Engineering the future -
a vision for the future of UK engineering

Engineering is the art and practice of changing and shaping the material world for the benefit of humankind – engineers turn ideas into reality. In any situation, an engineer must have a clear understanding of the issues to be addressed and the science behind the issues. An engineer must understand how technical and scientific knowledge can be applied and implemented, while also being cognisant of the cost, reliability and socio-economic implications.

This briefing provides an engineering perspective on the major issues currently facing the UK and highlights five policy priorities for government to address.

Contents

Introduction

The UK's future prosperity requires the development of a more diverse economic base. The UK must create more successful high-added value businesses and industries to manufacture, build and maintain the wealth creating products, infrastructure and services of the future. These innovative enterprises will build on our national strengths in science and technology, address grand challenges, boost GDP and underpin social progress at all levels.

The scale and complexity of the process of 21st century re-industrialisation required is such that it cannot be left solely to the market to deliver. Creating the hi-technology economy of the future will need government to provide incentives and support of a kind not seen in modern policymaking to unlock investment from business and industry. New models of cooperation between industry, government and educators will be needed to transform the politics of production.

The engineering profession has formed an alliance, *Engineering the future*, to strengthen our engagement with policymakers and support a thriving economy based on wealth creation and prosperity through engineering innovation.

Summary

Engineering the future has identified five key policy priorities for government. These areas of policy, which are addressed in more detail later in this document, can be summarised as follows:

1. Sustaining and encouraging investment in the skills for the future (pages 2-3)

It is essential that the UK has the skills to compete internationally to create the high-value, technology-based industries of the future. Government should:

- apply a greater focus on STEM in schools and colleges to ensure that all young people are taught by specialists in each of the scientific subjects
- provide incentives for industry and in particular SMEs to encourage the provision of apprenticeship places and graduate training
- give the new engineering-related 14-19 Diplomas time to embed and develop as planned so that they can prove their value
- ensure the right level of investment in university engineering departments
- recognise professional qualifications in engineering that strengthen the aspirations of students and apprentices

2. How to make the UK a leader in low carbon technology (pages 4-5)

The UK must seize the opportunity to develop global leadership both in low carbon energy in order to power a low emission industrial base, and the low energy processes that will make industry efficient and competitive. Government should:

- put in place a stable, unambiguous and well communicated policy and regulatory framework
- give priority to research funding for low carbon technologies
- simplify and reduce barriers to market entry and the costs of doing business

3. Ways of capitalising on the value of the UK science and engineering research base (pages 6-7)

To realise the full potential of the UK science and engineering research base, greater business support and commercial advice is needed in order to improve the commercialisation of research outputs. Government should:

- provide incentives for more engineering business to work closely with university departments
- introduce an expanded R&D tax credit scheme to put the UK ahead of European competitors

4. Harnessing the power of public spending to encourage innovation (pages 8-9)

Total UK public procurement is worth around £220 billion a year. Government should:

- implement a more outcomes-focused procurement policy across the public sector
- set targets and encourage innovation in public procurement, recognising the opportunity costs of failing to do so

5. Making greater use of engineering advice in government policymaking (pages 10-11)

The delivery of most areas of public policy has an engineering dimension that is best considered at the outset of the policymaking process and before the project commissioning process. Government should:

- develop the contribution to policymaking of the engineers within the civil service
- draw upon the expertise of the professional engineering community in a systematic way

1. Sustaining and encouraging investment in skills for the future

Engineering and technology skills are of immense value for a variety of reasons: they are a core component in establishing an international comparative advantage in a range of sectors, they equip the UK with the means to meet policy challenges through technical measures and they provide an excellent means of increasing social mobility and opportunity.

