Ingenious Britain

Making the UK the leading high tech exporter in Europe

A report by James Dyson

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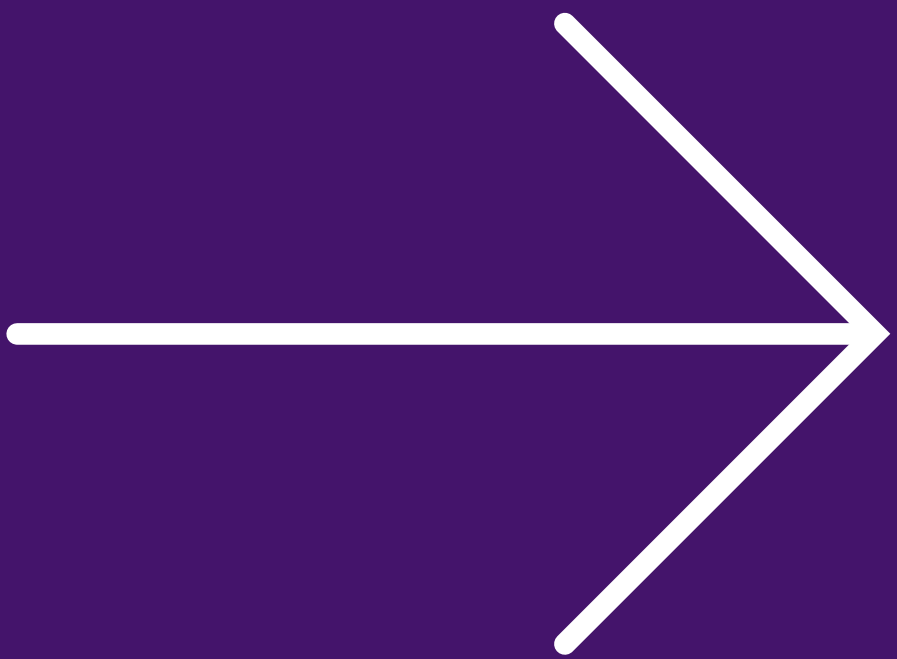

Foreword

When David Cameron invited me to help the Conservatives reawaken Britain's innate inventiveness and creativity I did not hesitate. Here was an opportunity to put forward my own views and those of some of Britain's leading industrialists, scientists, engineers and academics in a coherent form – a way forward rather than a nostalgic glance back. There has been much debate and even more common ground. The clear consensus is that action is required now. I am immensely grateful for the contributions of these individuals.

The mission David set was clear and ambitious but undoubtedly within reach: for Britain to become Europe's leading generator of new technology. A challenge, yes. But forgive the mechanical analogy, we have the right components: the chassis, an engine and all four wheels. We just need fuel, perhaps a bit of tuning, and most of all a sense of direction. Britain is not in a so-called "post-industrial" state, nor is science and technology niche. I am not an enthusiast lobbying to return to a bygone era. Industry, science and technology create jobs and create wealth – beyond the Square Mile.

The task was broken down into five key challenges, challenges that a future Conservative government must tackle if Britain is to generate and export more technology. Very simply:

Culture: How can a Conservative government bring about a culture where science, technology and engineering are held in high esteem?

Education: How can a Conservative government inspire a future generation of scientists, engineers and technicians? And how can we nurture those young creative brains so that they go on to pursue Science, Technology, Engineering and Mathematics – the STEM subjects – in further and higher education?

Exploiting Knowledge: We have world-renowned universities, but how can a Conservative government encourage the practical application of blue skies research in order to create world-beating products?

Financing High Tech: How can a Conservative government establish a financial system that actively invests in high tech companies and projects?

Supporting High Tech: How can a Conservative government incentivise R&D investment by companies and support British exports?

Not every opinion will be echoed by the Conservative team, nor will all of our ideas make it into the final manifesto. Policy suggestions that clash with those developed by other taskforces could have been weeded out, but that would be disingenuous and perhaps disloyal to the scientists, engineers, inventors and manufacturers whose flag I am attempting to fly. My hope is that the Conservative team will see that Britain's talent for researching, developing, producing and exporting new technology is alive and (relatively) well. With long-term government vision, focus and support, I believe that the nation's instinctive talent can propel Britain forward out of recession and towards sustainable growth.

We have brilliant, brilliant minds and a good dose of obstinacy. Ideal really.

James Dyson

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Executive Summary

Now, more than at any time over the past twenty years, I sense there is a real opportunity to set a new vision for our economy. To do this, a new government must take immediate action to put science and engineering at the centre of its thinking – in business, industry, education, and, crucially, in public culture.

David Cameron and George Osborne have rightly highlighted the need to build a sustainable economy based on investments, exports and savings. I believe that it's high tech companies that can contribute the most to this new economy. From my perspective, high tech companies are those who, regardless of the sector they are in, are making genuine investments in research and development to gain an advantage over their international counterparts. The UK has numerous examples of these companies – our goal must be to expand their size and number. And we'll do this by combining our entrepreneurial culture and ability to innovate.

What should a Conservative government do to make it all happen? There aren't any magic bullets – there rarely are. In contrast to previous reviews, rather than focusing on one component, we've tried to tackle issues across the board. Considered and implemented together, they have a chance of working for the long-term economic prosperity of the country. This requires a shift in public consciousness towards science and engineering – a challenge that requires a strong government.

Culture: Developing high esteem for science and engineering

Culture. I know that's a challenge. But I worry that too much time is spent coming up with buzzwords and initiatives like 'Creative Britain,' without much substance to back them up. Britain can't PR its way out of the financial black hole. It's absolutely right to encourage creativity in all its forms, but why limit it by defining which sectors are creative and, by passive association, those which are not?

- To remain internationally competitive, government needs to get serious about engineering and science – in its commitment to research, delivering skills and backing significant infrastructure projects. High tech exports create real wealth and will help us recover from our deficit.
- We don't need to look hard for excellent examples of science, engineering and invention. We simply need to celebrate them and the ingenious people who develop them. Future Conservative ministers need to be vocal about these examples both at home and abroad – where ministerial advocacy can reap benefits. Bringing together key parties to consider campaigns, prizes and the role of the Design Council must be the first step for a new government.
- Commitments to *grands projets,* such as high-speed rail, nuclear and offshore wind power, will demonstrate to the public the Conservative government's ambitions for the country. Commitment needs to be matched with better decision making by ministers. This requires a greater appreciation across government of the challenges facing companies in different sectors.

Education: Getting young people excited about science and engineering

The cultural assumptions of de-industrialisation extend to education. Design and technology education is struggling to shake off a dreary image, and core science subjects are being sidelined in the rush to expand the curricula. I believe that we must give our schools and universities the freedom and flexibility they need to deliver the future generation of scientists and engineers.

- Great teachers are the single most important factor in successful teaching. Facilitating the transition into teaching for other career professionals through a new programme, Teach Now, will be an important step. Utilising the expertise and goodwill of independent schools can also lift the standards of the whole system. But fundamentally we need to ensure that teaching is attractive to our top science and engineering graduates by paying off their student loans over time and giving Head Teachers greater scope to pay Science, Maths and Technology (STEM) teachers more.
- An urgent review is required to ensure that all STEM teachers are able to refresh their basic training and learn of the latest advances in industry and academia through Continuous Professional Development (CPD).
- Teachers want to teach the three science subjects – a Conservative government must let them. Kids get turned off by dumbed down teaching, but rise to the challenge of mastering something difficult and satisfying.
- Technical, as well as academic, qualifications must be promoted. For too long they have been pigeonholed. A Conservative government needs to

promote a variety of routes to better jobs and securing degrees.

- Universities need to have greater freedom and flexibility in how they are funded and regulated to develop courses best suited to their strategies – be it high quality research led teaching courses or more vocational courses with industry experience.
- Better careers advice will help kick start more young people going into study STEM subjects at undergraduate level. We should go further by offering industry scholarships to foster more engineers, schooled in the theoretical and experienced in the workplace.

Exploiting knowledge: Collaboration, not competition, between universities, companies and not-for-profits

Many of the best new ideas are being created in university labs and the UK has far more than its fair share of leading universities. And the fact that more than 70% of full time engineering and technology postgraduates are from outside the EU shows that our universities provide world-class research led courses in engineering. But, with a few exceptions, we are not world-class at taking ideas out of university and into the market. While support for our strong research base needs to be maintained, we need to take action to:

- Give universities greater autonomy by creating a less bureaucratic assessment system – one that provides a diverse range of incentives and the space for universities to pursue their own research strategies.
- Promote knowledge transfer offices as a springboard for collaboration by focusing funding on successful offices and providing broader support to other researchers.
- Develop new ways of promoting collaboration. Public-private research institutes, capable of developing the next millennium's breakthrough research, are a powerful way of doing this.

Financing high tech start-ups: Turning good ideas into world beating products

High tech start-ups, with great ideas, burn cash. There's no getting away from that. I believe that more can be done to provide the right financial architecture for innovative businesses. We need to unlock the potential of angel investors and encourage lending by commercial banks by:

- Increasing the Enterprise Investment Scheme (EIS) relief available to 30% for angel investors supporting high tech companies.
- Encouraging more lending by banks to innovative businesses through a government guaranteed business loan scheme – provided that the borrower and lender are at risk too.

Supporting high tech companies: Creating the right conditions for R&D investment

Companies know that investment in R&D delivers long-term sustainable advantage. But often an emphasis on short-term gains scuppers these investments. A Conservative government needs to back those companies investing in R&D – through the tax system, better procurement and good export advice.

- Tax credits can be an excellent way of supporting companies willing to risk their own capital in R&D. The current system is well intentioned but not well targeted. A Conservative government should refocus R&D tax credits on high tech companies, small businesses and new start-ups in order to stimulate a new wave of technology. When the public finances allow, the rate should be increased to 200%. Loss making small companies also need greater help, and the claim process must be streamlined. These changes need not necessarily lead to a higher overall cost to the exchequer.
- Conservative ambitions to deliver 25% of procurement and research contracts through small and medium sized enterprises (SMEs) are admirable. Implementation will be crucial and an urgent review should be launched to highlight how a Conservative government will deliver on these ambitions.
- UK Trade and Investment (UKTI) support for export ready companies needs quickly to bring in the expertise of our overseas embassies to promote exports and inward investment.

These actions need to occur alongside the much needed deficit reduction that the Conservatives have argued for. Taken together the reforms and recommendations suggested will put the UK on course to become the leading high tech exporter in Europe.

The UK's Challenge

The UK has an innate creativity, inventiveness and competitive spirit. We need to harness these attributes to develop new products that create nationwide wealth. Our need is greater than ever. The UK has to earn its way out of twin black holes – its yawning trade and fiscal deficits – and forge a new economic future. Can we achieve it? My answer: an emphatic 'Yes'. I strongly believe that the UK can develop a prosperous high tech future, driven by science, technology and engineering (we are actually very good at them) and that we can end our over-dependence on the volatile paper wealth created by the property and financial services sectors.

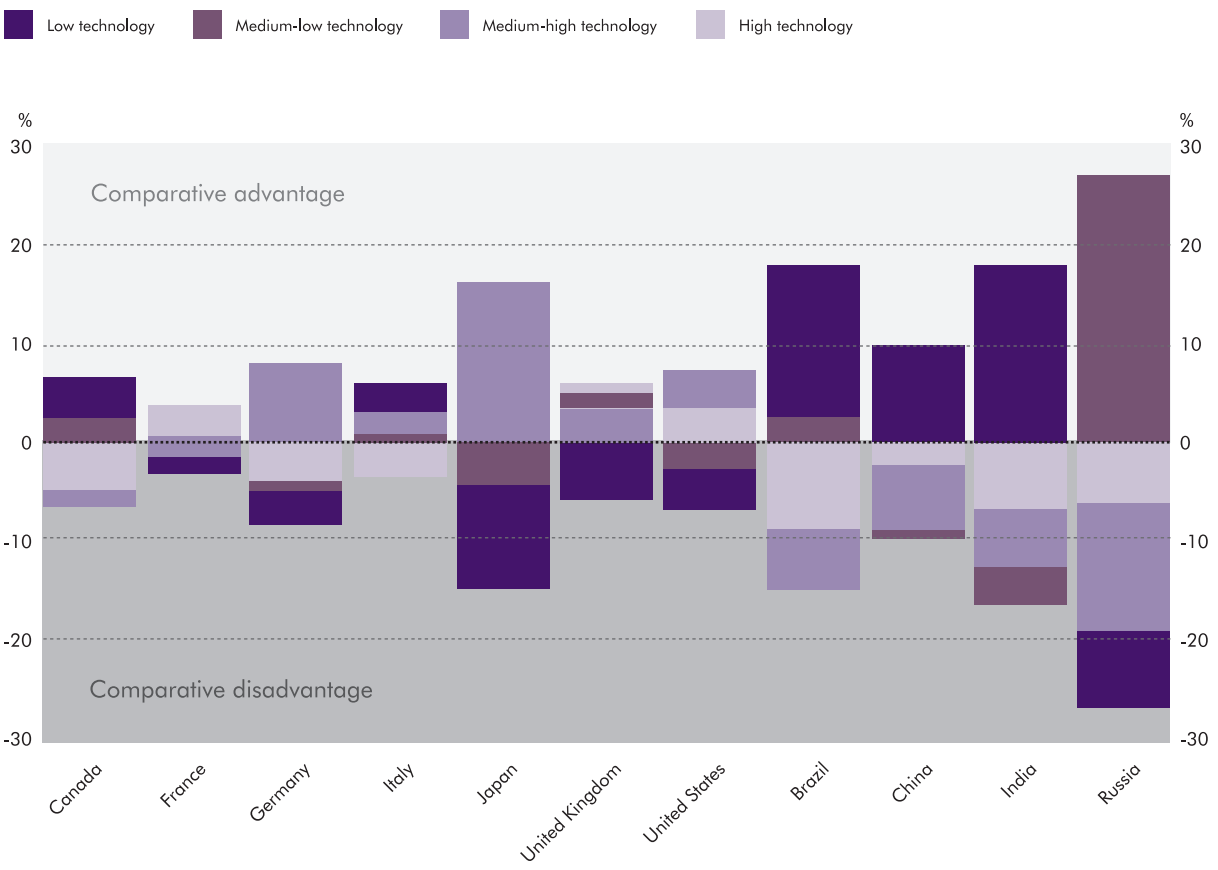
As Rolls-Royce demonstrates with every engine it sells, innovation is the absolute key to its success.

The same is true of every successful high tech company. They all show that these are activities at which the UK can excel. According to 2008 OECD analysis of trade statistics of the G7 group of leading economies, the UK and the USA have the edge when it comes to developing and exporting high technology.[1]

But decades of de-industrialisation mean there's a lot of ground to make up. In the medium-high technology bracket, the UK barely makes an imprint on world trade (see Figure 1). Unsurprisingly, Japan and Germany are the global leaders in this important segment.

The same study shows that, between 1970 and 2003, the UK suffered the sharpest decline in manufacturing as a share of total employment of any advanced economy. A collapse that has seen employment from

Figure 1 Comparative advantages of leading economies in technology fields
As % of total manufacturing trade



[1] OECD, Staying Competitive in the Global Economy: Compendium of Studies on Global Value Chains (2008)

manufacturing fall from nearly one third of total workforce to just over a tenth.[2]

Does this matter? Yes, for three reasons:

- **Re-balancing away from financial services and property.**

  The banking crisis and subsequent recession showed that the UK had become over-dependent on financial services and property. Even worse, it is now clear that the banking and financial services sectors, taken as a whole, did not generate as much added value as has been supposed. Instead, paper profits were reported which were based on leveraging the price rise of financial assets. Economists tell us that exports can play a central role in reducing our current account deficit. Manufacturing, the sector that produces half the UK's exports, is capable of generating more exports in the future. Additionally, the public can have greater confidence that the profits high tech companies generate are genuine. You create value by making things and then selling them for more than they cost. The profits and wealth this creates are real.

