], the total prize funds available in the USA more than tripled, with 78% of the new money that they identified representing inducement prizes rather than recognition prizes, such as the Nobel Prize, that reward previous achievements.

6.16 On 17 November 2011 the Queen Elizabeth Prize for Engineering was launched. The £1 million biennial Prize will recognise and celebrate the best and also serve to illuminate the excitement of modern engineering. It will provide a high profile opportunity to demonstrate how engineers and engineering are making a real difference across the world.

6.17 Inducement prizes can also be used to encourage wider collaboration across public and private sector organisations, communities and service users in response to a clearly defined challenge or opportunity. For example, the NESTA Big Green Challenge ran from 2007-2009 and used a staged approach to generate community innovation on climate change. Ten finalists achieved 10-46% reductions in CO_2 emissions in their communities.

6.18 A well-designed prize will aim to solve a multidisciplinary problem that is not the subject of existing research grant programmes or challenges. By stimulating the creation of new collaborations and networks, prizes can bring together different types of knowledge and other resources to solve problems that would otherwise remain ignored.

6.19 Inducement prizes offer a range of benefits that complement other public sector support for innovation[50], including:

- **Social value**: prizes can raise the value that society places on the solving of a particular problem, which makes it more likely that innovators but also communities, businesses, service providers and other organisations will focus attention on that issue;

48 http://www.redtapechallenge.cabinetoffice.gov.uk/themehome/disruptive-business-model/

49 'And the winner is… Capturing the promise of philanthropic prizes' (2009). McKinsey&Company. 2009

50 The economics of climate change prizes (2007), Vivid Economics for Defra & NESTA, 2007

- **Collaboration**: a well-designed prize will appeal to individuals and businesses who may not have been involved in the subject matter before. This creates opportunities for people who would not normally work together to collaborate with a common goal;
- **Risk and reward**: offering a prize to solve a problem shares the risk between a wider range of organisations, and offers a reward for successful innovation that incentivises people to commit resources to this; and
- **Commercialisation**: prizes identify and publicise innovations, engaging investors and innovators to take new solutions to market.

6.20 Successful prizes require an underpinning infrastructure that provides a capability to design and manage the prize competition, market it and communicate it to the community at which it is targeted. This infrastructure needs to set an achievable and well-defined goal and the criteria by which entries will be judged and facilitate new collaborations across individuals and organisations. The infrastructure also needs to be able to determine when the criteria have been met and the prize can be awarded. Resources need to be available to support prize competitors in exploiting their success.

UK Prize Centre

6.21 We believe that prizes should become a more integrated part of the UK innovation system, looking to stimulate innovation in areas where it is most needed. To create an infrastructure to support successful innovation prizes, **NESTA will establish a Centre of Expertise to run, design and facilitate inducement prizes.** It will broker support across Government, the private sector and philanthropic organisations to pull together collaborations with the skills, knowledge, and finances to support, design, run and judge future prizes. NESTA will work with partners including the TSB to develop the Centre.

UK Prize Fund

6.22 **BIS and NESTA will co-finance a new fund to run future inducement prizes, which will be run by NESTA.** It will leverage interest and investment from the private and public sectors, and philanthropic organisations. We will contribute £250,000 per annum towards the fund and an additional £100,000 will be made available to co-fund the first prize that the UK Prize Centre will run. Prizes run by the Centre will seek to solve interdisciplinary challenges, stimulate new innovative collaborations across organisations and individuals, and incentivise the development of solutions where innovation is required but not supported through existing mechanisms.

Design Challenges

6.23 The Design Council has developed and run a number of successful design-led open innovation competitions to address major societal challenges such as crime, reducing the risk of infection in hospitals and discouraging violence and aggression in A&E departments. Building on this experience, the **Design Council will work with government departments and partners to identify further challenges that would benefit from this approach.**

Government as a Lead Customer for Innovation

6.24 The scale of Government's purchasing power means that the public sector can be a lead customer for innovative products and services. Through engaging with the supply chain, the public sector can identify opportunities to incentivise the development of new products and services, and use the scale of the public sector market to accelerate the commercialisation of innovation, benefitting the wider economy. This approach has been used successfully in the USA, through programmes such as the Small Business Innovation Research (SBIR).