Engineering skills in demand

Although the UK is generally well provided for in terms of those qualified to degree level and beyond through Masters Degrees and PhDs, there are still particular sectors where this is not the case. The indications are that once the UK starts its economic recovery there will be considerable demand at all levels with a forecast requirement for 587,000 new workers in manufacturing in 2017.[1] This demand will occur against a backdrop of a pool from which to recruit young people that will decline by 8% over the next decade[2] and is coupled with the legacy of under recruitment of women into engineering – only 12% of engineering graduates[3] and 2% of technicians are women.[4] There is also a real shortage of technicians – leading to uncertainty about careers for sub-degree entrants and distorting the demand for graduates.

Sustain the supply of talented engineers

The pressing need to address energy, transport and communications infrastructure, climate change and the Olympic Games is already creating a demand for a world class talent pool of engineers at all levels. There are currently a wide range of pathways into the engineering profession including apprenticeships, 14-19 diplomas, vocational qualifications and degrees – this diversity is beneficial and must be retained.

Engineering at all levels is underpinned by the STEM learned at school. While there have been significant increases in the number of people studying mathematics after the age of 16, advances in the number of people studying physics, chemistry, design and technology and engineering have only been modest. There must be more focus on STEM in schools and colleges and young people must be taught STEM subjects by STEM specialists in order that they can attain and progress with these important subjects. More effort needs to be made to ensure that all learners are enabled to make connections across areas of learning that support an education in engineering.[5]

Reforms to career information and guidance offered in schools and colleges must be pursued with urgency. Too many students get incomplete or inaccurate information on where a course of study might lead them. Students with ability in STEM subjects need detailed information on the full range of options available to them by STEM specialist advisors.
To ensure a globally competitive supply of graduate engineers, we need, at the very least, to maintain current levels of investment in university engineering departments in the face of cuts in the higher education budget.

Overall, applications in engineering and technology are up 16% since 2007. Encouragingly, this includes an 11% increase in UK-domiciled students.[6] Yet some university engineering departments are closing or remain under threat of closure or merger as universities seek to reduce costs by concentrating resources away from degrees with higher overheads.

In 2003/4, the funding of engineering departments was cut from double the basic unit of resource to just 1.7 times the basic unit of resource. According to research conducted by The Royal Academy of Engineering, the resource allocation needs to be at least 2.5 to enable engineering departments not only to ensure the provision of world class engineering degree programmes, but also to deliver such requirements as enhanced engagement with industry.[7] With national government being the primary provider of the funding for Higher Education funding, priority should be given to securing the supply of those subjects – such as Engineering – necessary to implement key national policies.

Apprenticeships and graduate traineeships

Apprenticeships and vocationally-related qualifications such as BTECs are the principal sources of future engineering technicians and fundamental elements of the skills infrastructure.

Technician vacancies account for 71% of current Skills Shortage Vacancies. This figure will increase as the economy recovers from the current recession[8] and necessitates a considerable expansion in the number of apprenticeships provided by employers, particularly in Small and Medium-sized Enterprises (SMEs) which account for the majority of engineering jobs in the UK (58% of employees work in businesses with fewer than 250 employees. This figure rises considerably in some parts of the UK, for Northern Ireland this figure is 72%).[9] However there remain considerable barriers to an expansion in apprenticeships due to the administrative burdens and the initial financial outlay involved. In the first year of an engineering apprenticeship, the typical cumulative net cost to an employer is £17,909 followed by £7,671 in the second year. It takes on average five years before these costs are fully recovered.[10] The need to interact with colleges/work based learning providers, Sector Skills Councils and the Learning and Skills Council and its successors also creates considerable additional administrative and time costs for employers. Given the economic necessity for placements, there is a strong case for providing further administrative support to cover such costs, or simplifying the process to further incentivise employers.

At the same time formal recognition of a technician class, particularly engineering and science technicians, is long overdue. Such recognition would enhance the attraction of careers at this level (which can often lead to full engineering professional status) while ensuring the completion of apprenticeships rather than loss of skills when employer or trainee feel they know enough to do the current job.