- **Regional imbalances.**

  The speed and scale of job losses in manufacturing since the early 1970s inevitably had a disproportionate regional impact. Over reliance on the financial services led to a concentration of economic activity in London. The example of Derby, with its Gross Value Added (GVA) 25% higher than the national average, highlights how a strong high tech manufacturing base can transform the fortunes of a city.

- **Cyclicality**

  Growing high tech companies, who by their very nature are more innovative, can help the UK develop a more diverse economy – one that is more resilient to cyclical downturns. Studies have demonstrated that innovative firms are less sensitive to recessions: 'Whatever it is that creates generic differences between innovators and non-innovators, the consequence is that the former are likely to be quicker, more flexible, more adaptable, and more capable in dealing with market pressures than the latter are.' [3]

[2] Ibid.

[3] Geroski et al, The Profitability of Innovating Firms, RAND Journal of Economics, Vol 24, No. 2 (1993)

Changing the Policy Setting

The UK's long-term performance depends on our ability to generate new ideas and bring them to market. And yet, India and China are producing hundreds of thousands of engineers each year in a bold move to increase their share of the value chain. To compete in the future the UK must use its ingenuity and creativity. But we are fast losing any advantage in these areas we may have had.

Meeting the challenge requires changing economic policy. It means recognising that the policies that have been pursued for the last 30 years are not enough. After the demise of industrial planning policies at the end of the 1970s, policymakers unduly focused on improving efficiency – achieving growth by making existing processes and businesses more efficient.

My only quibble with this is that it's not what the best firms actually do. Of course, successful firms are always seeking ways to improve their efficiency. But it's not what makes them the best. Successful firms are in the business of harnessing innovation to gain sustained competitive advantage: new and better products that deliver more value to customers, priced to reflect this higher value. This drives long-term wealth creation and rising living standards. New inventions and new products define economic eras.

Does that mean the liberalising policies of the past were a mistake? It's not a question of whether pro-competition, market liberalisation policies were wrong, because they are not; it's that by themselves, they are not sufficient.

This is now widely understood. In his 1985 book, Competitive Advantage, Harvard Business School professor, Michael Porter's focus was all about improving the efficiency of the value chain. Seventeen years later, Porter's focus had shifted from efficiency to product innovation. Saying that, for advanced economies with relatively high labour costs, producing standard products using standard processes would not sustain competitive advantage:

> *Advantage must come from the ability to create and then commercialize new products and processes, shifting the technology frontier as fast as their rivals can catch up.*[4]

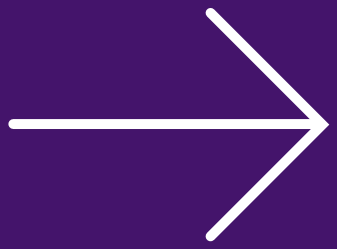
I couldn't have put it better myself.

Government policies need to catch up with the reality of how wealth is created in today's world. Policies should aim at moving the UK up the value chain. A return to centralised planning is not the solution.

Equally, as a recent Cambridge University study has highlighted, we need to move away from fixed policy notions about innovation occurring in only universities and being financed solely by venture capital. Instead the focus must be spurring enterprise and innovation to develop the next generation of wealth creators - high tech companies and entrepreneurs, across all sectors.

We need more entrepreneurs. We need more innovators. We need more scientists, engineers and designers who can turn ideas into working products. We need to be better at supporting the ecosystems that transfer new ideas from universities and which incubate new firms. We need an education system that equips young people and germinates the seeds of industrial ambition in them. And we need government to support innovating firms, especially smaller ones, both through the tax system and the power that comes from being Britain's single largest customer.

[4] Michael Porter and Scott Stern, National Innovative Capacity, The Global Competitiveness Report 2001-2002, (2002)

1 

Culture:
Developing high esteem for science and engineering.

4% of teenage girls
want to be engineers,
14% want to be scientists,
32% want to be models.
New Outlooks in Science
& Engineering.

James Dyson:

Our challenge is to stimulate science and engineering to generate wealth for the UK. Fiscal and education policy is an obvious place to start, but I'm starting with something trickier: culture. It is not a new debate, and it hasn't been cracked – yet. But breeding a culture of appreciation, of esteem, for technology (and those developing it) sets the wheels in motion for government policy.

And government is the place to start. Government must publicly celebrate technology: new inventions, ambitious engineering projects and the pioneers propelling Britain forward. Their role in generating wealth for the nation has to be underlined because there's a creeping danger that people only believe money can be made from money; the quick deal rather than the slow burn of generating new technology. Slow, but thrilling.

But government must go further – actively pushing forward ambitious infrastructure projects, through quick and timely decisions. Such schemes can be risky, but they galvanise and inspire. In 2008 the Large Hadron Collider was among the Times' most popular online topics (so what if there were some teething problems – that's engineering and people are interested in the fix as well as the fault). The Conservative Party has already taken the initiative, committing to a new high-speed rail link linking our major cities. Moreover it is proposing to open the project up as a national competition. This is exactly the kind of venture that inspires both understanding and enthusiasm for science and engineering. But more than that, it instils pride in British ingenuity.

We need active leadership, setting the tone in language and action. Terms like 'post-industrial' and 'creative industries' only serve to reinforce misconceptions. In two words, they render invisible the significant contribution of science and engineering to the economy. They must go. As long as we continue to invent and make things (no matter if they're assembled in the UK or elsewhere) we're industrial. Less chat about what songs are on the PM's iPod, more about the British brains who actually developed MP3 player technology (no, it wasn't Apple).

I strongly believe that people are fascinated by technology and there is no need to dumb it down. If we need to rally interest, then create a serious and prestigious prize to match the Stirling Prize, but only if it can reach beyond the knowledgeable and interested few that other engineering prizes currently reach. People need to know that we're not technological has-beens or heroic failures. Britons are developing new materials, creating greener energy and pioneering breakthrough medicines. There is an awful lot to marvel at and be proud of.

And in terms of opening the eyes of the public and young people to engineering's opportunities, we already have a committed cadre of organisations out there doing some outstanding work to promote the value of science and engineering. The key is to coordinate their activities so that the whole is greater than the sum of the parts.

By leading in word and action, government can unlock the UK's latent enthusiasm for design and engineering. The young are innately curious about how and why things work. We must capitalise on this.

The Challenge

Making the UK a leading high tech exporter requires aptitude: a talented workforce, an inspirational education system and effective research. It requires the right resources: supportive financing and incentives to innovate. But it also requires the right attitude. If changes proposed are to be effectively implemented, it will require the will to make them work. This can only come through fostering a culture of understanding and appreciation for science and engineering in the UK: in government, education, industry, media and the British public.

The UK has a great tradition of science, engineering and invention; new ideas were the driving force behind industrial and wartime Britain. Brunel and Stevenson are British icons. This ingenuity and potential still exists today: in the buildings and bridges of Wilkinson-Eyre; Formula One cars of Williams and McLaren; the high tech submarines of BAE; and the pharmaceutical breakthroughs made at GlaxoSmithKline and Astra Zeneca. UK companies and universities are alive with many other compelling examples of high tech ingenuity.

Yet despite these examples, the public perception of science and engineering is of geeks and mechanics. The achievements of scientists and engineers are rarely recognised or sufficiently commended. Unsurprisingly, this continuing misconception does not inspire young people to study these subjects, nor does it encourage high tech companies to flourish in our economy.

If the UK is to capitalise on its strengths as a high tech exporter, it needs to change the perception of science and engineering. This cannot be done overnight. Policies are important, but a new government should first set the tone of the debate and signal a real commitment to science and engineering.

The Evidence

Science and engineering have become progressively less valued and understood since 1945. People struggle to define what it means to be an engineer.[5] Only 4% of teenage girls are interested in training as engineers and 14% as scientists compared to 32% who want to be models.[6]

While Lewis Hamilton and Jensen Button received the plaudits for winning Formula One titles, it was their British engineering teams that developed the technology that secured victory. Apple's iPhone is a consumer phenomenon – but it's not widely known that much of its technology is designed by British companies. In fact, the MP3 player was invented thirty years ago by a British innovator, Kane Kramer.

Young people's perception of engineers and scientists would be comical if it were not tragic. Look at the national stereotypes. Scientists are egghead lab-coated geeks; engineers are metal-bashing factory workers or mechanics fixing broken appliances.[7] It's no wonder careers in science and technology are deemed unappealing by both parents and their children. By contrast, countries like the USA, Germany and France hold these careers in much higher esteem. A 2009 Harris Poll found that the USA public thought being a scientist was the second most prestigious occupation while engineers were 9th – scoring significantly higher than lawyers, Members of Congress, athletes and entertainers.[8]

The problem is not confined to the school playground. Many parents have no idea of the value and excitement of science, technology, engineering or maths careers – they assume that to succeed, their children must become bankers, lawyers or accountants (probably in that order). We must add engineers and scientists to that list.

But even more worryingly, this lack of understanding is shared by too many of our leaders and policy makers, as well as many in the media. The James Dyson Foundation experienced this when it tried to establish a school for 14-19 year-olds, focused on engineering and science in Bath. Its efforts were constantly rebuffed by bureaucrats despite the strong support it enjoyed from local Head Teachers.

Media reporting on manufacturing is weak. While high street sales and UK bank profits are important, they are not the sole barometers of UK economic success.

[5] Royal Academy of Engineering and the Engineering and Technology Board, Public Attitudes to and Perceptions of Engineering and Engineers (2007)
[6] New Outlooks in Science & Engineering (Noise) survey cited in The Guardian, 3 October 2008
[7] Royal Academy of Engineering and the Engineering and Technology Board, op. cit.
[8] Harris Interactive Poll (August 2009)

This is not to criticise science coverage in the media (The Times' Eureka supplement and the BBC's 'Bang Goes the Theory' are two recent examples of new, mainstream science reporting), but it does highlight that the media rarely links high tech to economic success.

The Way Forward

British science and engineering is world class. But the good work in our laboratories, factories and research centres is not being sufficiently communicated. In their annual Skills Surveys, the Institute of Engineering and Technology (IET) asks employers what needs to be done to address skills shortages in engineering. For four consecutive years, the top response from industry is 'improving the image and profile of engineering'. It needs a concerted effort to boost the public image of these subjects.

As Ian Taylor noted in his review in 2007, government must take science and engineering seriously. It must lead the change and show that wealth creation – economic and social advancement – can occur through long-term investment in technology and those people developing it. By doing so, more young people will be encouraged to study science and engineering and become the entrepreneurs that are vital for the future of the UK as a high tech economy.

Getting the language right

A Conservative government should focus first on using the correct language when referring to high tech companies – to instil public confidence and awareness. Talk of "post-industrial Britain" or "creative industries" should end. Design is not simply aesthetics; it's the rigorous process that links new technologies to business – creating things that work properly. And manufacturing isn't just assembly; it's intellectual property, technology, design and specialist engineering. Creativity exists in all sectors, not just media, fashion and art. It's high tech and high value. And it's essential to both our economy and society.

But it requires more than rhetoric. Ministers, MPs and civil servants must champion British science and engineering both at home and abroad. There must be a clear understanding of each sector of the economy where we have a chance to lead internationally (such as aerospace, defence, pharmaceuticals or nuclear). This must be applied to language and actions - each Cabinet Minister should contribute to the debate on improving science and engineering. Proposals in this report should only be viewed as the beginning of the development of a comprehensive policy framework where science and engineering are woven into the fabric of government activity.

Commitment to fast decision making on infrastructure

It is essential that a new government is clear and vocal about its upcoming infrastructure, technology and manufacturing requirements and that it makes early and bold decisions on large projects. The government is in a unique position to stimulate innovation and generate growth through infrastructural investment and it should take full advantage of this. Plans for high speed rail are an example of how a government initiative could set a vision for industry and academia to follow. This long overdue upgrade will help put Britain on a par with its competitors and provide significant stimulus to the individuals, companies and industries responsible for the project.

Endless discussion and indecision on the costs and benefits can needlessly delay essential projects. Assertive, forward looking action is required. The French nuclear industry is a good example: at the time of Chernobyl the French took a lonely path ploughing ahead – now they are reaping the rewards, exporting both power and expertise.

Championing success

Good high tech products should be celebrated. A new government should work with high tech businesses to make sure the right stories hit the headlines. Projects like HMS Astute submarine and the UK engineered Bloodhound, the world's fastest car, are examples of British ingenuity that should be widely publicised and lauded by ministers.

We need leadership and agreement amongst the diverse institutions, industries, universities and royal academies to present a coherent, collaborative and convincing message – that can be marketed to the British public and media. In 2004, the current government set up the STEM programme, assigning specific actions to different government departments, as well as bodies like the Royal Academy for Engineering. Given the right support from communication professionals, actions like the STEM ambassador scheme have the potential to provide a strong platform to promote the UK's cultural understanding of science and engineering.

A new government needs to ensure the message is reaching people, with a senior cabinet minister convening the various different interested STEM bodies to:

- **Coordinate initiatives:**

  Get the buy-in of the major UK engineering and science firms, charities and organisations: use the skills of their PR and marketing professionals. Continue to streamline initiatives. Encourage more proactive engagement: promoting free resources and activities.

- **Develop role models:**

  Ensure young engineers and scientists are trained as STEM ambassadors for use beyond education (like the Science and Engineering Ambassadors scheme run by STEMNET) – reaching out to the media, parents and the wider public. Encourage high profile industry leaders and TV personalities with STEM backgrounds to front campaigns.

- **Communicate great stories:**

  Work with broadcasters like the BBC and Channel 4 to promote great British science and engineering stories, both historic and contemporary. The aim is to help children and parents understand science and engineering, without oversimplifying.

- **Make science and engineering a product:**

  Science and engineering needs to be made relevant and tie in with contemporary issues that will make an impact on their future, like robotics and climate change. Support industry and SMEs in a coordinated approach to public engagement work, particularly with local schools.

The Design Council

A future Conservative government should review the funding, objectives, and impact of the Design Council. In an age where design is celebrated in the windows of Selfridges to the headquarters of large multinationals, the role of the Design Council in promoting good design is difficult to pin down. With the Design and Victoria and Albert museums both running excellent design education programmes, practical assistance for designers and engineers is more likely to be useful. For example, activities to help design and engineering students commercialise their products through incubators – a successful model pioneered by the Design London programme. The Council's role in delivering these sorts of programmes should be examined.

Engineering prize

Celebration of achievements will undoubtedly stimulate cultural interest. The Stirling, Booker and Turner prizes, in architecture, literature and the visual arts respectively, are effective promotional tools: creating awareness and understanding of subjects often outside mainstream debate. A new government should consider setting up a major national prize scheme for engineering, or better yet, work with established STEM bodies to raise the profile of existing engineering prizes such as the Royal Academy of Engineering's MacRobert Award.