6.25 The UK public sector is a significant, and sometimes lead, consumer in a number of areas: health and pharmaceuticals, food and catering, energy, environment, construction, transport and logistics, and security. Recognising the importance of the public sector as a lead customer for innovation we committed £20 million to the Small Business Research Initiative (SBRI) at Budget 2011. There are examples of where organisations have developed early engagement with industry and delivered impressive results.

Small Business Research Initiative (SBRI)

Managing Long Term Health Conditions

Picture of the Eykona Wound Measurement System courtesy of Eykona Tecnologies.

This competition was launched by the East of England NHS and sought innovative technologies to help with the remote management of long term conditions, thereby reducing the need for patients to travel to hospital to meet with specialists. It aimed to allow community based assessment and treatment of patients to improve patient care and saved time and money. Through this competition Eykona Technologies identified a substantial and recognised unmet need in the objective measurement and characterisation of chronic wounds such as diabetic ulcers. It is meeting this need through the use of a patented 3D imaging medical device based on cutting edge technology developed in the University of Oxford and consisting of a proprietary camera and software package. The project has delivered hand-held 3D imaging hardware which is now being used by clinicians. The SBRI contract was instrumental in raising £2.4 million funding, and as a result Eykona has grown from 4 to 14 employees – with first sales already made and an expected £10 million turnover by 2014.

Forward Commitment Procurement (FCP)

Ultra Efficient Lighting for Future Wards Project

Picture: CGI image of the ward lighting solution courtesy of Integrated Medical Interiors Limited.

Like many healthcare organisations across Europe, The Rotherham NHS Foundation Trust needs to deliver carbon reductions, save money and at the same time provide environments that are built around patient needs.

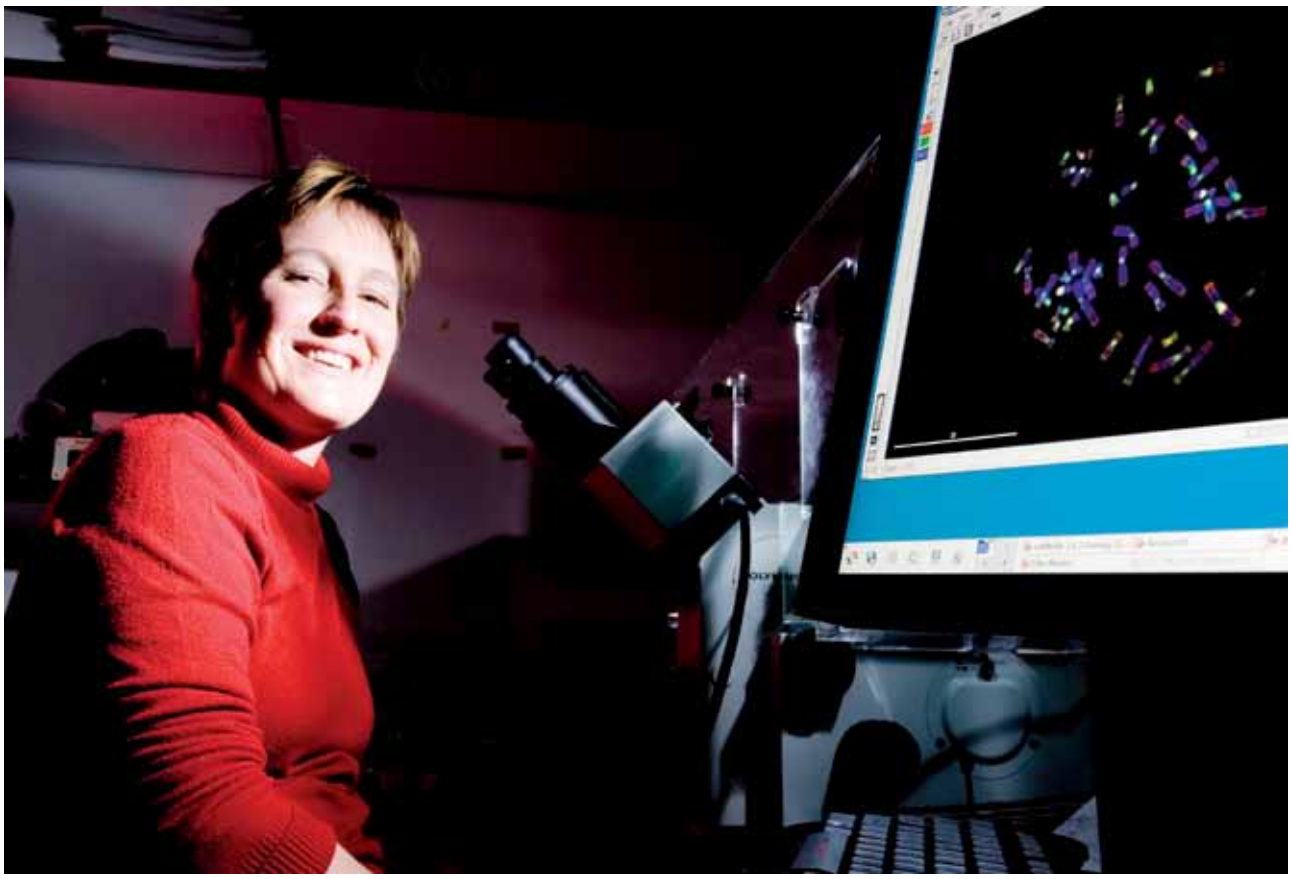
The Trust has addressed these challenges by using Forward Commitment Procurement (FCP).