We are concerned that the advantage to the country of the rise in the numbers of engineering graduates will be dissipated if the training places are not available for them to gain initial professional development leading to their gaining the range of skills necessary to fully capitalise on their degree, and gain professional (chartered or incorporated engineer) status.[11] Employers will need to be incentivised to provide traineeships, but government can do more to formally recognise the profession of engineering and acknowledge its importance to the country (see also under point 5).

The 14-19 Engineering Diploma

The 14-19 Engineering Diploma is a fairly recent and welcome addition to the pathways into the engineering profession. 2,500 learners started the Diploma in September 2008 and it is estimated that between 4,000 and 5,000 learners will have started in 2009.[12]

The initial signs are very positive; over 1,000 employers have signed up to help with work-related learning. These vary from major contractors and the large utilities companies to local businesses.[13] An analysis of the entry requirements for engineering courses at Russell Group universities, carried out in May 2009, found that the Diploma is accepted for admission to 79% of available courses, provided students achieve sufficiently high grades and have studied certain options. The Engineering Diploma has been expressly welcomed by many of the top universities in the country, including Oxford and Cambridge.[14]

The Diploma provides a good mix of theoretical and "hands on" learning which has all the potential to appeal to a significant demographic of students and to employers who call for these mixed skills. The Diploma should therefore be given enough time to be tested in real world conditions and to overcome initial challenges in take up and provision. It is crucial that efforts continue to be made to maximise employer engagement.

Policy recommendations

1. We must create a more scientifically literate society. There must be more STEM focus in schools and colleges and all young people must be taught by specialists in each scientific subject. Young people should also have the opportunity to study at least one STEM subject beyond the age of 16 and renewed efforts made to ensure that more women study maths and physical sciences and are also encouraged to consider engineering as a career.
2. More specialist science and technology teachers need to be trained, with ongoing professional development throughout their career including strong links with industry so they can bring STEM to life in the classroom.
3. Reforms to careers information and guidance offered in schools and colleges must be pursued with urgency. Too many students get incomplete or inaccurate information on where a course of study might lead them. Students with ability in STEM subjects need detailed information on the full range of options available to them by STEM specialist advisors.
4. Further support should be provided for the administrative costs of apprenticeships, internships and graduate traineeships, and other means found to incentivise employers to provide apprenticeships and stimulate employer interaction with course content and delivery.
5. Formal recognition for professional qualifications in engineering that strengthen the aspirations of students and apprentices is needed from Government.
6. The resource allocation for engineering courses in higher education institutions should be at least 2.5 to guarantee world class engineering programmes and deliver enhanced engagement with industry.

2. How to make the UK a leader in low carbon technology

The UK government has set the challenging target of reducing CO_2 emissions by 80% (against 1990 levels) by 2050. More immediately the Climate Change Act has set an interim goal of a 26% reduction by 2020. In the short term much of the engineering sector's focus will need to be on deploying existing low carbon technologies at scale. In the longer term, however, we will need to harness scientific and engineering innovation to develop new and/or more efficient products, services and infrastructure.

Two key factors underpinning continued green innovation – boosting engineering skills and maintaining the health of the UK's world class science base – are covered elsewhere in this document.

A clear and stable policy framework

Investing in low carbon innovation is risky and risk adds to costs. In the current economic climate it is therefore vital that government plays its part in reducing risk by setting and maintaining a framework with clear goals and stable policies for achieving them. Key issues include:

CO_2 reduction

Decarbonising energy supply will be at the heart of the transition to a low carbon economy. Alongside the very clear goals of the Climate Change Act, the UK also has EU level commitments to increase the proportion of its energy derived from renewable sources.

While there is understandable reluctance for government to "pick winners", the upfront costs of developing the technology in areas such as Carbon Capture and Storage are so great that government must give a clear indication that it is willing to support and facilitate their future deployment beyond the four trials proposed in the current Energy Bill.

