The Royal Academy of Engineering

A Vision for Science and Society

Department for Innovation, Universities and Skills

October 2008

1. Introduction

1.1. The Royal Academy of Engineering and the professional engineering community welcome the publication of *A Vision for Science and Society* and the opportunity to respond to it. This response has been produced with the input of the major engineering institutions and is endorsed by all the engineering organisations detailed in Annex A.

1.2. In addition, the Academy has been involved with a group of organisations, led by the British Association, who have submitted a joint response of a general nature. This response addresses issues specific to the engineering community, however, the views expressed reflect many of the views expressed by the British Association-led.

1.3. In common with the organisations that we have engaged with, we do not feel that tackling all questions posed in the consultation directly is either practical or conducive to the full expression of our views. This response, therefore, is in the form of a commentary on the main sections of the consultation with answers to specific questions where appropriate.

1.4. The DIUS Vision for Science and Society includes engagement with society in its broadest sense, from science centres and festivals, through information provision by consultation, active dialogue and other media, to enabling citizen empowerment and decision-making. It also includes in its scope the use of science by society and the provision of scientific advice to policy makers for the benefit of society. It ranges from the promotion of science through to full public participation.

1.5. The vision as set out in the consultation is for a simplified, better coordinated and streamlined approach to public engagement for science. It also appears to offer a homogenous view of public engagement. As an objective, we think this approach is flawed because a “one size fits all” approach to public engagement is unlikely to succeed. There is already a large number of successful public engagement activities across science and engineering, each addressing separate needs with differing approaches depending on the objectives or audience. It is important for the vision to be clear on the distinction between public engagement that promotes science and engineering to the public and participatory engagement. The latter is a particular type of public engagement which aims to create a platform for debate and dialogue in order to capture how society frames socio-technological issues as part of policy thinking, formation and decision making. This has distinctly different set of objectives and expectations than that of public engagement more generally.

1.6. For participatory engagement to succeed, it is essential that more policy makers, scientists and engineers understand not only the methodology to be used, but also see the benefit of such activities. It is only by observing and taking part in more participatory engagement activities that key players will value the involvement of the public in higher level policy debate.

1.7. Public participative engagement in policy-making requires methods and techniques that are very different from the general promotion of engineering and science to the public. Differing results should be expected depending on locality and the people being engaged. For example, when using public engagement techniques to help inform policy decisions (such as the siting of

nuclear powerplants), the approach and results will be very different with a local community than with the population in general.

2. The place of engineering in the Science and Society Vision

2.1. We underline the importance of placing engineering at the heart of the Government's Science and Society strategy. Engineering (in its broadest sense) is where science meets society and where scientific advances impact on the health, wealth and wellbeing of individuals and the nation.

2.2. Engineering is a complementary discipline to science. The boundary between the two remains indistinct, with much cross-over between them. The merging, in the Vision, of all scientific-related disciplines under the umbrella term 'science' may be convenient but does little to promote understanding and engagement with the differing nature, outputs and impact of pure science research, applied sciences, engineering and the production of technological products and services.

2.3. While creation and exploitation of scientific knowledge are both important the emphasis in the Vision of the term "science" tilts the balance towards the pure and away from the applied, despite the attempt to define "science" to include engineering and all other forms of related knowledge. We recommend that the Vision also focuses on the aim of the UK being a world leader in the exploitation of science, as well as the creation of scientific knowledge. The emphasis in the Vision solely on the creation of scientific knowledge fails to address the commonly held criticism that the UK is good at creating scientific knowledge that is then utilised by international competitors rather than being developed in the UK.

2.4. The Government needs to recognise specifically that engineering is the driver that will overcome the most significant Science and Society challenges that we face both nationally and internationally, including those stated in the consultation: tackling and adapting to climate change; global security and international terrorism; food, water and energy security.

3. A society that is excited by engineering and values its importance to our social and economic well-being

3.1. We recommend that the Vision promotes a society that is aware of the nature of science and engineering, understands the roles of science and engineering and their impact on society, as well as being able to engage in decisions surrounding it. This will lead to a society that is 'excited' by science and engineering, but also able to discuss and debate both its applications and implications.

3.2. Perceptions of engineering

3.2.1. Public misperceptions and misunderstandings of engineering are, arguably, the greatest barrier in achieving any Vision for Science and Society. The study by the Academy and the Engineering and Technology Board, *Public Attitudes to and Perceptions of Engineering and Engineers 2007,* demonstrates that there is very limited public awareness of the nature and scope of engineering and its impact on society. Young people in particular have a significantly limited understanding with six out of ten 16 to 19 year-olds stating that they know 'very little' or 'not very much' about engineering.

3.2.2. Public engagement activities need to be based on topics that show science and engineering in context, raise awareness of their impact on society, and are relevant to individuals. For example, the Academy commissioned the theatre-company, Y-touring, to develop and deliver an audio play to engage young people with engineering and technology in society. The play, entitled *The Projectionist* has been used to raise young people's awareness of the role and impact of engineering in society and on their lives by engaging them in a creative storyline and informed debate about surveillance technology, crime prevention and privacy (http://www.ytouring.org.uk/).