A good prize will take time to establish itself and government would need to be prepared to start small and learn from early mistakes. Key design aspects to consider include:

- **Be people and project focused**: like the Stirling prize, the interesting stories are the projects, but there has to be a human interest too.
- **Be supported by strong communication** including a central website and educational links. 'Important' engineering projects are not necessarily immediately interesting to the public. Ideally this would involve a media partner, rather than simply industry, to give it profile (as with National Lottery's Living Landmarks: The People's Millions, which was broadcast on ITV in 2005).
- **Be suitably supported by a large prize fund** and funding for logistical support.
- **Provoke debate**, like the Turner prize.
- **Have a strong philosophy** behind it. This could be Dyson's problem-solving approach.
- **Consider the long-term.** The Stirling Prize judges new buildings, which haven't had the chance to establish their worth. This engineering prize could look at a project that, through problem solving, has done the most to make an environment substantially better.

2

Education:
Getting young people excited about science and engineering.

Almost one in four secondary schools in England no longer has any specialist physics teachers.
University of Buckingham.

James Dyson:

Making wonky matchbox holders in woodwork lessons didn't inspire me to pursue a career in design and manufacturing. I discovered engineering by accident at the Royal College of Art. And I was hooked.

At Dyson, we have a team of young, dynamic and creative engineers, developing new technology. I look for a particular type of engineer: a polymath, a 'hands and brains' person.

'Hands', in that they can solve problems, have no fear of failure, and follow their theories through into practice by actually making things. 'Brains', in that our best engineers and scientists have the theoretical and scientific foundations to inform their work. And the intelligence and creativity to follow a logical course of development.

But it is getting harder to find these people. Why? Science teaching has been compromised and arguably watered down, and Design and Technology in schools has been marginalised (it was made non-statutory in 2004). Over the past two decades, young people have flocked to fashionable subjects such as media studies and sociology, leading to increasingly disappointing numbers of graduates in the STEM subjects.

Halting this migration from science and technology must start in schools and continue at university and beyond. Without long-term change, we will be failing to offer our young people the education they deserve, and the higher salaries that come with STEM training. And fundamentally, we will be failing our economy which needs STEM graduates to exploit the opportunities of high tech.

In schools and colleges, we must focus on great teachers and great curricula. We can do this by:

- Teaching real science, not quasi-science courses. Seek to ensure every state school offers triple science courses: physics, chemistry and biology at GCSE level. And teaching Design and Technology courses which demand creative responses and are technologically rigorous.
- Harnessing the knowledge of mid-career professionals through the Conservatives' 'Teach Now' programme. Providing our schools with subject specialist teachers by encouraging our top STEM graduates to go into teaching by paying off their student loans and offering competitive salaries.
- Using the expertise and goodwill of independent schools through reform of the Independent State Schools Partnership.
- Promoting technical qualifications and apprenticeships as a route to better jobs and degrees.

At universities, we must attract more students into degrees in STEM subjects and then encourage our talented young scientists and engineers to stay on track for careers in these fields. We can do this by:

- Attracting more students by offering industry scholarships to engineering students and, in the short-term, ensuring that we allow our high tech companies to recruit the best of the foreign STEM graduates and postgraduates from our universities rather than forcing them to return home after their studies.
- Encouraging more internships and placements so that students and researchers gain hands-on experience of the technologies used by industry, better preparing them for the world of work.
- Exploring radical reform of university funding and assessment to give universities the flexibility and freedom to develop courses tailored to the needs of their students. We don't treat students as one homogenous mass, so why do we do this with universities?

The Challenge

The desire to increase the number of STEM – science, technology, engineering and mathematics – graduates is not new. Over thirty years ago, the Finniston Report urged immediate action to increase the supply of engineers. It did so because Finniston and others realised that STEM graduates are wealth creators in our economy – whether through the higher wages they earn, the high tech start-ups they establish or the valuable skills they offer companies outside the high tech sector.

The analytical and numerical skills derived from a STEM education are highly valued by employers. So much so that leading management consultants, like McKinsey & Company, actively target engineering graduates at leading universities. The City of London is awash with physics and maths graduates. The value of engineering graduates is reflected in the fact that over their lifetime they earn more than all other graduates, apart from doctors.[9] Beyond this, grounding in STEM subjects is vital in an age where technology pervades all aspects of life. The physicist and novelist, CP Snow foresaw this, arguing that those in government cannot make informed, crucial scientific decisions without foundations in scientific training.[10]

Currently the need for more STEM graduates is most starkly seen in the field of engineering, where there is a serious skills shortage, with 43% of companies finding it hard to attract the right graduate recruits.[11] This situation is likely to become worse as the proportion of engineers requiring degrees is predicted to increase to 47% in 2017 compared with just over 32% in 1987.[12]

There has been heavy investment in education in recent years, with mixed results. Examination of the pipeline of STEM graduates does not engender hope for the future:

- Schools and colleges: The scientific performance of students in UK secondary schools was described as being considerably above the international average in a major study by the OECD. However, our place is slipping – since 2001, the UK has dropped from 8th to 12th place in Maths, and from 4th to 14th place in science.[13] We also have real problems attracting students to study STEM subjects. The number of young people taking A-levels in Chemistry, Biology and Maths has not increased significantly over the past ten years. In England, the numbers taking A-level Physics fell from just under 30,000 in 1992 to 24,730 in 2006. These sharp falls now appear to be halting.[14] Even so, just one in ten pupils from maintained schools achieved a single pass in an A-level science subject.[15] Equally there is an immediate need for qualified technicians. We already have a far smaller proportion of technicians in high tech companies than our European counterparts, a situation compounded by a high level of unfilled positions in industry – 71% of current vacancies in engineering are for professional technician and process operative roles.[16] Engineering UK 2009/10 highlights declining numbers of technicians up to 2004. Since then numbers have started increasing – we must ensure that this continues.
- Universities: In the past five years, there has been a 16% increase in the number of students taking first degrees in the STEM subjects, and a 35% increase in students getting masters degrees. However, this overall trend disguises a more worrying trend concerning UK students. More than a third of this increase in STEM undergraduates has come from overseas. In engineering, the trend is more dramatic, with the number of UK engineering undergraduates actually falling.

To a large extent, the STEM agenda has also ignored its silent D (design). Used as a tool to make products a reality, design links engineering to business. At school level, Design and Technology should receive the same priority status as Science and Maths. And in higher education, it must receive the same preferential funding treatment by the Higher Education Funding Council for England (HEFCE) as Science and Engineering. Dr Paul Thompson, Rector and Vice-Provost at the Royal College of Art:

> *To cast academic disciplines within such rigid and artificial moulds does not mirror the way in which technologists, engineers, and indeed scientists work these days. Very often it is in close concert with designers, architects, automotive designers, industrial design engineers and software designers.*

Beyond the numbers of graduates and technicians, there is also an issue of quality – specifically,

[9] Universities UK/ PWC, The Economic Benefits of a Degree (2007)
[10] CP Snow, Science and Government (1961)
[11] IET, Engineering & Technology Skills & Demand in Industry Annual Survey (2009)
[12] Engineering UK, Engineering 2009, (2009)
[13] OECD, Programme for International Student Assessment (2007)
[14] House of Commons Science and Technology Select Committee, Third Report (2002) and data from jcgq.org.uk.
[15] Adrian Smith, Developing the STEM Agenda (2009)
[16] Department for Business Innovation and Skills, Skills for Growth, (2009)

recruiting graduates and technicians with the skills companies need.

A singular focus on improving both the quantity and quality of STEM graduates is required. This can be delivered by tapping into the innate curiosity of children. It will mean taking positive action from schools to universities. Reform needs to encourage more students to study STEM subjects, through the provision of better careers information and appropriate incentives. Finally, we need to ensure students are learning the right mix of skills. Quality of STEM teaching needs to be improved through the adoption of a 'hands' and 'brains' approach – ensuring that students are skilled at making things and have a good grasp of the underlying theory. All of this needs to be delivered by a new cadre of motivated, subject specialist teachers.

A. SCHOOLS AND COLLEGES

Great Teachers: The Evidence

In their McKinsey report on top-performing schools, Michael Barber and Mona Mourshed highlighted how the quality of an education system cannot exceed the quality of its teachers.[17] Students placed with high-performing teachers consistently progress three times faster than those placed with low-performing teachers.[18] And low performing school systems rarely attract good teachers.[19]

England suffers from both a teacher recruitment shortage and large number of poor quality graduates.[20] Government figures show that Maths and Science continue to have higher teacher vacancy rates than other subjects.[21] Good quality graduates, as well as individuals with work experience, must be recruited to reduce these shortages.

Many of our teachers aren't subject specialists. Almost one in four secondary schools in England no longer has any specialist Physics teachers.[22] Less than half of recently qualified Maths teachers has a degree in maths, only 41 per cent has a 2:1 or better in any degree, and 16 per cent had a third class degree or worse.[23] Science teachers who aren't specialists have been found to be far more likely to adhere to schemes of work tailored to passing examinations – to the detriment of creative and inspirational teaching.[24]

Steps taken by the current government have had some impact. Teach First – a programme targeting top graduates into teaching in inner city schools for at least two years – is a successful campaign, which the Conservatives have already pledged to expand. The number of accepted applicants for initial teacher training courses in STEM subjects has also increased as a result of golden hellos for new teachers – by 7.7% for Science courses and 32% for Maths courses between 2008 and 2009.[25] However, there is a considerable way to go. In 2008, only 77% of Maths, 86% of Science and 61% of Design & Technology PGCE training places were filled.[26] The increase in the numbers in training must be maintained if we are to reduce the shortfall, but we must ensure we accept only the brightest of applicants.

Therefore, the first priority of a new government should be to ensure that the right teachers are being recruited and developed.

Great Teachers: The Way Forward

People go into teaching primarily because they want "to help a new generation succeed in a world in which skills and knowledge are crucial to success." For professionals and senior managers coming from other professions, salary was seen as the main deterrent to becoming a teacher. Other major deterrents included safety in the classroom and teacher morale.[27]

These findings form the basis for action. The recent Conservative Party proposal to **repay student loans for the best STEM graduates who go into teaching**, is welcome. As is Michael Gove's proposal to take this approach further with the introduction of **Teach Now**, a fast-track programme similar to Teach First for high calibre experienced and retiring professionals. As well as the promised creation of an online fast track application system, removing bureaucracy and getting teachers straight into schools, in the first instance, Teach Now should target senior STEM professionals – the success of the Teach First campaigns demonstrates how this can be done. This should be coupled with attractive salaries and a continuation of the existing 'golden hellos', with the removal of barriers to entry such as formal in-university training and micromanagement in schools. For areas with significant difficulties, like Physics, a new government should seek to **ensure that Head Teachers are using flexibility in pay to recruit teachers with Physics degrees.** To monitor progress on recruitment, the Department for Children, Skills and Families and Ofsted should examine whether they can publish statistics for individual schools on the number of STEM teachers with relevant degrees.

Making recruitment routes more flexible will yield results in the medium-term. In the short-term, a new government should seriously consider how the independent sector can support the maintained sector. There is much to learn from the successful model pioneered at London's St Paul's School. St Paul's acts as a centre of excellence, where young, inspiring Mathematics teachers are released to spend a small portion of their timetable running extension classes for the most able local state school children. These classes don't teach to the national curriculum, but inspire in the children a passion for the subject, and an interest in pursuing it beyond GCSE and

[17] McKinsey & Company, How the World's Best Performing Schools Come Out on Top (2008)
[18] Ibid.
[19] NCEE, Tough Choices or Tough Times (2007)
[20] Policy Exchange, The Labour Market for Teachers 1997-2008 (2008)
[21] Full-time classroom teacher vacancy 1 rates in local authority maintained secondary schools by subject, 2009. (DCSF)
[22] University of Buckingham, Physics in Schools IV, Supply and Retention of Teachers (2008)
[23] Hansard, 13 October 2009: Col 868-870W
[24] Lyn Haynes, Studying STEM: A Literature Review of the Choices Students Make (2008)
[25] Graduate Teacher Registry, Provisional end of year applicant acceptances
[26] Policy Exchange, More Good Teachers (2008)
[27] Ibid.

A-Level. A Conservative government should **review the functions and impact of the Independent State Schools Partnership**, and prioritise funding towards STEM programmes. A programme such as that run by St Paul's should first be piloted, and if successful, implemented nationally. At around £5,000 per independent school per year to fund the wages of cover staff, the programme would be cost effective, and have immediate impact in enthusing young people to study Maths and Science.

The McKinsey report[28] highlighted how successful education systems first identify the right people to become teachers and then develop them. Great individuals are the place to start, but professional development is vital to keeping teachers up to date, motivated and invigorated. In the short-term, it can radically improve the standard of teaching in schools, and longer term, support teacher retention. A new government should **review the national provision of teacher training for STEM subjects, especially Design and Technology**, to ensure all teachers can refresh their basic training and learn of the latest advances in industry and academia. A report from the Wellcome Trust[29] noted that half of the secondary science teachers interviewed had not participated in any subject-specific CPD (continuous professional development) in the previous five years. The model employed by the National and Regional Science Learning Centres is working well, but the Design and Technology programme is currently under-funded – relying on the generosity of a small number of funders such as the Gatsby Charitable Foundation and the Royal Academy of Engineering.

Great Curricula: The Evidence

To maintain and increase the UK's competitiveness in STEM education, a Conservative government will need to look at how science, design and engineering is taught in schools.

Science

From its inception in 1951, the take-up of O-level Physics increased more than eightfold to 1989. However, following the introduction of combined science GCSEs, it has fallen back to less than a quarter of its peak. The Royal Society of Chemistry has described the devaluation of the GCSE science syllabus as 'catastrophic'[30]. While all pupils in maintained schools now study some Physics as part of science, fewer specialise than in the past. The switch from GCSE Physics has occurred mainly in comprehensive schools.[31]

Students in independent and grammar schools are more likely to take A-level Physics (14.4% and 10.2% respectively in 2004) than those in comprehensives (6.2%) or sixth form colleges (4.0%). And second year sixth formers in independent schools are 52% more likely to read Physics at university than those from comprehensive schools.

Design & Technology, engineering and vocational routes

The greatest shortages in UK engineering industries are within the technically skilled areas; with 71% of vacancies from the skilled trade, professional and technical occupations and process operative roles.[32] It's clear that the school system needs to better deliver young people who are able to solve problems and create solutions – practically. In his speech to the RSA, Rolls-Royce CEO, Sir John Rose said:

> *In Britain, we must revisit past decisions and recreate technology colleges or their equivalent to improve vocational learning. Their curricula must be defined by industry's needs and provide the sort of well-educated workforce that can support the high value activities of the future.*

Design & Technology, the Engineering Diploma, apprenticeships and vocational courses at Further Education centres can all help young people find their way into engineering careers, at technician or

[28] McKinsey & Company, How the World's Best-Performing School Systems Come Out on Top (2008)
[29] Wellcome Trust, Believers, Seekers and Sceptics: What Teachers Think About Continuing Professional Development (2006)
[30] The Daily Telegraph, 26 November 2008
[31] University of Buckingham, Physics in Schools and Universities, II. Patterns and Policies (2006)
[32] Engineering UK, Engineering UK 2009 (2009)

chartered level. These courses also provide the UK with young people who are technologically literate – essential to an advanced technological society.