Regulation, planning and tax

Uncertainty around the future price of carbon is the single biggest barrier to investment in low carbon innovation. Government needs to continue to strive for a binding international agreement. It should also signal that it will create a floor for the carbon price, either by promising to intervene in the EU Emissions Trading Scheme or by shifting the burden of business taxation to "polluter pays" taxes, thereby encouraging greener forms of industry.

Companies assessing future options, as well as investors making lending decisions, look for certainty and durability of the tax and regulation regime. This has a direct impact on their assessment of the risk and potential return on investment and therefore the scale of investment made by the private sector in low carbon innovation. Government must acknowledge this and look to maintain a stable regime across all engineering and manufacturing sectors. However, as long as signalled well in advance, changes to support mechanisms dependant on certain market conditions being met, or being time-bound, would be a useful way of ensuring that certain technologies did not become over-supported as their stand-alone commercial attractiveness increases.

In addition, when making investments in innovation that will lead to new physical infrastructure, the ability of the planning regime to produce predictable results, within a reasonable time frame (ideally under a year) is vital. We therefore welcome the introduction of National Policy Statements for infrastructure and the new decision making procedures for major projects currently overseen by the Infrastructure Planning Commission. The engineering institutions will work with the government consultation process with a view to ensuring that the National Policy Statements represent correct and adequate engineering advice.

Turning ideas from academia into practical innovation

The UK has a poor record of turning its world-leading academic research into commercial products. A classic example for the low carbon agenda is wave power, where research in UK universities stretching back to the 70s and 80s has only, so far, found application overseas, notably in Portugal.

The UK has strong mechanisms for supporting pure research and applied research in its universities. However, the bridge between applied research and commercially exploitable products and services remains weak.

Government has set up the Technology Strategy Board (TSB) to help address this gap but its current funding is too small and the spread of areas in which it operates too wide for it to be fully effective.

Capturing and disseminating “hidden innovation”

In many areas of engineering, for example major infrastructure projects, much innovation is “hidden”, taking the form of organisational and process improvement, technology transfer from other sectors, and “on the job” problem solving. Improving the engineering sector’s ability to capture, disseminate and absorb this information will be central to improving its overall contribution to reducing emissions. Professional engineering bodies have a key role here but government can help by continuing to support Knowledge Transfer Networks.

The Technology Strategy Board (TSB) supports 25 Knowledge Transfer Networks, which link industry, academia, government and other stakeholders. The KTNs provide a means to speed up the transfer of knowledge within and between industry sectors. They also provide a focal point for industry to advise government on its innovation needs.

Policy recommendations

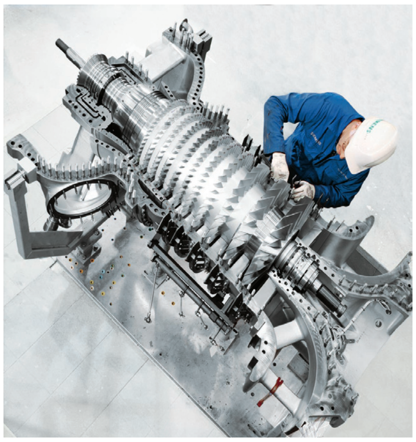
The UK must seize the opportunity to develop global leadership both in low carbon energy in order to power a low emission industrial base, and the low energy processes that will make industry efficient and competitive. Government should:

1. Put in place a stable, unambiguous and well communicated policy and regulatory framework.
2. Give priority to research funding for low carbon technologies.
3. Simplify and reduce barriers to market entry and the costs of doing business.

3. Ways of capitalising on the value of the UK science and engineering research base

The UK has successfully developed a vibrant, world-class science and engineering research base, which provides a huge store of new ideas, technologies and intellectual property. This base has benefited hugely from significant growth in public funding for research over the past 10 years. In most science and engineering disciplines, the UK is among the top four countries in the world in terms of the quality of its research output. In many specific areas it is pre-eminent. Maintaining this position will provide a solid basis for the creation of a knowledge-led economy, recruiting and retaining the brightest minds, and attracting inward investment by international research-based companies.