The project team started by describing what they needed from lighting in a future ward in terms of outcomes, rather than in terms of existing products available on the market. This 'unmet need' was then developed into a specification working with the supply chain.

The pro-innovation procurement approach has brought to the market an integrated 'future ward' modular solution, with integrated bio-dynamic lighting, trunking, and storage for use by patients and staff.

Detailed costings, verified by an independent quantity surveyor, show that the innovative solution will cost the same as a standard ward solution with not only the required step change in patient experience and lighting efficiency but also with reduced on-site build time and additional benefits.

6.26 However, Government's capacity to act as an 'intelligent customer' is limited by skills and knowledge gaps[51]. It currently has difficulty in evaluating the benefit of innovative proposals, particularly where new or cutting-edge technology is concerned.



Source: © David Martin, University of Dundee.

6.27 Collaboration between organisations would provide advantages around sharing risks, combining resources and opening up wider markets in the public sector to grow innovative products and services. However, the number of organisations in the public sector makes co-ordination difficult so these benefits are not always realised.

Procurement Centres of Expertise

6.28 **We will develop Procurement Centres of Expertise** in key areas with an initial focus on sustainability and healthcare. The Centres will act as a source of expertise on a market in a particular technology area/sector, build relationships and be a strategic focal point for engagement with industry.

6.29 We will develop Centres from existing organisations that have demonstrated capability in working as a lead customer with industry.

51 House of Lords Science and Technology Committee report on public procurement as a tool to stimulate innovation, 2011.

Small Business Research Initiative (SBRI)

6.30 **We will be investing more into SBRI**, to increase its impact in supporting and growing technology based SMEs whilst sourcing new solutions to public sector challenges.

6.31 The additional funding will enable a better structured and expanded programme to be delivered. It would also support the development of technology-based SMEs and better solutions to challenges faced by the public sector, supporting growth and improving efficiency.

Public Private Procurement Compacts

6.32 **We will work with public and private sector partners, through the Prince of Wales' Corporate Leader's Group, to create public-private Procurement Compacts**. These will build on the success of the FCP process, through expanding the number of organisations involved, to increase the incentive for the development of innovative solutions. Three areas will be targeted initially: catering; heat and power for buildings; and low carbon vehicles. This will stimulate the market to develop new technologies and provide innovative solutions to both public and private sector challenges with an additional outcome of driving economic growth and resource efficiency.

Design and Innovative Procurement

6.33 Design thinking can play an important role in strengthening the public sector's capacity to be an intelligent customer as it involves bringing together different perspectives, including industry and users of a service or product, to understand needs. The use of design can deliver cost savings and improved efficiency in the delivery of public services and help to generate solutions to societal challenges.

6.34 Building on their existing public sector mentoring programmes, and working with BIS, the Cabinet Office and other partners, the Design Council will develop:

- **A design-led commissioning toolkit** for adoption by government departments and more widely across the public sector; and
- **A coaching programme for senior civil servants**. This could initially be aimed at the 'Top 200' group and potentially be delivered in collaboration with the Institute for Government.

Improving Diffusion of 'What Works' in Public Services

6.35 There are many existing examples of innovation developed and driven by the UK public sector, but a number of systemic and cultural barriers mean that new

innovations in the public services can often remain marginal and not achieve maximum impact[52]. Government needs to become more sophisticated in how it supports the scaling and diffusion of new products, services and practices that improve the effectiveness of public services so that budgets can be focused on where return on investment is highest – whether they originate from the public, private or third sector.