Practical lessons

STEM lessons are also becoming less and less practical, due to health and safety fears, and they are consequently less engaging. Professor Sir John Holman, Director of the National Science Learning Centre, believes that trainee teachers spend too little time preparing exciting experiments:

> *There is much less practical work now because of a huge focus on exams. Schools are so aware of health and safety — they will say, 'That's too dangerous.'*

Both Professor Holman and David Phillips, Emeritus Professor at Imperial College believe that without the stimulation produced by making elements combust and fizz, pupils won't continue science beyond GCSEs. "All the evidence points to practical work being the thing that pupils like to do," Prof Holman said. "This isn't about how do you get more Grade Cs in GCSEs, it's about how you inspire more young people." [33]

The STEM curriculum as it's currently taught doesn't always engage young people – who often don't see the practical application of what they're learning. The fall in popularity for the physical sciences is partly due to "a curriculum that is often perceived by students as being too theoretical and not relevant." [34]

Great Curricula: The Way Forward

A Conservative government must **reform the curriculum to teach pure science**, rather than 'How Science Works' or 'Science for Citizenship.' Reform of curricula is never quick or easy to implement, particularly if results dip in the short-term. However, it is vital if we are to ensure that schools teach the theory well and engage students with exciting practical experiments. All state schools should be expected to offer separate science GCSEs – and these courses must be rigorously assessed. Clearly, having high calibre, subject specialist teachers is fundamental to success of this policy.

Successful reform of the curriculum can occur only if health and safety concerns are challenged and addressed. Former Conservative trade secretary Lord David Young is leading a review into how the health and safety culture could be curbed. It should include the Health and Safety at Work Act being amended to ensure the danger of prosecution does not put teachers off from encouraging children to engage in adventurous experiments.

Allied with these reforms, a new government **must emphasise the validity of technical and academic skills, regardless of age or level, as a route to better jobs and degrees.** We welcome the Conservatives' commitment to expanding and improving the apprenticeship programme so that all 14-16 year olds have access to genuinely vocational qualifications. This would involve funding 30,000 places a year (compared with the present 10,000) and allowing schools to offer self-funded places if there is demand beyond 30,000 places.

The Conservative plan to build a new University Technical College in each of the 12 largest urban areas in England, with the long-term ambition to have one in every area of the country, is a good one. These high tech academies would raise the status of technical qualifications, boost Britain's science and engineering base, and provide real choice for parents and young people. These Colleges would be funded from within the £4 billion set aside for new Academies from November 2009 – 2013.

A Conservative government should also **support the Engineering Diploma.** The qualification has been welcomed by the Royal Academy of Engineering and the Institute of Engineering and Technology as a vocational qualification more likely to provide students

[33] School lab health and safety rules could stop future scientists, The Times, October 5, 2009
[34] Shell Education Service, Learning to Love Science (2008)

with a better understanding of industry. This Diploma is also recognised as a valid route into engineering degrees by elite universities, such as Cambridge. Launched in 2008, it has not yet been given an opportunity to prove itself fully, though an initial report from the Institute of Engineering and Technology is extremely positive.[35]

B. UNIVERSITY EDUCATION

Quantity of STEM Graduates and Postgraduates: The Evidence

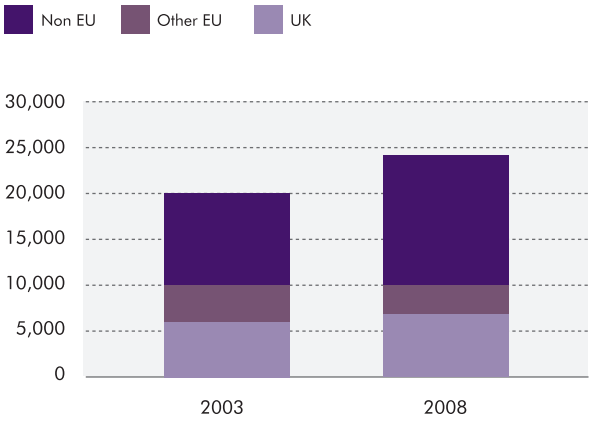
Whilst the overall number of applications for STEM subjects at university has started to grow again, this increase has lagged behind overall student growth, and significantly behind growth in social sciences and communications subjects.[36] From 2003 to 2008, all STEM subjects showed annual growth of 1.6% with engineering first degrees having marginally lower growth of 1% – compared to 3% for all subjects, 5% for social studies and 6% for media studies.[37]

Postgraduate education is particularly important in STEM. It offers a significant route to industry, as well as producing the next generation of lecturers and researchers.

While overall numbers of STEM PhD students have risen over the past ten years, the trend masks some significant problems. Engineering and technology doctorates have risen by an average of 2% per year, but the number of overseas postgraduate students has risen much faster. This is likely to mean that in engineering, the number of UK-resident PhD students has more than halved.

If all postgraduate degrees are considered, the picture is even starker. Students from outside the UK now make up more than 70% of all engineering and technology postgraduates. Although their numbers have risen by almost 20% in the last five years, the growth has almost entirely been made up of overseas students. In other words, of the additional 3,825 students in postgraduate engineering education in 2008, only 70 came from the UK (Figure 2).

Figure 2 Engineering and technology postgraduates, 2003 and 2008



[35] The Institution of Engineering and Technology, Transforming Engineering Education (Sept 2009)
[36] Higher Education Statistics Authority (HESA)
[37] Higher Education Statistics Authority (HESA), STEM subjects excludes medicine and veterinary

Quantity of STEM Graduates and Postgraduates: The Way Forward

The lack of UK engineering students and the recruitment problems that this causes are serious problems for the UK economy. Although the additional earnings potential of an engineering degree is second only to medicine, this message is not getting through to students choosing degree courses.

Engineering and technology are the most popular subjects at universities for international students, with around 24% coming from outside the EU in 2007/08.[38] This attractiveness of our engineering courses is a great indicator of their quality, but overseas students frequently take their knowledge and expertise back home, setting up in direct competition with British firms. The benefits of keeping overseas students in the UK when they graduate are apparent from studies of migration in the USA where the number of foreign born migrants creating high tech start-ups and registering patents has grown dramatically.[39]

In the last academic year, 42,000 students from outside the EU obtained visas to stay on after obtaining a degree through the Post-Study Work Route of the immigration system. This route is now being re-examined by the Migration Advisory Committee, with a view to restricting the institutions and types of degree eligible. If the system becomes more restrictive, we could have a significant economic cost if we fail to keep the best overseas STEM students in the UK after their graduation.

The need for increased numbers of STEM graduates and postgraduates requires bold thinking from a Conservative government. Short-term policy actions such as encouraging overseas graduates to stay in the UK need to be combined with longer term initiatives to increase the overall numbers of UK students studying STEM subjects, particularly engineering. Immediate action to improve the attractiveness of STEM subjects at A-level will deliver more STEM graduates in the medium-term.

The first step needs to be to improve the **quality of careers advice to all students and school pupils**, and the Conservative proposal to ensure students get information on routes into STEM subjects is welcome. Expecting 16-year-olds to make informed decisions without providing them with a basic level of information is negligent. Improved careers advice at school needs to be founded on better information from universities. This should include data on the average salaries following graduation for each subject area, as well as the range of careers that graduate leavers have reported.

Beyond school, we need to attract more engineering students by **offering widely available industrial scholarships**, as soon as public finances allow. Offering golden hellos has been shown to be successful in recruiting science and maths teachers. The future demand for STEM graduates and postgraduates means that we must act now to ensure that we have the right skill set for our high tech companies to succeed.

With students in England now facing average debts of £23,000[40] (under the existing fees system), costs of doing courses have now become a real factor for students in deciding what course to select. The Government's own survey[41] reported that one in three students say their decisions about higher education were affected by the availability of funding and financial support and 25% of full-time students indicated that concerns over debt had nearly stopped them going to university.

The immediate focus should be on engineering, as this subject has the most serious recruitment problem. Offered through companies, these scholarships would have the following advantages:

- Increasing the attractiveness of engineering courses over others by offering a financial incentive to students.

[38] Engineering UK, Engineering 2009 (2009)
[39] Applied Research in Economic Development, Skilled Immigration and Economic Growth (2008)
[40] PUSH, Student debt survey (2009)
[41] Institute for Employment Studies and National Centre for Social Research, Student Income and Expenditure Survey 2007/08 (2008)

- Ensuring that industry has a strong voice in the way courses are designed and taught to the students they sponsor.
- Leveraging funding from industry towards the costs of these scholarships.
- They would be unlikely to distort the current funding mechanism beyond the current bias towards subjects like biology and geography.

The scholarship scheme could be modelled on the Institute of Engineering and Technology's Power Academy.[42] Under this initiative, energy companies provide students at seven universities with an annual bursary of £2,200 and a paid summer placement. For our proposed scholarship scheme, government would provide half the funding for the bursary, allowing industry funding to go further. Awareness campaigns and criteria, developed with industry, could target these scholarships to high achievers or those from less privileged backgrounds. For example, the scholarship could be used as an incentive for successful apprentices to move onto degree courses.

The alarming shortage of UK students taking engineering and technology postgraduate courses warrants further attention. Again financial incentives, potentially in the form of an enhanced postgraduate fellowship, need to be considered. Many UK engineering undergraduate courses now result in a Masters qualification. Therefore it may be more appropriate to target a fellowship at doctoral students who currently receive an annual stipend of £13,290 from the annual Engineering and Physical Sciences Research Council (EPSRC). It is important to recognise that the brightest students will have opportunities to study abroad, where they can earn $30,000 each year in Hong Kong, or command good starting salaries in industry. If the UK is to continue to attract the best home students to advanced research, increases to the EPSRC stipend to make it competitive with other options for engineering graduates must be considered.

In the short-term, we should seek to ensure that **routes for the best overseas STEM students to stay in the UK, such as the Post Study Work Route, remain open.** These individuals are highly skilled by definition. The key will be to ensure the best students have flexibility in choosing employers and that the visa system is more efficient.

The quality of the UK's STEM graduates and postgraduates has been vital for the ingenuity and enterprise of our high tech companies.

Quality of STEM Graduates and Postgraduates: The Evidence

In an era when India produces over 170,000 engineering graduates each year[43], the ongoing success of our high value-added companies relies increasingly on delivering STEM graduates, postgraduates and technicians of a very high calibre. In the UK this is critically dependent on universities continuing to deliver graduates and post graduates who have a firm grasp of the latest advances in theory and the know-how to apply this knowledge in an industry setting.

The Institute of Engineering and Technology (IET) argues that a shortage of adequately skilled candidates is one of the major barriers to recruitment over the next five years. In particular 25% of employers cite a lack of practical experience in graduates as their main weakness. This inexperience is also an issue for postgraduates with 17% of employers citing it as a problem.[44] Dyson has seen this trend first hand – compounded by an over reliance on computer software. The workforce is also very male dominated and as high performing companies are recognised to have a diverse workforce, this too is a problem.[45]

New challenges will require graduates to work in interdisciplinary teams.[46] GlaxoSmithKline seeks to sponsor interdisciplinary research to identify drug targets. For example, they are sponsoring a Cambridge University team drawn from members of departments of Psychiatry and Experimental Psychology and the Institute of Metabolic Science to optimise the early clinical development of new GSK medicines for obesity and addictive disorders. Graduates leaving universities will need to be well versed in working in such teams to prepare them for their careers.

[42] www.theiet.org/about/scholarships-awards/power-academy/
[43] Vivek Wadhwa et al., Issues in Science, Where the Engineers Are (2007)
[44] IET, Engineering & Technology Skills & Demand in Industry Annual Survey (2009)
[45] Ibid.
[46] NESTA, Technology Policy and Global Warming (2009)

Quality of STEM Graduates and Postgraduates: The Way Forward

Businesses value the graduate output of the UK highly but it is important that universities continue to respond to business's demand for high quality STEM graduates. The CBI reports that 35% of employers are dissatisfied with the business awareness of graduates[47], making those with business awareness or industry experience through an internship or placement highly prized.

Professor Christopher Snowden, President of the Institute of Engineering and Technology, and Vice-Chancellor of the University of Surrey:

> *The most valuable thing that universities produce is the people - not just undergraduates, but at all levels. This is the output that businesses most appreciate.*

The key to delivering improvements in the quality of teaching is the promotion of greater autonomy and competition for universities. This will allow individual universities to identify where their competitive advantage lies and develop courses to meet the needs of their particular set of students.

This cannot be achieved without **radical reform of how universities are funded and assessed**. In turn, this will require deep thought and analysis into the fundamental question of what public funding for universities is seeking to achieve. This is ever more pressing in an environment where universities are being asked to cover several different functions, and are attracting greater numbers of overseas students. Universities now have on average 10% of their student body drawn from non-EU overseas countries, with the figure getting as a high as 49% for some individual institutions[48].

A more flexible funding and assessment system for universities should make it possible for universities to offer a greater variety of course structures, and cater better to the variety of student and employer needs. This should result in a more diverse university sector – with individual institutions competing to offer shorter courses, more part-time provision and greater industry involvement in curricula and in providing industry placements. In particular, it could help develop three improvements in the types of courses on offer:

- **Shorter courses with real industry experience:**

  Internships or sandwich courses are an important way of incorporating industry knowledge into the student experience, but are increasingly hard to find. By combining a year of industry placement with two years of teaching, based on a longer teaching year (for example, with four terms instead of three, as pioneered by the University of Buckingham and other institutions), it would still be possible to achieve a full degree in three years whilst still accruing valuable industry experience. While not suitable for all universities, this could be an attractive course programme for some students.

- **Equivalent or lower Qualifications:**

  Most engineering degree courses last four years and culminate in an MEng. HEFCE currently regards this as a postgraduate qualification. Under current HEFCE rules, MEng students wishing to continue to pursue engineering at postgraduate level, for example on the Royal College of Art and Imperial College's successful Innovation Design Engineering programme, no longer qualify for funding for postgraduate qualifications. This has impacted the IDE course negatively, and greater flexibility in the funding system should recognise courses like IDE as providing a qualification higher than an engineering masters.

- **Courses designed with industry in mind:**

  Loughborough University has a customer-focused approach which it develops through close relationship with industrial partners. Dyson staff are involved in the engineering department's Industrial Advisory Committee, helping to shape course content. The committee forms a reliable feedback loop, ensuring that on more vocational courses, graduate skills and behaviours are meeting the needs of industry. In a freer market place, this sort of interaction can provide individual institutions with a competitive advantage. More universities need to develop courses directly with industry.

- **More courses which mix science and business:**

  The interdisciplinary nature of the 21st Century workplace also has important consequences for teaching at our universities. Forward thinking universities already encourage students and researchers to attend different courses and seminars and undertake research across disciplines. Design London seeks to stimulate joint research between designers from the Royal College of Art and engineers and business school students from

[47] CBI, Nord Anglia Education and Skills Survey (2009)
[48] Higher Education Statistics Authority 2007/08

Imperial (see box below). Arrangements like this could be important in preparing our future engineers for work in industry, and our future business leaders with a firm grasp of science and engineering.

The underlying principle of reform needs to be giving universities the freedom and flexibility to identify what students and industry want. Under the current system, the number of students the leading universities can teach is capped with penalties imposed for exceeding your quota. Equally the university assessment framework – the Research Assessment Exercise (RAE) – perversely incentivises all universities and teaching departments to undertake some level of research even if this would not be the core activity for a teaching department. Flexibility to offer courses of varying lengths is also restricted. While the RAE will need to change, these changes will not themselves necessarily provide the right incentives for some universities to specialise in teaching or research. Therefore options such as a high quality vocational STEM teaching accreditation scheme may need to be considered as part of wider reforms. The university assessment system and suggested changes are discussed in more detail in the next chapter.

Additionally it will be important to consider how changes in funding, assessment and other incentives impact on what universities seek to do. The current system incentivises all universities to pursue both research and teaching. Changes in the RAE will not necessarily provide the right incentives for some universities to specialise in teaching or research. Therefore options such as a high quality vocational STEM teaching accreditation scheme may need to be considered as part of wider reforms.