The key to capitalising on our strong research base lies in the ability to transfer knowledge from academia into the market place, either through links between established companies and research groups, or through the formation of new spin-out companies exploiting the findings of academic researchers. To realise the full potential of the UK research base, greater business support and commercial advice needs to be provided to incentivise the greater involvement of our world-class engineering sector in leading university departments and unleash a wealth of ideas and ways of thinking that could bring tangible social and economic benefit.



Many programmes and initiatives already foster collaboration. Research Councils are placing academics in industry and vice versa, enabling those involved to gain from new perspectives and better understanding of the others' working methods and needs. A number of regional funds support knowledge exchange activities in higher education institutions, as does the Higher Education Innovation Fund. The TSB brings people and organisations together in the hope of sparking new ideas, unlocking hidden or intrinsic innovation and providing support to bring such innovations closer to market.

The UK can boast some real successes in this area. Around a quarter of innovative UK businesses recognise their use of information from higher education institutions and a quarter use information from government or public research institutes. In 2006/07, 327 spin-out companies were formed based on publicly-funded research. From 2003 to 2007, 31 university spin-outs were floated on stock exchanges with an initial public offering value of £1.5 billion, and 10 were acquired for a total of £1.9 billion – a win-win situation for business, higher education and the economy.[15]

However, the UK lags behind some of its international competitors in its ability to capitalise on the output of research. Our private sector R&D spend – generally seen as a good indicator of the strength of our potential to commercialise research – trails substantially behind public sector investment in this area, and is also significantly lower than the levels achieved by key competitors, standing at 1.1% of GDP compared with 2.6% in Japan, or 1.8% in the USA.[16] Internationally, the UK's ratio of private to public R&D is low – the UK should be getting more private-sector bang for its public-sector buck. If we do not keep up with our competitors in this area, we are at great risk of losing inward investment by exactly the sort of mobile, high value-added businesses we wish to encourage to capitalise on the investment we have already made in our research base.

Further along the innovation cycle, the UK has a poor track record in nurturing and retaining growing companies. It is a stated aim of the government to grow a £1 billion science-based company, but to date the UK has not come close to achieving this goal. Many growing companies have relocated outside the UK to take advantage of preferential tax and grant regimes.

We believe that the UK government should provide all the support which it can introduce, within national and international legislative frameworks, to encourage the transfer of knowledge from the research base to commercial application and the creation of new billion-pound businesses in the high technology sector.

Policy recommendations

1. Incentivise the business sector to engage with universities. Knowledge transfer is a resource intensive process. If it is to be effective, it requires businesses to dedicate time and effort by experienced and knowledgeable staff to identify the opportunities arising from the work of their research partners. By providing incentives, government can ensure that business can afford to give the knowledge transfer process the priority it deserves.
2. Enhance support for collaboration and people exchange between universities and industry. The 2003 Lambert Review of Business-University collaboration created a framework for the transfer of knowledge between universities and businesses which has worked well. A similar framework for the transfer of individuals could substantially improve on current working practices.
3. Improve national infrastructure and supply chain management systems for transport and electronic communications (such as broadband) to facilitate the development of knowledge networks. Better links will promote the engagement of

individuals from different organisations, especially those based in more remote locations in the UK.

4. Roll out the Small Business Research Initiative (see page 8) across government to incentivise all departments to engage with small science-based businesses. In the USA, the equivalent scheme has been widely embraced by federal government and has shown significant success in both supporting small businesses and providing innovative products to meet government requirements. In the UK, take-up within government has been low. If it could be increased, the scheme has the potential to achieve the kind of results already proven in the USA.
5. Maintain the provision of long-term investment in start-ups through a large-scale research-focused venture capital fund. Government has just announced the introduction of the £1 billion Investment Fund for innovative new companies – we support this initiative and wish to see it continue. It will be vital for this fund to be maintained despite public spending pressures to ensure long-term success. It will be important for the fund to focus in particular on the needs of science-based businesses, which have longer lead times than those seen in other sectors.
6. The R&D tax credit scheme should be expanded to ensure that the UK is positioned ahead of its European competitors.