6.36 In the Open Public Services White Paper we committed to support better commissioning in public services. A partnership led by NESTA and the ESRC, has identified the difficulties of using evidence around what works in public services to help decision making in both policy making and procurement and commissioning. The partnership has identified barriers that include inconsistencies in terms of the quality of evidence being commissioned, a lack of linkage between supply and demand and the way in which evidence and data is made available and communicated and the need to develop the public sector's capacity to review and incorporate evidence appropriately.

6.37 We will improve the public sector's capacity to grow and diffuse new forms of innovation in public services so that public investment is focused on what works, resources are shifted away from less effective practices and private and third sector public service providers benefit from growth opportunities:

- **NESTA and ESRC will work through the UK Alliance for Useful Evidence to advance the public sector's understanding of evidence and the case for backing 'what works'; and**
- **We will roll-out a web-based set of innovation tools to help public sector organisations to more effectively share and spread innovations.**

Summary of Actions

Since May 2010 the Government has:

- **Made it easier for public sector bodies to open up the data they hold, for the benefit of both businesses and citizens, through a new Open Government licence**
- **Committed £20 million in funding at Budget 2011 to the Small Business Research Initiative (SBRI) to use public procurement to stimulate innovation to meet public sector challenges**
- **Published an Open Public Services White Paper in July 2011 setting out how we will support new approaches to delivering public services**

52 The Innovation index 2009, Nesta

To take this further:

- **The Government will open up access to core public datasets on transport, weather and health, including giving individuals access to their online GP records by the end of this Parliament. The Government will provide up to £10 million over 5 years to establish an Open Data Institute to help industry exploit the opportunities created through the release of this data.**
- **Research councils will develop a web-based publicly searchable "Gateway to Research"**
- **NESTA will develop a new UK Prize Centre and Prize Fund to run inducement prizes in challenge areas where innovation is most needed;**
- **We will develop Government's capacity to be a lead customer and to use its procurement power more effectively to meet its challenges whilst also stimulating innovation in the economy through Procurement Centres of Expertise and Public Private Procurement Compacts and investing more in SBRI; and**
- **NESTA and ESRC will work through the UK Alliance for Useful Evidence to advance the public sector's understanding of evidence and the case for backing 'what works'.**

Conclusions

Next Steps

The Government has an ambitious vision for the UK as a dynamic, balanced, competitive and growing economy, driven by business investment and revenues from technology-based products and services. This vision will not be realised immediately; it will take years of sustained investment and effort to bring it into being, through increasing the level of innovation in the UK economy.

The aim of this Innovation and Research Strategy is to set out how the Government will achieve this, and leverage the significant public investment in these and related areas to drive sustainable growth. The central elements of this new approach will be:

- continued support for blue skies, curiosity-driven research across a broad range of disciplines, with a focus on supporting excellent research and excellent universities;
- identifying and mobilising resources to exploit emerging technologies such as graphene, whilst driving innovation in high technology sectors and in response to societal challenges;
- encouraging increased business investment in all forms of innovation, particularly by SMEs, including technology development, but also in intangible assets such as design, the development of new business models and skills;
- increasing knowledge exchange and facilitating networks, clusters and research campuses as hubs for interaction at local, national and international level;
- strengthening the capability of the UK to be an active participant in and beneficiary of the changing geography of innovation, supporting UK research and business communities in benefitting from international collaboration, FDI and market access; and
- a commitment by Government to maximise its contribution, by making public data available to innovators, removing red tape that blocks innovation, using prizes and challenges to solve problems and acting as a lead customer for innovative products and services.

Measuring Success

Increasing the level of innovation and growth in the UK will require both public and private sector investment and the commitment of other resources. The complex nature of innovation and interactions within the innovation system means that monitoring progress in implementing the Strategy needs a broad range of indicators. These relate to both the research and innovation performance of the UK, and also the delivery of our commitments made in this Strategy. We will measure our performance in delivering this through:

- monitoring the UK's performance in terms of research outputs, and maintaining our reputation for excellence;
- increased levels of business investment in R&D and intangible assets, and an increase in the number of businesses in the UK that are actively innovating;
- increasing the number of businesses, particularly SMEs, claiming the R&D Tax Credit;
- higher levels of investment in venture capital, and business angels in innovative and entrepreneurial businesses;
- delivering Government investment commitments in Catapult centres, High-Performance Computing and e-infrastructure and the Graphene Global Research and Technology Hub;
- monitoring the proportion of UK research outputs that have an international co-author, the quality of these collaborations, and the volume of R&D investment leveraged from abroad;
- tracking the international activities undertaken by the Catapult Centres;
- increasing the successful engagement of UK universities and business with EU funding programmes;
- increasing the number of innovative companies that export;
- increasing the number of high quality inward investment projects from overseas;
- reducing the number of regulations that restrict innovation, and increasing the availability of public data; and
- evaluating the impact of the UK innovation prize fund, and the impact that this has had in stimulating new innovations.