Funding will also need to follow the wider aspects of reform. Knowledge is most effectively transferred between universities and businesses through placements and recruitment.[49] Incoming graduates, postgraduates and researchers are a critical driver of innovation within businesses. An increased emphasis on internships and placements can be achieved by:

- Examining how funding could be better targeted through the Technology Strategy Board (TSB) **for postgraduate and postdoctoral placements into industry.** Currently Knowledge Transfer Partnerships place researchers into businesses to conduct research there, generally for a year or more. They are very highly regarded by businesses that participate, but are currently limited to around 1,000 places.
- **Working with industry to identify how undergraduate internships in industry can be promoted.** There are benefits for the student, company and university in developing internships. Companies paying undergraduate interns are more likely to use them effectively and deliver a rewarding experience for the undergraduate. A new government should seek to identify where there is greater scope for industry financed internships, how this can be capitalised upon and where co-investment from government would increase the number of internships.

[49] Cambridge: MIT institute, UK PLC: Just How Innovative Are We? (2006)

DESIGN LONDON – INNOVATION AND INCUBATION

Design London blends design represented by the Royal College of Art, engineering and technology represented by Imperial College Faculty of Engineering and the business of innovation represented by Imperial's Business School to share knowledge and create new businesses. Funded by NESTA and HEFCE, Design London is clustered around four strands of work: education, research, incubation and an Innovation Technology Centre.

- Education: Teaching promotes the sharing of knowledge between postgraduate students at the RCA and Imperial.
- Research: Exploration of how design can be integrated more effectively with business and technology.
- Incubation: A facility has been developed to enable entrepreneurial graduates, from the RCA and Imperial, to hone and develop their ideas in a multi-disciplinary environment. The range of skills contained within Design London will provide unique support and the chance of unexpected collaborations between different disciplines, organisations and places.
- Innovation Technology Centre: The Centre is home to world leading design, visualisation, modelling and rapid prototyping technology, helping students and partners to maximise their innovation capacity through simulation exercises, digital tools and facilitation.

Links across industry and academia foster conditions for creating world beating products and services, ensuring London stays at the cutting-edge in a competitive international field.

Initiated in 2008, Design London has already led to a better understanding of how different disciplines can work together – establishing a new way of incubating companies. Although it is still in the early stages of development, three incubated companies are already showing signs of success, all expected to exit successfully from the incubator. A Conservative government should learn the lessons from Design London over the next year to examine how the model can be applied to other universities, courses and incubators.

3 →

Exploiting knowledge: Collaboration, not competition, between universities, companies and not-for-profits.

We have the raw material.
Nobel Prize winners:
116 – UK
320 – US
The US population
is around five times the
size of the UK.

James Dyson:

Britain has historically led the world in scientific knowledge – most of it generated in universities. Cambridge, one of our best engineering universities, celebrated its 800th birthday last year. Our researchers are internationally renowned for being the most efficient and productive in the world – and we're second only to the USA in the number of Nobel Prize winners we cultivate. There's much to be proud of.

I've seen this excellence first hand. It's one of the most exciting things about working at Dyson. Newcastle and Cambridge universities are helping us develop new technologies. You might not see or hear about them for years, but at the moment, I am confident that they are the most advanced in the world. The knowledge from university 'blue skies' research can eventually result in new applications and great products. But Britain needs to do more of this.

The challenge for a UK government is to harness the potential of breakthroughs in scientific research and – though it may sound 'impure' to some – use this potential to create products. To do this we need a flexible approach. Just as the best engineers are polymaths – creative, academic, scientific and practical – our system must develop its various strengths to meet diverse requirements. Universities must work with industry and investors to capitalise on our world-beating research and to accomplish the equally exciting task of commercialising ideas. Pure research on its own will not be enough.

And, what is the government's role? To help this collaboration flourish by providing an environment free from the barriers of adversarial negotiations over IP and short-sighted demands on universities to prove their impact.

I'm privileged to be involved in Design London – a partnership to bring together students from the Royal College of Art, Imperial Engineering departments and Imperial Business School. It is early days, but seeing the results of these disciplines working together is exciting.

As Sir Chris Gent, Chair of GlaxoSmithKline, has stressed: "Removing barriers to cluster development and creating increased opportunities for movement of staff between industry and academia are both important measures. But as well as strengthening translation, we must not neglect 'blue skies' research, the stimulus for many useful industrial applications. Overall, the focus must be on excellence, providing increased support to those areas where the UK is globally competitive."

In the short-term, I believe we need to:

- Draw back on the plan to judge funding applications on the basis of their short-term commercial impact. Instead we should seek to promote collaborations between academics, industry and not-for-profits to allow an open exchange of ideas – whether this is done through research partnerships or having academics spend more time in industry.
- Signal a long-term commitment to blue skies research by maintaining funding through the research councils.
- Change the way knowledge transfer offices work to free up resource and aid researchers and entrepreneurs in and around the university.

Our work must be long-term. A Conservative government must take the first steps to help our university sector meet the challenges of the future by:

- Establishing new university/ industry institutes (similar to those in Germany and Japan) to promote collaboration in technology development. The focus should be on five or so centres capable of becoming world leaders in their fields.

The Challenge

Our universities are among the most highly regarded in the world, renowned for their world class research and excellent teaching. Our creative approach to science and engineering is highlighted by the fact that the UK has had 116 Nobel Prize winners, second only to the USA's 320 prize-winners from a population around five times the size.

The success of our high tech companies has been achieved through a combination of a good grasp of blue skies research, creative application of research and entrepreneurial spirit. Stimulated by the important policy steps outlined in the Sainsbury and Lambert Reviews[50/51], the UK has made much progress in each of these areas:

- UK researchers are the most efficient and productive researchers in the world according to leading scientific indicators.[52]
- Student numbers in the UK have grown rapidly over the last 10 years from 1.8m to 2.3m. This has not compromised teaching at our leading universities which have improved their positions in global university rankings.[53]
- Improvements have been made in technology transfer. However universities in other countries outperform the UK in applied research and its commercial exploitation.

Research is the basic starting point for all technological innovation. While the UK excels at basic research, there are often breaks in the chain of development that mean we do not fully capitalise on this expertise. Smoothing the transitions between the stages of technology development could enhance the ability of the UK to capitalise on our scientific expertise.

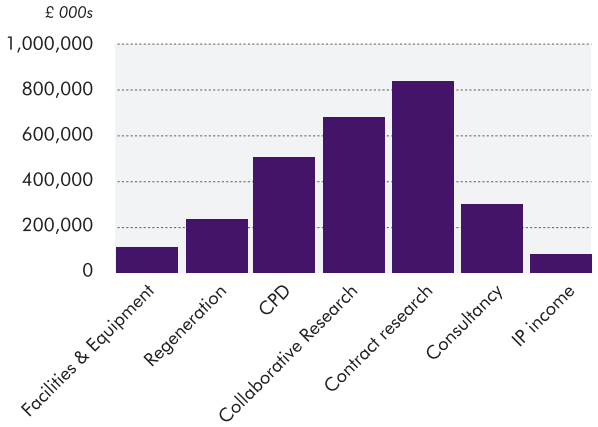
A Conservative government should protect the excellence of British research and encourage productive relationships with industry and not-for-profits. These goals need to be recognised as separate but complementary. The current system places perverse incentives on academics and technology transfer officers which need to be changed if universities are to continue to be a wellspring of ideas and knowledge.

The Evidence

Universities' approach to intellectual property highlights the current confusion over what they are being asked to deliver. Licensing and spin-outs are perceived to be the most important commercialisation work that universities can undertake. Statements from universities and government frequently quote patents and licensing as a measure of success in generating economic gains from research. This reinforces this confusion.

This emphasis on intellectual property (IP) is unhelpful. Income from patents and licensing represents only a small proportion of income generated by universities (see Figure 3). Access to patents represents a small part of why businesses choose to collaborate with universities, and IP is frequently cited as a barrier to collaboration by businesses.[54/55]

Figure 3 Total income from Knowledge Transfer activities [56]



Research

The proposed Research Excellence Framework (REF), which will form the basis for distribution of approximately £1.5 billion of research funding in 2009/10, introduces the notion of 'research impact' into the evaluation of research quality. The REF pilot requires academics to identify where they have built on research "to deliver demonstrable benefits to the economy, society, public policy, culture and quality

[50] HM Treasury, Lambert Review of Business-University Collaboration (2003)
[51] HM Treasury, The Race to the Top: A Review of Government's Science and Innovation Policies (2007)
[52] Department for Business, Innovation and Skills, International comparative performance of the UK research base (2009)
[53] Times Higher Education World University rankings (2009)
[54] Advanced Institute of Management Research, Examining the attitudes of EPSRC industrial collaborators towards universities' (2009).
[55] NESTA, Connected University (2009)
[56] Higher Education-Business Community Interaction Survey (2008), excludes spin-outs

of life". There is a risk that this becomes a fruitless, bureaucratic exercise which fails to recognise that the time lag between research and when it will make an impact can be impossible to predict. Even relatively 'applied' biomedical research, with a clear intended purpose, may find its application in an unexpected area.

The application of the full economic cost to research proposals has made the UK one of the most expensive places for industry to fund research. This can act as a major disincentive for companies seeking to sponsor research and can drive privately funded research to foreign universities.

Knowledge Transfer

Universities engage in a range of activities that disseminate the latest advances in the field to businesses, non-profits and government – in recent times, this has been termed knowledge transfer.

In the last few years, government funding has helped establish a knowledge transfer office (KTO) in almost every university in the country. Most KTOs are funded through the 'third stream' of HEFCE funding: the Higher Education Innovation Fund (HEIF)[57]. This funding is allocated based on academic staff numbers and knowledge transfer income, with an upper funding limit.[58] Some KTOs undertake valuable work to facilitate business uptake and commercialisation of research developed in university laboratories. For example, they provide back office support for collaborative research agreements with companies, co-ordinate industry networks, arrange training to businesses, and support student entrepreneurship.

However, the security of government funding has arguably engendered in KTOs a curious form of risk aversion when it comes to patents – their staff are often content to lose income rather than expose themselves to claims of failing to capitalise on a 'blockbuster patent'. This is evident in surveys where businesses complain of unrealistic expectations by KTOs in IP discussions.[59]

Good KTOs clearly divide commercial work from knowledge transfer work that has wider economic benefits, but does not generate profits for the institution. Meanwhile, ideas with significant commercial potential need careful evaluation, IP protection and commercial funding. This function can be successfully outsourced: the University of Glasgow works with the IP Group and industry partners to decide whether an invention is worth protecting with a patent. IP that doesn't have the potential to attract commercial funding is then made freely available. Similar outsourcing occurs through Imperial Innovations, a limited company working with Imperial College.

[57] Teaching and research are the other two 'streams'.

[58] http://www.hefce.ac.uk/news/hefce/2008/heif4.htm

[59] Bruneel et al, The Search for Talent and Technology: Examining the Attitude of EPSRC Industrial Collaborators Towards Universities (2009)

The Way Forward

Blue skies research is critical if the UK is to develop high value added industries, as is improved interaction between universities and companies. A Conservative government should seek to preserve the excellence of UK blue skies research, by maintaining funding levels through the Research Councils, whilst encouraging collaborative relationships between businesses and universities. This approach will require a coherent policy response focused on ensuring that academics, industry and university administrators have a clear set of objectives and the tools to deliver them.

Knowledge Transfer Offices

Universities are important sources of new ideas and improvements for businesses. There is a role for bodies within universities who ensure that businesses can make contact with relevant research groups, and that researchers are able to find commercial outlets for their ideas. Subsidies from government will be important to ensure that good universities' investment in teaching and research is not to the detriment of promoting knowledge transfer. However there is considerable scope for reform of the current system:

- **Concentrating on fewer offices.** Not all universities have sufficient research activity to justify a dedicated office. HEIF funding should focus on those offices with sufficient flow and a proven track record in knowledge transfer. Other universities should be encouraged to outsource or share resources with high performing offices. Exploitation of patents and other IP for commercial benefit should be measured on returns, and decisions should be informed by industry expertise. Equally knowledge transfer offices should seek to identify and promote best practice in the recruitment, training and support for university-business go betweens.

  This will free up resource for other important activities. For example, a portal that aggregates information on university research across the UK could be developed to make it easier for businesses to locate relevant research partners. Such a portal already exists for 13 Scottish universities. Similarly, offices could also be funded to help entrepreneurs emerging from postgraduate courses and the wider community to take the first steps toward realising a potentially valuable technology.

- Proof of concept funds are needed in order to undertake initial stages of development – in advance of securing commercial funding. This would bridge a significant gap between university research funding and commercial application. Scottish Enterprise already runs a similar fund[60], and Cambridge, Oxford, Imperial and University College London have previously collaborated to pool funding for this purpose. Funds should be drawn from current RDA budgets for innovation and combined with those of the Technology Strategy Board to deliver a nationally coordinated programme.

Improving collaborative research

A Conservative government needs to ensure that collaborating is a simple, straightforward and rewarding process for academics, industry and not-for-profits.

- **The current REF pilot is flawed and decisions should be delayed** until lessons can be fully learnt from the pilots. As part of this learning process, a new government should examine whether an element of the assessment should focus on measuring and promoting networks with industry, other UK universities or not-for-profits. This would develop real incentives for academics to spend time in industry and identify useful research projects which could be jointly funded. In some areas, collaborations could be more limited (e.g. pure mathematics) and this will need to be factored into the overall assessment framework.

- **Perverse contractual arrangements which prohibit or limit collaborations with UK based companies should also be removed.** Prohibitions often exist on the amount of time an academic researcher receiving a British research grant can spend with industry. This ignores the fact that no restrictions are placed on collaborations with international universities – both public and privately funded ones. This effectively allows companies in other countries to access and exploit ideas developed in the UK.

- **As part of measures to increase the autonomy of universities,** the case should be examined for universities being able to apply full economic costing or have freedom to set fees based on their own circumstances and the prices charged by their international competitors. Obviously the current fiscal environment and the challenges it poses to university funding may constrain what universities

[60] Scottish Enterprise Proof of Concept programme: http://www.scottish-enterprise.com/poc

can do over the next few years.

- New university/industry research institutions capable of becoming centres of excellence in a particular research field should be given government sponsorship. These institutions should provide space for interactions, promote staff moving between business and academia and allow sharing of expensive resources. Government funding could be matched by industry, with any VAT issues resolved in advance. The key to success of these institutes is that industry will work in partnership with leading universities to identify priority areas for research and bring commercial expertise in developing emerging technologies from these institutes. In the current fiscal climate, this proposal would need to be considered alongside other spending capital and revenue commitments on research centres. Professor Sir Peter Knight has said:

  Our industry partners have told us they would like to be able to identify experts who can provide solutions to their problems through a single, one-stop-shop, Centres of Expertise. We would argue for focusing funding for research on such centres through a 'hub and spoke model' with the UK's top universities at the heart of this model

MODELS FOR NEW RESEARCH CENTRES OF EXCELLENCE

The Rolls Royce University Technology Centres provide a template for new university-industry research centres of excellence. Rolls Royce has fostered a network of 27 centres worldwide, the majority in the UK. The centres each focus on a key technology and cover a range of engineering disciplines from hydrodynamics to composites. Rolls Royce has also invested in other partnerships, such as the UK Manufacturing Technology Centre in Coventry and the Advanced Manufacturing Research Centres.

Other models include IMEC in Belgium, which preserves proprietary IP, while sharing the benefits of generic innovations. IMEC also transfers a researcher from the industry partner to work with the internal team.[61] The Fraunhofer Institutes in Germany are well-respected public-private institutes that serve industry research and act as a valuable source of knowledge and new technologies.[62] The new Academic Health Science Centres (AHSC) and the evolution of a number of the UK's Public Sector Research Establishments (PSREs), such as Daresbury, provide a useful model for academic-public sector collaboration.