4. Harnessing the power of public spending to encourage innovation

As previously stated, the government spends £220 billion a year on goods and services procured from the private and third sectors. With the right processes in place, public procurement can harness and foster innovation, resulting in:

- a revitalised and reinvigorated high tech sector. Many scientific and technological discoveries are made in the UK but we need to get better at "translating" discoveries into products and business. An important way of achieving this will be making better use of public procurement to "pull" new products and services into the marketplace
- better public services and better value for money. At a time of high national debt, all the major parties have said that public sector budgets will need to be cut after the General Election. By taking advantage of emerging technologies, government can maintain or improve many services with reduced long term costs

At present public procurement is failing to encourage innovation. Addressing this should be one of the main priorities of government.

Public procurement of goods and services

The OGC Publication "Promoting Skills though Public Procurement"[17] makes a good start, but needs to be more fully enforced. There is a tendency for government procurers to buy well-known, "off-the-shelf" products, aiming for "lowest cost at any cost". A recent report found that two thirds of government departments do not encourage suppliers of goods and services to offer innovative solutions when they tender for work.[18] Public sector staff tend to continue with existing solutions which appear "safe", rather than buying innovative new solutions which could transform public services. This should be balanced with an enhanced commitment to innovation, tempered by an appropriate awareness of risk. Best practice would require procurement staff to:

- engage in discussion with industry early on, before setting purchasing specifications, thus giving suppliers more time to prepare innovative solutions
- set outcome based specifications: outlining what they want to achieve rather than merely specifying what they want
- consider skills needs: procurement decisions should consider the long term development of the UK's skills capacity and make decisions accordingly
- ensure that small and medium sized enterprises (SMEs) are able to bid for contracts, as they are often better able to innovate than large companies
- keep procurement processes simple. There should be few (or no) prequalification requirements as this discriminates against many SMEs, and particularly start-up businesses

Engaging SMEs

There are specific problems around ensuring SMEs are able to bid for public sector contracts. Only 16% of the total value of central government contracts was won by SMEs in 2005/6.[19]

In 2008, Anne Glover led a committee to examine what could be done to make it easier for SMEs to supply to the public sector. The committee made 12 recommendations which would increase SME engagement with government procurement by increasing transparency, simplicity and making procurement more strategic.

Pre-commercial procurement

This is procurement of research and development (R&D) towards the creation of new products and services. Typically, pre-commercial procurement will take place in a number of stages. The procurer will fund developers through a particular stage of R&D (for example exploration and feasibility) and then if this stage is successful, provide additional funding for the next stage of R&D (for example prototyping). Each party benefits: the procuring party stimulates development of products and services in which they are interested while the developer can share the financial risk of R&D. Ultimately, the aim is to bring the product or service under development to a stage where it is commercially viable.

The main vehicle for pre-commercial procurement in the public sector is the Small Business Research Initiative (SBRI). In the USA the SBIR – the equivalent of the UK's SBRI scheme – has been in place since the early 1980s. SBIR has proved hugely successful. For example, SBIR schemes administered by the National Institutes for Health between 1992 and 2001 resulted in 666 new patents and 322 new trademarks. As another example, companies involved in SBIR schemes administered by the National Science Foundation generated cumulative total sales of $2.2 billion directly attributable to their involvement in SBIR, with another $6.9 billion indirectly related to SBIR research.[20] There is an opportunity to have a similarly dramatic impact in the UK (see recommendation 4, page 7).