We will report on the baseline for these commitments in the Annual Innovation Report 2012, which will be published early next year, and we will continue to monitor through NESTA's Innovation Index and other key indicators of research and innovation performance, including:

- The biannual report on the International Comparative Performance of the UK Research Base
- Office of National Statistics – Business Expenditure on Research and Development
- Community Innovation Survey Report 2012
- And at an international level:
- Innovation Union Scoreboard

Conclusion

The future prosperity of the UK will depend upon our ability to innovate successfully, and to adopt and embed new innovations across business and the public sector. Innovation is the main pathway to sustainable economic growth, higher real incomes and greater wellbeing over the long term. Raising our innovative capability, and increasing the level of private sector investment in innovation are the only ways in which the UK can prosper in the global economy.

Innovation and Research Strategy: Monitoring the UK's Innovation Performance

This document has set out how we will work with business, universities, the research councils and the Innovation Ecosystem to support private sector led growth.

Our overall objective is to increase levels of innovation that drive growth and create jobs in all parts of the UK, and we need to demonstrate that we are delivering the programmes and initiatives set out in this strategy. The key milestones are set out in the delivery plan below:

Action	Lead	Timescale
Discovery and Development		
We will invest over £200 million between 2011-15 in establishing an elite national network of Catapult centres We have announced the first three Catapults in High-value Manufacturing, Cell Therapies and Offshore Renewable energy	TSB	The technology areas for the final three TICs will be announced in early 2012, with all six centres being operational by 2013
We will identify our priorities for investment in emerging technologies through the Technology Strategy Board, focusing initially on synthetic biology, energy efficient computing and energy harvesting	TSB	By 2012
We will invest £50 million in the development of a Graphene Global Research and Technology Hub	EPSRC with TSB	The centre will be fully operational by 2015

Action	Lead	Timescale
Innovative Businesses		
We will raise the rate of tax relief for the SME R&D Tax Credit to 225% of qualifying expenditure. To increase usage of the R&D Tax Credit we will: • Work with HM Treasury, HM Revenue and Customs and the Devolved Administrations to increase awareness and take-up of the SME scheme • Work with the Design sector to raise awareness of how the Scheme can help support research and development • Further simplify the scheme piloting a pre-approval scheme for smaller companies	BIS/ HMT	The rate will be raised from 1 April 2012 Increase take up of the SME scheme by 2014 HMRC to start the pre-approval pilot in late 2011
We will introduce an 'above the line' tax credit to encourage research and development activity by larger companies	HM Treasury	Consultation at Budget 2012 Implementation in 2013
We will increase our funding of Designing Demand to £1.3 million enabling more businesses to benefit.	Design Council	Up to 100 SMEs a year will receive design mentoring from April 2012
We will increase our funding of Designing Demand to £1.3 million enabling more businesses to benefit	Design Council	Up to 100 SMEs a year will receive design mentoring from April 2012
We will invest £25 million in enabling large-scale demonstrators in areas such as integrated systems for cities.	TSB	Establish Demonstrators by 2014
We will deliver a major conference in London 2012 around the Olympics with the British and US Venture Capital Associations and NESTA, to showcase and secure investment for some of the UK's leading innovative companies	BIS, US Dept of Commerce, BVCA, NVCA, NESTA, UKTI, TSB	July 2012
We will establish a team based in the Technology Strategy Board, that enables us to make maximum use of European Regional Development Fund (ERDF) funding to support innovation investments	TSB	The team will be recruited and operational by 2012