[61] http://www.imec.be/wwwinter/mediacenter/en/SR2003/docs/iiap_brochure/iiap_brochure.pdf
[62] Discussion with Jörg Überla, German venture capitalist.

LETTING UNIVERSITIES AND BUSINESSES LEAD IN DEVELOPING CLUSTERS

Clusters are local concentrations of companies and public institutions from a particular sector or group of sectors, often around access to shared expertise or facilities. The co-location – and repeated exchanges between organisations – promotes both competition and co-operation, and promotes innovation and entrepreneurship.

Clusters typically spring up around universities. The Cambridge high-tech cluster is one of the most admired in the world: a vibrant community of academics, investors and entrepreneurs. The cluster has taken more than 30 years to become established after early steps were taken by enlightened academics, investors and entrepreneurs in the late 1970s. There are other less well-known clusters in the UK. For example, a biomedical cluster has developed around Dundee which now employs 4,000 people and accounts for 16% of the local economy. The cluster began as a result of pharmaceutical companies seeking to collaborate with Sir Philip Cohen's laboratory.

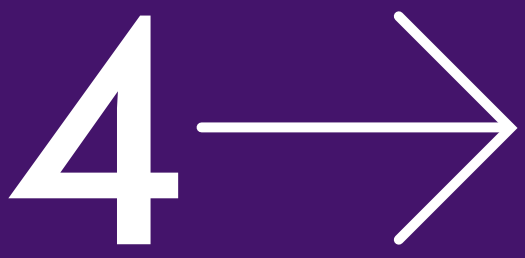
Whilst government interventions to promote cluster development and growth are mixed, there are some good examples from around the world of how other governments have played an important role in creating the conditions for new clusters:

- Israel: Beginning in the late 1960s, the Israeli government poured significant funds into Israeli university-led research. This led to the development of a highly skilled workforce, supplemented by military engineers and scientists. The catalyst of company growth and cluster formation was arguably the establishment of a venture capital industry. This was made possible by the government's establishment of Yozma, a publicly funded venture capital company.
- Germany: Germany has announced plans to develop offshore wind in the Baltic Sea. At Bremerhaven, they are putting together all the elements of an innovation and industrial cluster, designed to attract inward investment. Specifically, coordinated investment has been made in developing demonstration sites, support for private sector facilities and R&D facilities.

In the UK, the recent announcement of a life sciences cluster, anchored by the large GlaxoSmithKline R&D facility at Stevenage, represents a similar approach.

- GSK partnered with the government, Wellcome Trust and the East of England Development Agency (EEDA) to develop a new biotechnology science park at GSK's site at Stevenage. The project aims to create a world-leading hub for early-stage biotechnology companies. The company hopes that the campus will compete with those in Boston, California and North Carolina in the United States, and will eventually become home to 1,500 scientists. GSK see the establishment of similar SME biotech clusters around the UK as a priority for a future government.

These examples point to an approach which aligns with Conservative principles on the government's role as an active facilitator of private and corporate efforts. Successful cluster development and growth under a future Conservative government will be depend critically on ensuring that industry and universities lead on developments, and are supported with fast decision making on infrastructure, planning and seed funding for commercially sustainable business incubators.



Financing high tech start-ups: Turning good ideas into world beating products.

The annual rate of lending to business fell by a record 8.1% in 2009.

Bank of England.

James Dyson:

Research and development takes time and it takes money, with many dead ends before breakthroughs occur. But it is how new technology is created; it's a long slog – ideas are instant but invention is long-term. Early debt for new companies is almost inevitable, which is why they require support.

The cash-flow pressures facing many start-ups hinder R&D, suffocating good ideas before they become world-beating inventions. Dyson vacuum cleaners would not exist were it not for Mike Page, my bank manager, who personally lobbied an initially reluctant Lloyds Bank to loan me the £600,000 I needed for tooling – the only way to start out on my own. Other businesses such as Autonomy or ARM relied on venture capital to fund the initial stages of development. So it's clear: for UK technology to thrive, financial support is required: lenders and investors with patience and risk-tolerance.

But too often, UK investors are reluctant to take a punt on technology, science or engineering. Private equity is drawn to larger, less risky leveraged buy-outs, and banks shy away from innovation. The credit crunch has only amplified the situation, our once overactive financial services sector lacking the foresight to promote economic growth.

We need an approach that relies on the good judgment and sharp eyes of already successful entrepreneurs and technology developers – angel investors. Angel investors bring not just funds but a wealth of understanding and experience too. I would like to see a Conservative government focus the Enterprise Investment Scheme on benefiting those who invest in high tech, R&D-intensive businesses.

A Conservative government should address clearing banks and their apparent unwillingness to lend to small, innovative businesses (Mike Page was a bit of rarity). Clearing banks have a unique understanding of small businesses and have the infrastructure to monitor small debt financing. The process of obtaining a clearing bank loan is simpler and more easily understood by fledgling start-ups. A loan guarantee scheme similar to the Conservatives' National Loan Guarantee Scheme proposal to stimulate small-business lending, especially to those exploring new technology, should also be explored.

Both actions can deliver immediate benefits and leave a lasting impression.

The Challenge

Investment in high tech research and innovation is inherently risky. These risks are compounded by the fact that many of the most innovative companies are young, small firms with little cash flow and few assets against which to raise money. This makes the availability of entrepreneurial finance crucial for innovation.

But the supply of this finance, whether in the form of angel and venture capital funding, or small business loans, is doubly constrained. The credit crunch has hit financing for innovative businesses hard, as witnessed by the collapse of both venture capital funding and business lending. But this merely exacerbates a longer-term problem: the hesitancy of investors to back innovative British entrepreneurs and investment in research.

If the UK is to become the leading high tech exporter in Europe, both new and existing high tech businesses need access to sufficient affordable finance to fund research and innovation. The time to do this is now, as the UK rebuilds its financial architecture after the credit crunch. A Conservative government should ensure that the right incentives exist for our financial system to fund investment in innovation.

The current government's attempts to solve this, particularly with venture capital, have had only partial success. A new government should focus on addressing those parts of the UK's financial architecture that offer most to innovators and where least has been achieved. In particular, it should look at how it can better support individuals willing to risk their own capital to back excellent high tech ventures, and how to ensure that debt finance reaches innovative businesses.

The Evidence

Innovative businesses rely on a range of types of finance. This includes both equity and debt finance: equity in the form of angel and venture capital investment, and debt in the form of small business bank lending. It also includes informal ways of funding investment like tax credits (such as the R&D tax credit) or contracts from lead users.

Levels of both equity and debt finance for innovative businesses have been hit badly by the credit crunch. But this short-term impact should not be allowed to obscure a longer-running need to improve the UK's ability to finance research and innovation.

Angel investment

Angels are wealthy individuals who invest either alone or collectively into start-up businesses. Research on the UK angel community has shown that successful angels are disproportionately former or current entrepreneurs, with relevant industry experience[63]: they bring more to the table than just cash, and can back up their money with understanding of the businesses they invest in.

Angels in the USA invest significant amounts of money: over $26 billion (£18.3 billion) in 2007. In the UK, by contrast, angel investment is on a much smaller scale. The most recent figures available show only £1 billion invested.[64] If UK angels invested as much as USA angels, relative to the size of the economy, they would provide £3.5 billion, as much as the combined funding of the UK's Research Councils.

The Enterprise Investment Scheme (EIS) has been successful in stimulating individual investors to back early stage companies. NESTA research identified that over 80% of investors had made use of the EIS scheme, with 24% indicating that these investments would not have been made without EIS. However the vast majority of companies receiving investment through the EIS have been in the service sectors. High tech companies have received only 25% of funds raised.

[63] NESTA, Siding with the Angels (2009)

[64] HM Treasury, The Race to the Top: A Review of Government's Science and Innovation Policies (2007)

Table 4 Enterprise Investment Scheme – number of companies and funds raised by industry sector [65]

Industry	2004-05		2005-06		2006-07	
	Number	Amount (£m)	Number	Amount (£m)	Number	Amount (£m)
Agriculture, forestry and fishing	13	3	13	12	15	6
High tech	600	151	589	178	564	177
Energy & Water Supply	22	7	25	13	24	12
Manufacturing	336	86	331	76	300	67
Construction	52	11	41	8	31	8
Distribution, restaurants and catering	404	137	406	139	372	145
Transport and communication	74	22	84	27	66	31
Business services	379	97	372	106	427	130
Other services	304	90	265	87	263	122
Total	2184	605	2126	645	2062	699

Venture Capital

In the UK, venture capital funding is characterised by two worrying phenomena: a long-term drift away from financing innovative, entrepreneurial businesses towards larger, leveraged buyouts, and a sudden drought of investment funds caused by the credit crunch.

Over time, private sector funds have grown larger and invested in later-stage businesses, often using significant leverage. Recent decisions by 3i and Apax Partners to leave the UK venture market are symptomatic of this trend. More recently, the credit crunch has seen a dramatic fall both in funds available for investment by tech venture capital funds, and in the new venture funds being raised.[66]

In addition, venture capital is skewed towards particular high-profile sectors, with other sectors (in which R&D may still produce significant commercial advantages) less well represented. 70% of investments are focused on IT, healthcare and telecoms sectors. Less than 15% of investments go to other non-service industries (see Figure 6).

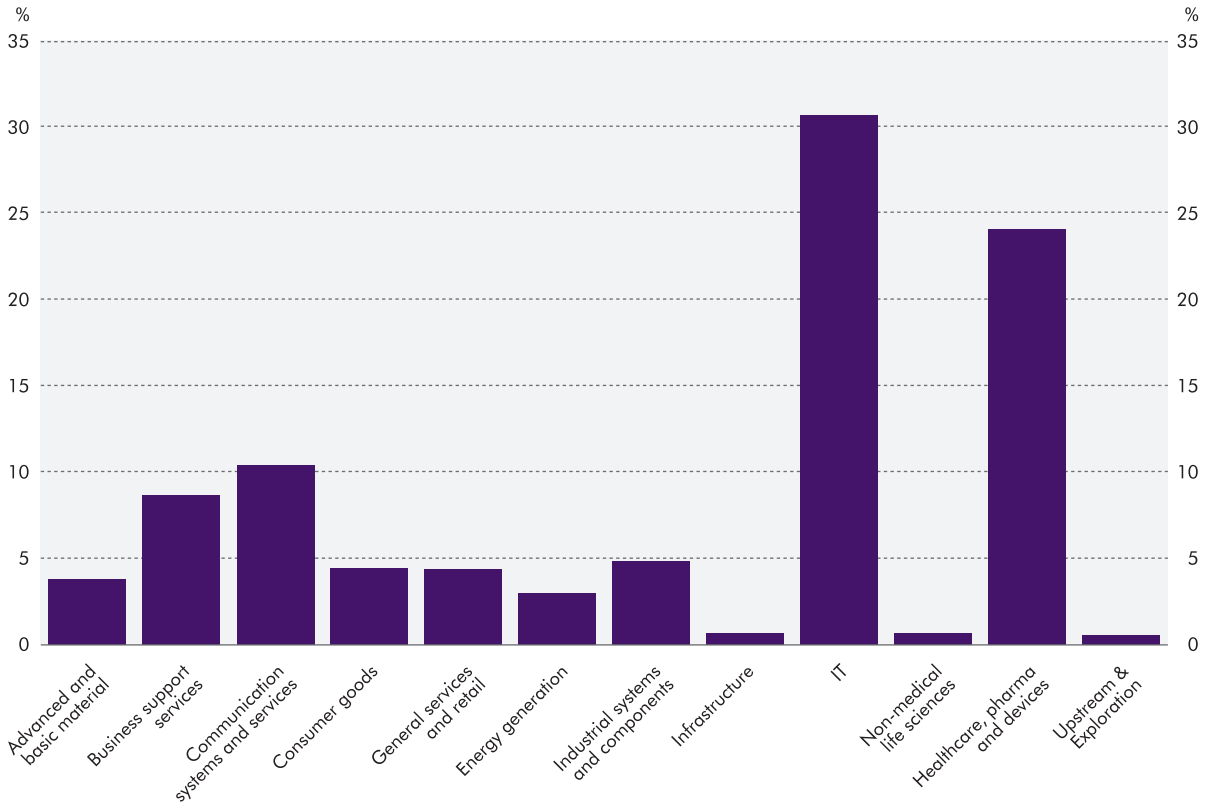
To a certain extent this bias represents the features of markets which venture capital funds look for – large, addressable, with scope for technologies to radically transform them. Since venture capital funds generally require a certain level of deal-flow to justify investing in industry knowledge, they are unlikely to maintain due diligence capability and experienced staff in sectors that generate fewer deals. But it may lead to good companies in underrepresented sectors being missed. This highlights the importance of having other forms of finance available than venture capital.

Table 5 UK early stage investments by amount invested (£m) 2001-8[67]

Finance stage	2008	2007	2006	2005	2004	2003	2002	2001	2000
Start-up	172	190	531	160	96	73	99	163	175
Other early stage	187	244	415	222	188	190	196	227	528
Total early stage	359	434	946	382	284	263	295	390	703
Early stage as a % of total investment	4.1	3.6	9.3	5.6	4.2	6.5	6.6	8.2	11.0

[65] ONS analysis of EIS return forms
[66] NESTA, Reshaping the UK Economy (2008)
[67] BVCA, Private Equity and Venture Capital Report on Investment Activity 2008 (2009)

Figure 6 Venture capital investments by sector, 2001-2008
Source: Library House



Public money has been invested into a variety of so-called "hybrid" venture capital funds, such as Regional Venture Capital Funds, Enterprise Capital Funds and the newly launched Innovation Investment Fund. Their track record has been mixed. Research by NESTA[68] and the NAO[69] has shown that many public funds lack private sector expertise, focus on narrow geographical areas and are too small. Small funds consume disproportionate amounts of operating costs, and for the same percentage of operating costs, attract weaker managers, resulting in poorer investment decisions. Although the fees paid to fund managers are comparable to those paid in the wider VC community, these overheads represent a sizeable percentage of the overall investment. The government's new Innovation Investment Fund attempts to overcome the size and expertise issues by adopting a fund of funds approach; but this approach risks overlaying additional management costs. This new Fund is not yet operational.

Bank Lending

It is notoriously difficult to prove definitively a shortage of bank lending: the banks argue that any decline reflects fewer businesses wanting credit as much as a shortage of banks providing it. Nevertheless, there is evidence that innovative small firms have had a particularly hard time. Positive lending figures for 2007 and 2008 (where banks lent on average £7 billion and £4 billion more than they received) have turned into negative figures in 2009. The annual rate

[68] NESTA, Reshaping the UK Economy' (2009), From funding gaps to thin markets (2009)
[69] NAO, Venture capital support to small businesses (2009)

The Way Forward

of lending to business has been rapidly falling each month, with lending falling by a record annual level of 8.1% in 2009[70]. Since the credit crunch, lending by banks to "real" businesses – not other banks, insurers or fund managers – has failed to recover, even though inter-bank lending is back to its pre-crunch rates.

Survey data from the Engineering Employers' Federation suggests that successful innovative manufacturers found it harder to raise money than less innovative business even before the credit crunch. The credit crunch has unsurprisingly made the situation more difficult with around 26% of innovative manufacturers reporting more difficulty in obtaining access to bank finance, compared to 19% of less innovative companies.[71]

Our future success as a nation of high tech innovators depends on entrepreneurs getting the financial backing they need to start and grow their companies. The vibrant seed capital markets in the USA and Israel have demonstrated the power of a robust financial architecture to support high tech companies. The UK needs to match their success by backing our emerging community of angel investors. Venture capital and bank lending also have important roles to play in financing high tech companies, but the key here is to get the right type and level of government support.