Policy recommendations

1. Recognise the potential of public procurement to increase the translational capabilities of the UK and improve public services.
2. Introduce a new culture of innovation across the public sector, reducing excessive risk aversion amongst civil servants and public procurement professionals.
3. Implement the recommendations in the Glover report as a matter of priority to ensure that innovative SMEs are able to engage in provision of goods and services to the public sector.

5. Making greater use of engineering advice in government policymaking

Engineering is concerned with the art and practice of changing the world in which we live. In doing this, engineers seek to achieve useful and beneficial outcomes in the physical world and in a business context. Much government policy is delivered by means that require engineering solutions, which need to be developed, informed and tested as part of the policy development process.

Government needs to recognise the difference between scientific advice and engineering advice and ensure that policy is appropriately informed by engineering advice at all stages of development and delivery, through the right blend of civil service expertise and outside advice from engineering professionals.

The value of the engineering perspective

The delivery of many areas of public policy has an engineering dimension that is best considered at the outset of the policymaking process. Moreover, an engineering perspective can enhance decision-making at all stages of the policy cycle by helping ensure that policy is feasible and practical and that the full range of technology options has been considered. The engineering dimensions of policies are often highly complex, requiring a balanced and expert assessment of different options. They are intrinsically linked to economic, social and environmental issues and should not be ignored until after the main decisions have been made.

Engineers understand how to work with risk and uncertainty in project delivery, a key element of identifying and weighing options in policy formation. In articulating the engineering issues inherent in and raised by a policy, an engineering approach can help identify potential barriers to implementation and ways of avoiding them.

Policymaking process

A number of key policies fundamental to the long-term national well-being have suffered and been found wanting as a result of a lack of good engineering advice being taken at the formulation stage. Under current ways of working, some individual engineers, industrialists and consultants are called on to provide policy advice but with little opportunity for peer review. A more formal policy-making process that would call for advice and ideas at a much earlier stage than at present could be helpful. This would allow government to access a broader range of engineering advice before the policy direction is framed and the opportunities to explore alternative solutions are closed.

IUSS Select Committee report

The need for policymakers to engage more effectively with engineering advice was one of the key recommendations of the House of Commons Innovation, Universities, Science and Skills (IUSS) Select Committee's report on engineering.[21] The organisations in the professional engineering community welcomed the committee's significant recommendations for a structure to provide engineering advice and have since been working together to create a well-signposted, open door for engineering advice for government – *Engineering the future* is one such initiative.

The professional engineering organisations have the potential to make a significant contribution to government policy. The focus of the professions is the public good and the engineering profession seeks to improve quality of life through its work.

The civil service

To commission engineering advice, evaluate and make best use of it, government needs to be an intelligent customer. This means having civil service staff who are able to understand and evaluate engineering advice. With the focus strongly on evidence-based policy, the civil service needs engineers amongst its staff who are able to source and assess technical evidence.

There have always been highly qualified engineers employed within government, but because engineering has generally always been seen as a policy delivery issue rather than a policy development issue, those engineers have tended to be employed in agencies rather than departments. As political ideas and imperatives are developed into policy within departments, there is a need to embed engineering advice within them by means of more trained and experienced engineers at all levels of the civil service. The government should provide professional development and also require the professional registration as Chartered Engineers, Incorporated Engineers and Engineering Technicians of both its technical staff and also the staff of its consultants and suppliers wherever such a route is available, to ensure the professional competence of the engineers and technicians providing it with advice.

One way of helping to achieve this would be to expand and adapt the Science and Engineering Fast Stream, whose participants spend time in all parts of a department to gain a broad understanding. However, the focus on handling a new brief every two to three years and delivering ministerial advice pulls against the retention of specialist skills and knowledge. Within the Science and Engineering Fast Stream it is possible for engineering graduates to specialise in engineering-related projects, but the numbers of graduates entering via this route is small – 15 in 2007-2008 compared with 190 recruited to central departments and 100 into the Economics Fast Stream. There is no evidence that the Fast Stream process acknowledges the professional development needs of engineers[22] – this should be addressed.