Action	Lead	Timescale
The IPO will adapt Masterclass training courses for advisors into modules to make it accessible for a wider range of business advisors. The IPO will also develop an online business advisor training tool	IPO	By March 2013
The IPO will consult businesses, business advisors and IP specialists on providing additional specific lower cost legal advice at a 'paralegal' level	IPO	By March 2013
The IPO will redevelop its dispute resolution service to be more customer-focussed	IPO	The IPO will consult businesses to determine what is needed during 2012 By March 2013 we will have developed the business needs for the service
We will work to increase innovation levels across economically important sectors starting with agri-food and utilities		
• Working with the Sector Skills Council to improve skill levels including management and leadership skills	Lantra & Improve Sector Skills Councils	2012
• Enable innovation in power distribution working with the Technology Strategy Board and the knowledge base	TSB	2012
• 'Help the UK water industry, working with the knowledge base, to innovate and so compete more effectively in overseas markets'	TSB	2013
• Targeted support from the innovation infrastructure to ensure that agri-food and utilities businesses are able to access Government support including raising awareness of support from the Technology Strategy Board and the R&D Tax Credit	BIS / HMT / HMRC / TSB / Design Council / IPO	2012

Action	Lead	Timescale
Knowledge and Innovation		
We will invest £158 million to boost Britain's e-infrastructure and make the UK a world leader in supercomputing research	BIS	The investment will be made by March 2012
We will implement a new innovation voucher programme to support collaboration between SMEs and external knowledge providers	TSB	We will invest at least £1m pa in a staged implementation of innovation vouchers programme in 2012-13, with the first vouchers awarded in 2012
Research Councils UK, working with the Funding Councils and in discussion with individual universities and consortia, will develop a principles-based Framework for treatment and submission of multi-institutional funding bids	Research Councils	The framework will be published in February 2012
We will extend Launchpad to support new and emerging clusters in other parts of the UK	TSB	The Technology Strategy Board will run three launchpads in 2012
We will introduce the EU VAT cost-sharing exemption to enable Universities and Charities to ensure that a VAT cost isn't incurred when services are shared	HMT	2012
We will respond to Sir Tim Wilson's forthcoming review of University-business collaboration	BIS	Spring 2012
Global Collaboration		
UKTI will deliver a package of measures to assist innovative UK SMEs to connect with overseas finance	UKTI	New programme to be announced before end of 2011
We will use the Olympic Games to provide a showcase of British business and research capability in front of an international audience under the GREAT brand	UKTI	Programme of events announced by the Prime Minister 21st September in New York. Events to take place during Summer 2012

Action	Lead	Timescale
UKTI will launch a collaborative online platform called "Open to Export", enabling innovative companies and service providers to support one another	UKTI	A beta version of the platform will be launched by Spring 2012
We will undertake a review of the support-system for potential UK proposers to EU funding programmes to ensure we have an effective system in place for Horizon 2020	BIS and TSB	New system to be in place by Summer 2013
Establish an agreement with the Chinese Ministry of Science and Technology to fund bi-lateral research projects in key areas of mutual interest	BIS, RCUK, TSB	Details of implementation agreed by April 2012. Joint research calls expected during 2012
New Innovation Challenges		
We will consider and act on the recommendations of the Dame Janet Finch Publications Working Group	BIS	Autumn 2012
We will consider and act on the recommendations of the Alan Langlands Administrative Data Task Force	BIS	Late 2012
Research Councils will develop a web based publicly searchable 'Gateway to Research'	RCUK	By 2013/14
An Open Data Institute will be developed, based in East London and co-directed by Professor Tim Berners-Lee and Professor Nigel Shadbolt	TSB	Implementation plan published by April 2012
NESTA will develop a new UK Prize Centre and Prize Fund to run inducement prizes in challenge areas where innovation is most needed	NESTA	The centre will be established in Spring 2012 The first prize will be awarded in 2013
We will work with others across the public sector to develop Procurement Centres of Expertise for innovative products and services, in key areas with an initial focus on sustainability and healthcare	BIS	We will establish at least one centre in both the initial areas by Summer 2012
We will develop Public Private Procurement Compacts in the areas of catering; heat and power for buildings; and low carbon vehicles	BIS (with the Prince of Wales' Corporate Leader's Group)	The compacts will be signed in Spring 2012

Action	Lead	Timescale
The Design Council will deliver a design-led commissioning toolkit for adoption by government departments and more widely across the public sector; and a coaching programme for senior civil servants	Design Council	The toolkit and the coaching programme will be developed and made available in 2012
NESTA and ESRC will work through the UK Alliance for Useful Evidence to advance the public sectors understanding of evidence and the case for backing what works	NESTA and ESRC	Alliance launched and work plan in development

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