Encouraging angel investment

A Conservative government should signal its commitment to promoting the best of UK innovation by **increasing the EIS relief available for investment in high tech companies to 30%.** High tech companies could be defined on the basis of their levels of R&D activity to ensure that companies across all sectors can benefit. This could stimulate significant investment in high tech companies.

This announcement could be coupled with a long-term signal that EIS would focus solely on high tech companies by 2015 or earlier. This would provide a clear signal to individual investors and the wider finance community about the value the UK attaches to high tech companies.

Venture capital

Venture capital has been a particular focus of government intervention over the past decade. While these schemes have had some success, research has shown that there is significant room for improvement. With a total of 28 funds under management, a new government should **initiate an assessment of public venture capital funds** to ensure that sufficient funds are available for meaningful initial and follow on investments to be made.

Bank lending

The vast majority of companies, including high tech ones, rely on debt financing for growth. The credit bubble and subsequent crash have had significant impacts on bank lending. The Conservative Party has already called for a National Loan Guarantee Scheme to underwrite around 90% of any new loans to business, particularly on short-term credit

[70] Bank of England, Trends in Lending, February 2010
[71] EEF, Innovation Monitor (2009)

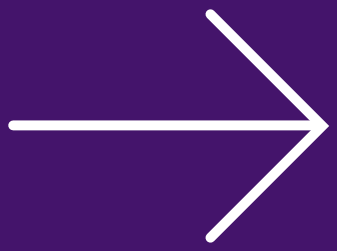
lines, overdrafts and trade credit. It is vital that a Conservative government **examines better routes to get debt financing to high tech companies.** If possible, this should involve using the power of government guarantees to encourage lenders (whether existing banks or new entrants) to extend credit to innovative small businesses.

INVESTING IN LOW CARBON TECHNOLOGIES

The UK needs new and emerging Low Carbon Technologies to meet its climate change targets as existing technologies - energy efficiency, onshore wind and nuclear - will only take us part of the way towards it (source: Carbon Trust submission to the taskforce). With demand set to grow, there is also an economic imperative to developing a thriving low carbon industry in the UK. NESTA research estimates that by 2013 the global low carbon market could potentially be worth £46 billion. In 2025 the world energy demand will have increased by 50% compared to 2005 levels and will reach the equivalent of 15 billion tons oil. In 2030, the EU will import almost 70% of its energy needs.

However, the UK currently has less than a 5% share of the global market for green technology – less than Japan, France, Germany, Spain or the US. International companies are also beginning to invest in low carbon technologies, as demonstrated by Google's announcement of a Proof of Concept fund to address the lack of funding between the R&D and commercialisation stage.

The UK needs to utilise its strengths by seeking to exploit early science and technology research and development, as well as the financing of low carbon technologies. In developing proposals for a 'Green Investment Bank', a Conservative government should consider how it could play a key coordinating role in bringing together financers of low carbon technologies with early stage developers in the UK. These discussions should also seek to identify where the UK has a comparative advantage in the development of certain low carbon technologies, and identify an appropriate response for the 'Green Investment Bank' and other government support mechanisms.

5 

Supporting high tech companies: Creating the right conditions for R&D investment.

Patents filed in 2007:
330,000 – Japan
240,000 – US
17,000 – UK
World Intellectual Property Organisation.

James Dyson:

China and India's rapid growth is impressive. Their bold ambition to be not only the factories of the world, but its research laboratories too, is to be applauded. This growth and ambition (and therefore threat) has led many governments to concentrate on supporting local industries that deliver the highest added value. If the UK is to compete and prosper as Europe's leading technology exporter, policies need to be developed that stimulate R&D investment across all sectors - policies focused on procurement, concrete advice and tax.

Procurement

Selling to the British government is notoriously – and torturously – slow, bureaucratic and often unproductive. When supplying the Royal Navy with landing craft (the Sea Truck) in the 1970s, I once hosted ten civil servants from the Admiralty, and their main preoccupation was the colour of the seat cushions. Suffice to say, no decision was reached that day. More seriously, the Royal Navy's approach was uncoordinated with each section (and various subsections) putting in their proverbial, and often contradictory, oars. It was futile and ultimately expensive for both supplier and buyer. Other governments simply bought 'off-book' without tinkering with (or more accurately, compromising) the boat's design.

A Conservative government must kick-start an in-depth review of state procurement (especially high tech) and identify a way to support small to medium sized firms.

Advice

But amidst that quagmire, there was a glimmer – embassies. Through the decades they have shaken off diplomatic grandstanding in favour of offering practical help when exploring new markets. Today, they are even more alert to the needs of British exporters, but are British exporters alert to them? Is the approach coordinated?

A Conservative government must take steps to ensure quick and direct access to valuable on-the-ground knowledge.

Tax

A lower corporation tax rate is prudent as the economy recovers. But if we are to rebalance the economy, extraordinary action needs to be taken now. Tax credits can be an excellent way of supporting companies willing to risk their own capital in R&D. The current system is well intentioned but not well targeted. A Conservative government should refocus R&D tax credits on high tech companies, small businesses and new start-ups in order to stimulate a new wave of technology. When the public finances allow, the rate should be increased to 200%. Loss making small companies also need greater help, and the claim process must be streamlined. These changes need not necessarily lead to a higher overall cost to the exchequer.

If technology is to fuel long-term growth and rebalance the economy, the touch-paper must be lit now.

The Challenge

In a global economy, UK markets are less important for company growth, and there's less incentive for companies to base their R&D and manufacturing sites here. As Sir John Rose vividly put it:

> *Companies need other reasons to locate in the UK, whether it is the strength of our science base, the quality of our people, our approach to innovation or government support.*[72]

R&D investment is a key contributor to high tech success. When coupled with measures to promote innovation (e.g. training, encouraging risk taking), investment in R&D[73] can lead to the success of companies and act as a driver for wider economic growth.

Yet the UK continues to lag behind EU averages in investment in R&D. This is also the case with R&D in manufacturing sectors, contrary to the myth that our lower R&D investment profile is due to the service nature of our economy.

A key objective of a Conservative government must be to put in place the right incentives for UK companies to invest more in research and innovation. It is not for the government to dictate how businesses should invest, but to ensure that government action that affects business – in particular tax policy and government procurement of technologies – encourages rather than discourages innovation. The current government has provided some support for investment in R&D by industry. However the UK's track record of using procurement to stimulate innovation is poor, and this needs to improve.

The strength of the UK's exports also depends significantly on government acting as an honest broker to ensure that UK high tech companies can access international markets using local knowledge wherever possible. The role of UK Trade and Investment (UKTI) is pivotal.

A Conservative government needs to adopt a coordinated approach, focused on helping companies undertake R&D by ensuring tax policy is conducive to research, and making government procurement an effective stimulus to high tech innovation. As is the case throughout this document, the focus must be on helping companies who are willing to invest their own capital in R&D and exporting, not on providing dirigiste subsidies.

[72] Speech at RSA, 2009

[73] Hubert Strauss, R&D expenditure and capital in Europe, Economic and Financial Studies, (2009)

A. ENCOURAGING COMPANIES TO INVEST IN R&D

The Evidence

While overall levels of R&D investment have increased, the level of investment as a percentage of GDP is still only 1.79%. More importantly, analysis of R&D investment by companies indicates that UK companies invest less in R&D regardless of their size.[74] Equally, R&D investment in manufacturing sectors trail competitor countries (Figure 7 below).

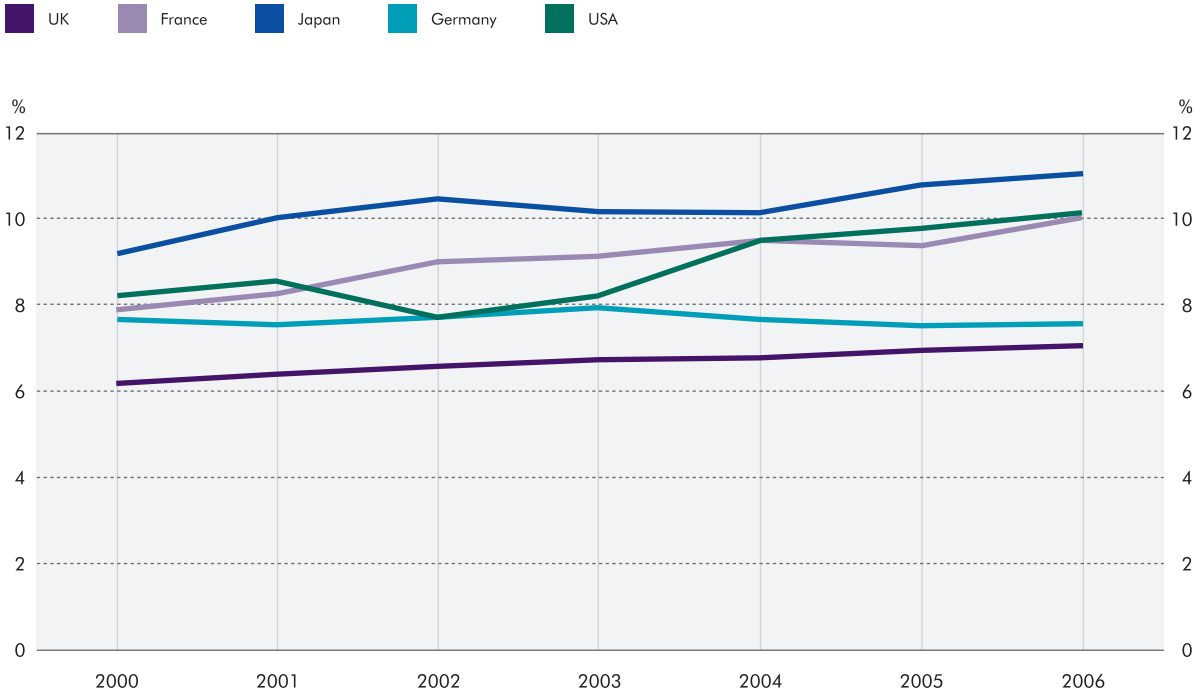
David Cameron and George Osborne have made it clear that a low corporation tax is a long term ambition. This would offer companies the flexibility to decide where to make investments – in plant, people or R&D equipment. Equally, a low corporation tax could widen the pool of high tech companies by encouraging entrepreneurs to start businesses, attracting inward investment, and stimulating existing companies to make new investments.

Alongside a low corporation tax rate, there is an urgent need to stimulate high tech companies to generate wealth for the nation, rebalance the economy and capitalise on strong demand in international markets. Therefore, targeted support for companies investing in R&D needs to be the immediate priority for a new government.

Support for the 'patent box' is an important first step – one that recognises the additional value added of high tech companies; the need to promote R&D and manufacturing in the UK; and the fact that UK companies operate in a competitive global environment where several countries are actively seeking to encourage R&D investment on their shores.

But the patent box is only likely to benefit a distinct subset of companies.[75] For the wider high tech sector to thrive, a new government needs to go further, by enhancing and refocusing the incentives available for companies investing in R&D. The CBI's Tax Taskforce recognised that while a low headline rate for corporation tax was a key policy objective, this needs to be supplemented by R&D tax credits to address genuine market failures in the investment profile of companies. Even countries with low corporation tax have instigated a separate regime to encourage R&D investment. For example, Ireland lowered its

Figure 7 Investment in R&D by manufacturing companies as percentage of manufacturing Gross Value Added



[74] Department for Business, Innovation and Skills, R&D Scoreboard (2009)
[75] CBI, UK business tax: a compelling case for change (2008)

corporation tax to 12.5% in 1998 but followed that with a new R&D tax credit in 2004. Similarly, Singapore has a twin policy of low corporation tax rates supplemented by an attractive R&D tax credit system. The swell of investment in France highlights how countries with high corporation tax rates can stimulate investment with the intelligent use of tax credits.

Tax credits are preferable to grants. Grants are used by governments to target investment into sectors identified as strategically important, such as low carbon technologies and nanotechnology.[76] The fact that government has to decide who receives a grant adds unnecessary bureaucracy and delays investment. Getting a better understanding of industry in different sectors could help reduce bureaucracy and speed up decision making. However these barriers suggest that grants should be used intelligently where tax incentives cannot practically be employed.

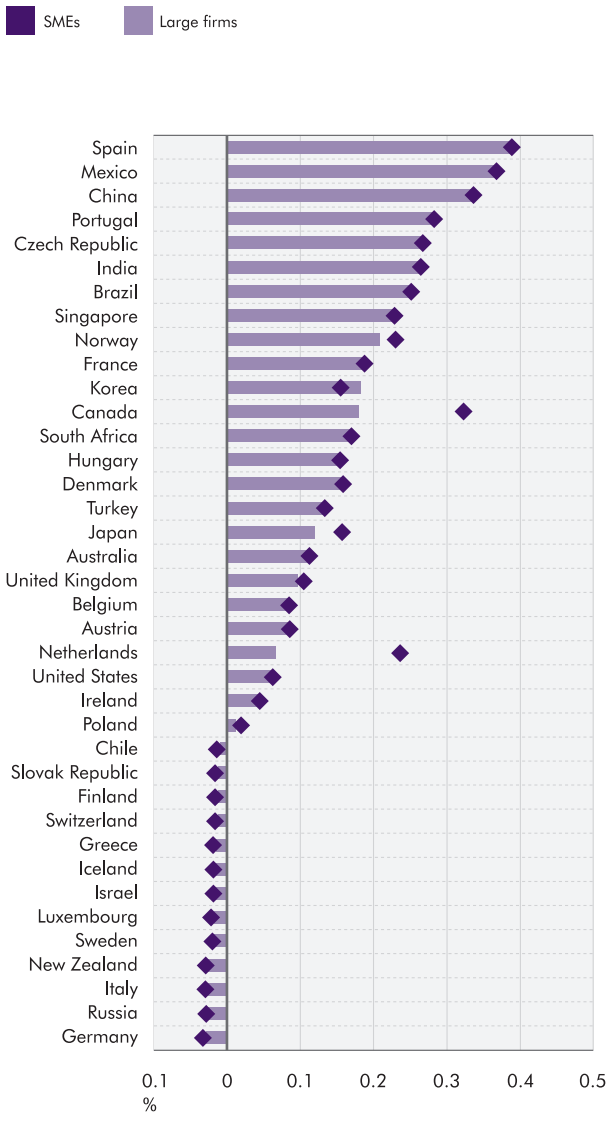
Of the various tax instruments available to government, R&D tax credits have the advantage that they seek to help companies that are themselves prepared to invest in R&D. Government does not need to choose sectors or companies, with the result that R&D can be encouraged in the widest possible range of sectors, taking advantage of businesses' own insights into likely breakthroughs.

Tax credits can be effective in promoting R&D in the UK. Economic papers highlight the difficulty of assessing the impact of national and international R&D tax credits. However the existing evidence suggests that R&D tax credits do have an impact on raising levels of R&D investment and contributing to long-term growth.[77/78] The value of the R&D tax credit has also been underlined by Richard Lambert, Director-General of CBI, who said:

> *As our economy seeks to re-balance over the months ahead, the government must recognise the value of the R&D tax credit and commit to retaining it and encouraging more firms to invest in research and development. It should also go further by building on its success; extending the rate and range of credit, enabling more companies to apply and covering more of their associated overheads.*

The implementation of the R&D tax credit has been lacklustre. It has been characterised by complex eligibility criteria, constantly changing rules and a profound lack of understanding of how research and development occurs in companies. HM Revenue and Customs' attempt to rule that any object with saleable value resulting from a pilot process in a manufacturing company highlights how a good idea, such as the R&D tax credit, can be betrayed by poor design. Botched implementation of the credit, coupled with a relatively low rate, dampen the impact of what should be a significant stimulus for R&D investment by companies.