Advisory network

Making fuller use of the engineering expertise available on the range of government advisory committees would also make an important contribution.

The Government Chief Scientific Adviser (GCSA) and the Departmental Chief Scientific Advisers (DCSA) network have done a very effective job of raising the profile of the scientific aspects of policy issues with ministers. The engineering dimension requires an equally direct focus.

The leadership role of the GCSA with the community of DCSAs and as head of the engineering and science professions in government is crucial. The engineering community is working to support the GCSA in his role of head of the science and engineering profession in government.

The impact of the DCSA network depends in part on the support they get in terms of staff as most of the DCSAs are part-time positions. Building the influence of DCSAs within their departments might be helped by making the posts full-time and ensuring that DCSAs have appropriate and effective staff resources within departments.

To reflect the centrality of engineering to certain government departments, these departments would benefit from the appointment of Chief Engineering Advisers, rather than, or as well as, Chief Scientific Advisers.

Effort should be made to recruit engineers to such posts who have practical experience of large-scale projects. Engineers working in business and industry could contribute skills in finding appropriate, cost-effective solutions to practical problems. This experience would be invaluable in helping departments to understand practicalities of rolling out technology at scale and understanding the breadth of engineering research in the private sector.

Policy recommendations

1. Ensure that policy is appropriately informed by engineering advice at all stages of development and delivery.
2. Introduce a more formal policy-making process that would call for advice and ideas at a much earlier stage and provide access a broader range of engineering advice before the policy direction is framed.
3. Make more systematic use of the expertise of the professional engineering community as a source of advice and support for best policy.
4. Recruit more trained and experienced engineers into all levels of the civil service, and expand and refine the engineering Fast Stream.
5. Ensure the professional competence of the engineers providing policy advice by requiring the professional registration of technical staff, consultants and suppliers wherever such a route is available and provide initial and continuing professional development for engineers and technicians entering the civil service and its agencies.
6. Recruit departmental Chief Engineering Advisers, rather than, or as well as, Chief Scientific Advisers, where appropriate.

With a combined membership of around 450,000 engineers, *Engineering the future* is a broad alliance of professional engineering institutions and associated bodies. The leadership is provided by a core group consisting of:

- The Engineering Council
- EngineeringUK
- The Institution of Civil Engineers
- The Institution of Chemical Engineers
- The Institution of Engineering and Technology
- The Institution of Mechanical Engineers
- The Institute of Physics
- The Royal Academy of Engineering

Engineering the future will be actively engaging with all major political parties in the lead up to the General Election with the aim of securing support for these crucial issues. To discuss any of these matters further, or to seek information from the engineering community in relation to any aspect of policy making, please do not hesitate to contact us.

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Footnotes

[1] Engineering UK 2009, the ETB, p16
[2] Engineering UK 2009, the ETB, p16
[3] Engineering UK 2009, the ETB, p113
[4] Engineering UK 2009, the ETB, p47
[5] Education for Engineering (E4E) Mission Statement
[6] Ibid p111
[7] Educating Engineers for the 21st Century, The Royal Academy of Engineering p11
[8] Engineering UK 2008, the ETB, p62
[9] Ibid, p87
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[11] www.engineeringgateways.co.uk
[12] Ibid, p70
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[14] Transforming Engineering Education: a report on the first year of the new Engineering Diploma for 14-19 year olds, The IET
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[16] OECD Science, Technology and Industry Outlook 2008
[17] OGC April 2009
[18] Innovation across central government (National Audit Office, March 2009)
[19] This is a best estimate based on the data available. Accelerating the SME economic engine: through transparent, simple and strategic procurement (November 2008)
[20] Statistics for the SBIR scheme from D. Connell, "Secrets" of the world's largest seed capital fund (2006)
[21] Turning ideas into reality, March 2009
[22] UK-SPEC – The Engineering Council