Figure 8 Rate of tax subsidies for USD $1 of R&D, large firms and SMEs, 2007



[76] http://www.oecd.org/dataoecd/35/15/2101604.pdf
[77] Ientile and Mairesse, A Policy to Boost R&D: Does the R&D Tax Credit Work? (2009)
[78] Hall and van Reenen, Effectiveness of R&D Tax Credits: A Review of the Evidence (2000)

The Way Forward

The importance of getting a well designed and implemented tax credit is demonstrated by its use abroad. Several other countries are aggressively attempting to attract high tech companies by providing a range of incentives. R&D incentives are a particular draw for these companies. In a recent OECD survey, the UK ranked 19th in terms of the attractiveness of tax credits for R&D, far below competitor countries. Last month, Singapore took the bold step of changing its R&D tax credit into an 'Innovation and Productivity' tax credit. Not only did the tax credit rate increase from 150% to 250%, further changes were announced to expand the range of activities eligible to include other important aspects of innovation, such as design, training and intellectual property protection[79]. France also increased its headline R&D tax credit rate in 2008 with the ambition to be the most attractive research tax regime in Europe. In contrast, the US R&D tax credit is considered to be less effective as it is renewed each year by Congress.

Germany has a different set of support programmes for its companies. For example, the renewable energy feed-in tariff has provided a substantial subsidy for electricity producers to stimulate their investment in technologies. In a recent EU wide survey, 28% of German manufacturing companies reported receiving state support, compared to 12% in the UK.[80]

A Conservative government needs to promote technical excellence in all sectors, starting with measures to stimulate investment in R&D. The R&D tax credit risks becoming overlooked when companies consider which country they should make their R&D investments in. The current system is well intentioned but not well targeted. It needs to be reinforced if we are to secure the future of the UK as a high tech hub. Too much money currently goes to the wrong companies and too little to the right companies. It needs to be refocused to those companies where the barriers to a sustained R&D programme are greatest and the potential spillovers to the rest of the economy are greatest. That means high tech companies, small businesses and start-ups.

- **Refocus R&D tax credits on hi-tech companies, small businesses and new start-ups.** When the public finances allow, the rate should be increased to 200%. This will have a substantial impact on company investment decisions and send a far reaching signal to both national and international companies about the Conservative government's belief in science and technology. Start-ups invest heavily and can be loss making for a few years. This type of investment must be encouraged by enhancements to the level of relief available for loss making small companies. These changes need not necessarily lead to a higher overall cost to the exchequer.
- **Improve the ease with which the R&D tax credit can be claimed.** A recent CBI research paper on the impact of the R&D tax credit in the UK found that 42% of firms surveyed identified the cost and the information obligation for claiming the tax credit on R&D as the main hurdle to filing a request.[81] Canada has simplified its processes and introduced standard guidance to assist filing. This has been reported (anecdotally) as leading to increases in claims – although empirical evidence of this is scarce. Options for simplifying the claims process in the UK include allowing external audits of the credit or pre-agreeing projects or activities with companies.

Sir Anthony Bamford supports this approach.

> *Talent and creativity are not in short supply in this country – what we lack is a forward-looking supportive framework for companies that want to translate invention into enterprise. All British manufacturers will welcome the proposal for enhanced tax credits on research and development.*

[79] Singapore Ministry of Finance, 2010 – 250% credit is eligible for a range of innovation related activities. Claims are capped at 300,000 Singapore dollars
[80] EU Community Innovation Survey (2000)
[81] CBI, Impact of the R&D Tax Credit – Adding Value, Reducing Costs, Investing for the Future (2008)

STRENGTHENING THE TECHNOLOGY STRATEGY BOARD

The Technology Strategy Board (TSB) supports innovation at its applied stage and through its technical development. It achieves this through providing grants for collaborative research and fostering industry/academic partnerships. Their investment is focused where the UK has technological capability, a large market opportunity exists and other measures (e.g. R&D tax credit) are insufficient to get the project off the ground.

As a relatively new body, the TSB is doing valuable work and must be given time to fully develop its role. They should consider providing funding for placements and internships for undergraduates, postgraduates and post-docs into industry. In addition proof of concept funding should be pooled and awarded through the TSB. Funds should be drawn from the RDAs innovation budgets, and combined with the money already made available through the TSB – this would simplify access to the funds and provide significant support to firms in the initial stages of development of their technology.

B. USING GOVERNMENT PROCUREMENT TO STIMULATE HIGH TECH INNOVATION

The Evidence

Government procurement contracts can provide companies, particularly start-ups, with a powerful incentive to develop new technologies. In the USA, the government was responsible for aiding the development of the internet through the procurement functions delivered by DARPA. The current government is relatively poor at accessing the market for high-tech products, compared to countries with thriving high tech sectors like the United States or Finland (Figure 9).

While large contractors can deliver a wider range of services and quicker response times, it is important to recognise that using a number of smaller companies could also deliver a range of benefits. Doing so could reduce risk, improve service and lead to more innovative and technologically advanced outcomes. With little reputation to trade on, small firms are often more responsive and more innovative. Procuring with several small companies also encourages competition between them, which can lead to quicker delivery and improved solutions. Frequently using several small companies to spread risk can also be more cost effective than placing one large contract with a large company. This is certainly the experience at Dyson. This runs counter to the tendency for procurement staff to rely on 'safer' large firms, but the evidence is positive.

Despite the benefits of dealing with smaller companies, the UK government's track record of doing this is poor, and the schemes available to help SMEs compare unfavourably with those in America.[82]

In the UK, only 16% [83] of the total value of central government contracts in 2005/6 was won by SMEs (firms with 249 or fewer employees), compared to 22% in 2004/05. This amounted to half of all contracts. SMEs gain a larger percentage of procurement from local government and in the same period gained 60% of the total value of these contracts.

In the USA, the Small Business Innovation Research (SBIR) programme awards contracts for the development of technologies that federal agencies believe they will require. It provides 100% of the funding required, plus a profit for the company. This is underpinned by legislation requiring 2.5% of all federal government agencies' external R&D budgets be distributed through this programme. Combined with other programmes, the SBIR delivers $1.5 billion in R&D contracts to small businesses.

[82] Kristian Uppenberg, R&D in Europe: Expenditure across Sectors, Regions and Firm Sizes (2009)
[83] HM Treasury, Accelerating the SME Economic Engine: Through Transparent, Simple and Strategic Procurement (2008)

The Way Forward

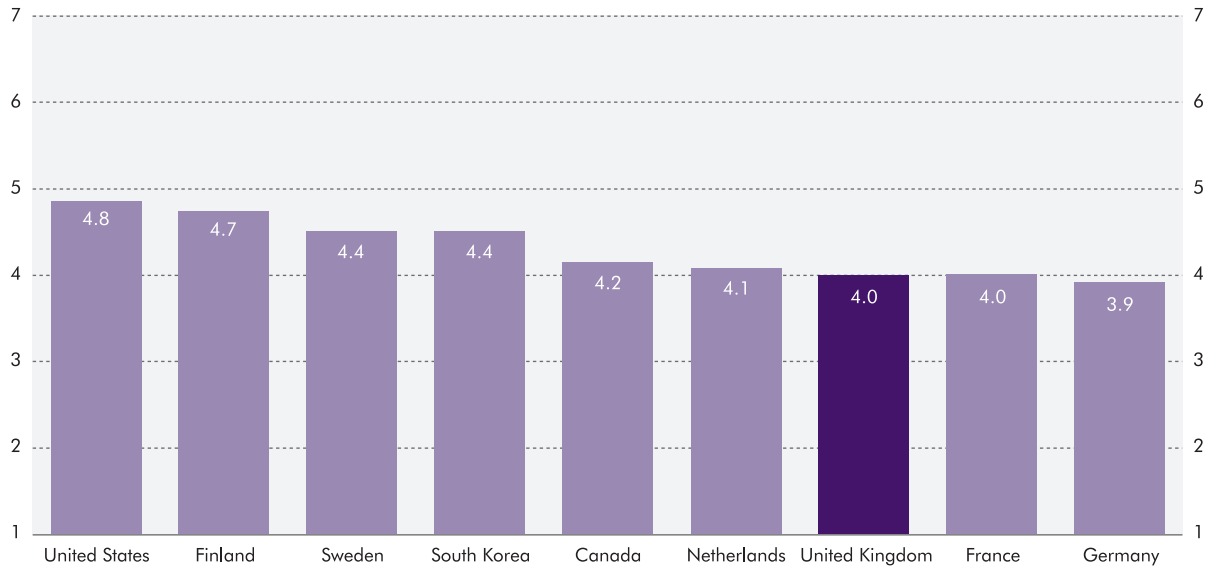
The UK's equivalent Small Business Research Initiative (SBRI) scheme has previously been accused of being significantly less effective and more limited in its scope than its American counterpart. The Richard Report criticises it for its focus on policy studies and quasi-academic research rather than "hard R&D".[84] A recent restructuring of the programme may help address some of these issues. But a more serious limiting factor remains: it has no identified funding, and relies on departments to earmark budget to spend on SBRI contests. Moreover, it does not apply to all types of procurement: merely novelties, which represent only a small percentage of overall government spending.

If procurement is to play a role in rebalancing the UK's economy, government policy needs to set a bold ambition. The Conservative Party's recent procurement briefing note makes an important step in this direction by setting the following aspirations:

- At least 25 % of the procurement budget of each government department should be spent with small and medium sized enterprises, either directly or through main contractors.
- 25% of government research and development contracts should go to early stage, high technology SMEs, either directly or via main contractors.

Achieving these ambitions will require a Conservative government to identify new ways of delivery. Increasing transparency through online advertisement and challenge-based procurement currently used in procuring architecture services offer two possible mechanisms which could be used to greater effect by government. Typically, several short listed candidates are partially funded through the initial stages of a project, before one is selected for the

Figure 9 Government procurement of advanced technology products
Note: Averages, Question: In your country, government procurement decisions result in technological innovation (1 =strongly disagree, 7 = strongly agree)[85]



[84] NESTA, Innovation Index (2009)
[85] Small Business and Government: Richard Report (2008), http://www.bl.uk/bipc/pdfs/richardreport2008.pdf. The report provides a good critique of the UK SBRI by David Connell.

final architectural design. This approach could have significant benefits when government procures innovative technologies from small companies. These companies would benefit from having both funding and a target client to work for. The Richard Review highlights the value of using this method to procure high tech products through the SBRI. So far SBRI has had limited traction with departments. A new government should **consider a range of options to increase participation in the SBRI**, such as highlighting success stories, engaging the SBRI team in helping define challenges or allocating specific funding for SBRI procurement rounds.

But the billions of pounds spent annually on government procurement offers a much more powerful lever to encourage innovation. Determining how to make the most of this requires more detailed work. Therefore, a new government should immediately commission a detailed **review to identify how the measures to promote innovative procurement can be implemented**. Led by an industrialist with real life experience of working with government procurement rules, the review should:

- Identify barriers to implementing innovative procurement – for both large and small companies.
- Identify international examples of best practice in innovative procurement.
- Analyse how procurement of high tech products can assist with lowering risk and provide value for money.
- Address how key issues, such as risk averseness and poor level of skills, can be overcome.

HARNESSING PUBLIC SERVICES TO ENCOURAGE INNOVATION

The UK is unique in the world in having leading blue skies and applied research. This is often not well coordinated with government activities. Nowhere is this more apparent than in healthcare where the UK has excellent clinical experts in world class hospitals and an incredible asset in the NHS. The NHS can act as the global catalyst for pioneering new treatments and care – as well as delivering real economic benefits for the UK. The key to unlocking this potential is to give clinicians and researchers both the time and space to work with industry and patients to develop these new treatments.

The creation of the Academic Health Science Centres is an important step towards realising the ambition of making the NHS a global leader in translational medicine, as are changes being instigated in the clinical trials approval process. A Conservative government, committed to giving front line staff more freedom, could implement the reforms which realise this potential. The reforms need to ensure that researchers and clinicians have the right incentives and support – both in terms of finance and time – to affect the changes. A new government should work with clinicians, researchers, patient groups and industry to realise the potential of the NHS.

C. SUPPORT FOR EXPORTS AND FOREIGN INVESTMENT

The Evidence

Export support and effective sign-posting for potential investors are critical if the UK is to become the leading high tech exporter in Europe. Support for exports and inward investment is currently provided by UK Trade and Investment (UKTI). The body has improved in recent years and is valued by companies it deals with.[86] However UKTI has suffered from a lack of prioritisation by government and too many ministerial changes in the past few years. Coupled with organisational changes, this has left UKTI responding to changing demands and priorities.

Service delivery is complicated by the activities of devolved administrations and the Regional Development Agencies: there are multiple offices representing different RDAs in cities such as Mumbai and Shanghai. This competition is counter productive and creates confusion for potential investors seeking to invest in UK businesses. Businesses are also often unaware of UKTI services.[87] Its website is difficult to navigate and does not readily identify the types of support or services that UKTI or individual embassies can offer.

The Way Forward

The vision for UKTI should focus on delivering services with high impact for the UK economy. The Shadow Minister for International Development, Geoffrey Clifton Brown, will publish a paper shortly on trade and our conclusions are identical. Manufacturing attracts more foreign investment to the UK than to any other country in Europe and globally the UK is second only to the USA. A Conservative government needs to ensure this continues.

The future of support for exports and inward investment needs to be based on delivering a sharper focus for UKTI's work. Trade promotion needs to be at the core of the role of an Ambassador and their staff. Our network of embassies all over the world gives us a tremendous platform to focus harder on promoting the UK's commercial interests. **UKTI should seek to direct companies quickly to advice from embassies** in the following areas:

- Providing overseas market intelligence, identifying useful business contacts and support in the UK and overseas, particularly on suitable innovative R&D organisations in the UK.
- Export support to promote attendance at trade shows, with market visits, develop relationships with customers and partners, and provide related press and marketing support.
- Matching foreign investors to UK companies: help overseas investors gain a quick insight into investment opportunities in the UK and match them to appropriate companies or advisors.

This will require **reform of the delivery of services**. There are two important elements to delivering services for high tech companies.

- **A user-friendly, flexible website**: UKTI's website needs to be thoroughly upgraded. It must act as the first point of contact for companies seeking help to export, and provide the right level of information (e.g. identify individuals in embassies who can help).
- **Paring back regional offices**: Reform of the RDAs provides an opportunity for UKTI to assess the right level of presence required in the regions to promote inward investment and identify savings which can be deployed more effectively elsewhere. In parallel, there should be opportunities to cut back on international RDA offices. This should ensure that there is a coordinated presence in major cities across the world and will free up resources

Underpinning these changes must be a renewed commitment to the promotion of exports by ministers.

[86] UKTI, Annual Report 2008-09

[87] CBI briefing, Improving Government Services for Small and Growing Businesses (2006)

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David Cairncross and Tim Bradshaw, CBI
Sir Anthony Cleaver, Engineering UK
The Conservative Party
Professor David Cope, Parliamentary Office of Science and Technology
Dr Kevin Cullen, University of Glasgow
Atti Emecz, Engineering and Physical Sciences Research Council
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