3.3. Engineering and the media

3.3.1. The Science Media Centre (www.sciencemediacentre.org) has provided a new and very effective route for engineers and scientists to work with the national media. Set up originally to provide rapid and accurate scientific advice on request to journalists involved in breaking news stories and putting them in touch with scientists willing to be interviewed, it has now expanded its service to offer proactive background briefings on current issues in science. In response to lobbying from the engineering community, the Centre now includes a full-time engineering press officer, who can call upon a database of increasingly media-savvy engineers and works closely with the Academy and the engineering institutions to identify engineering issues where the SMC can contribute. These have included the Greyrigg train crash, the Heathrow plane crash and Government announcements on energy policy and climate change.

3.3.2. Organisations themselves can also specifically and proactively raise the media profile of science and engineering. The provision of media training of people within organisations can be very helpful in this regard.

Case study: ChemEnvoys

In 2007, IChemE (the Institution of Chemical Engineers) embarked on an ambitious external relations strategy to raise the profile of the profession. Part of the campaign involved recruiting a team of ChemEnvoys – member volunteers to face the media as an IChemE spokesperson within their area(s) of expertise.

Using an external PR agency for support, the 12-month campaign was a success with ChemEnvoys and senior members of IChemE staff appearing throughout the national and international media. The ChemEnvoys initiatives provided a foundation on which the Institution, now working without external agency support, can maintain and build.

3.3.3. As shown from *Science in Society: findings from qualitative and quantitative research* conducted by MORI on behalf of the Office of Science and Technology in 2005, over 70% of the population gather their information on science from television. Programmes specifically labelled "science" or "engineering" are likely to attract mainly those with an existing interest in the subject. However, we can raise awareness of engineering and its impact on society to a much wider audience by using media briefings to embed engineering content and expertise on specific issues and topics. There is an opportunity for the engineering community to focus its resources and build better relationships with editors, broadcasters and producers. This would lead to raised awareness of the nature and rich diversity of engineering topics that could provide excellent content as well as offering a route into

essential engineering expertise and commentary for TV programmes that cover engineering-related issues.

Case Study: BritDoc Festival

The Academy teamed up with the Channel 4 British Documentary Film Foundation to bring together engineers and documentary makers in an unusual networking session at last year's BritDoc 2007 Festival in an event called *Would Like to Meet*. Based on a speed dating type format, the event provided opportunities to build potential collaborations and valuable contacts between two creative yet radically different sectors. Covering a variety of contemporary and engaging topics, such as artificial intelligence, smart materials, climate change and disaster relief, the aim was to provide a catalyst for the making of future documentaries on engineering-related issues.

3.4. 'Professionalising' public engagement with engineering

3.4.1. The national academies, learned societies and other organisations have a key role in enabling, facilitating and leading the drive for more engineers and scientists to engage, and engage well, with society. There will always be a need for organisations such as these, along with other public engagement practitioners, to broker and facilitate engagement of engineers and scientists with society and provide training, examples of best practice, networking opportunities and peer-support.

Case Study: Ingenious – Engaging Citizens; Engaging Engineers

The Academy's DIUS funded Public Engagement Grants scheme (Ingenious – engaging citizens; engaging engineers) aims to foster a community of engineers who have the knowledge and motivation to raise public awareness and take part in debate about engineering and its impact on society. The Activities and Development awards is one of the two streams of funding offered. This particular awards scheme was founded on the basis that, for those new to the field, public engagement can be a daunting endeavour. Hence the awards provide much-needed training, mentoring support and experiential learning to engineers across the UK, from different disciplines (from both academia and industry) and levels.

4. A society that feels confident in the use of science and engineering

4.1. Public dialogue in policy making

4.1.1. It is important for the Vision to be clear on the distinction between public engagement that promotes science and engineering to the public and participatory engagement. The latter is a particular type of public engagement that aims to create a platform for debate and dialogue in order to capture how society frames socio-technological issues to feed into policy thinking, formation and decision making. This has distinctly different set of objectives and expectations from 'public engagement' more generally.

Case study: Theatre of Debate Programme

The Academy, in partnership with the Y-touring theatre company, is developing and delivering a major 'theatre of debate programme' consisting of a touring play, debate series and public dialogue activities. The project will use the play as a stimulus to explore and gather audience attitudes and views on the use of electronic patient records and databases for health and medical research. The information will be gathered using electronic polling, deliberative workshops and a public conference. The findings will be disseminated to the appropriate stakeholders and those involved in policy formation to inform higher-level debates and provide data on how various public audiences frame the issues, applications and implications of this controversial use of information technologies for health and medical research.

4.2. Engineering advice in policy making

4.2.1. There is a great need for those involved in policy making, across the various government departments, to become aware of the breadth, depth and scope of engineering. The policy development process will be enhanced by listening to the voice and specific expertise of engineers involved in many of the significant science and society issues such as artificial intelligence, data security, carbon capture and storage, energy, food security and sustainability, and synthetic biology.

4.2.2. We urge the Government to ensure that policy-making is informed by the best engineering advice at every stage of the policy cycle. Organisations such as the Academy and the engineering institutions are able and prepared to provide independent views that have no political or commercial bias. By drawing on these sources of engineering advice and involving them more visibly in public engagement on policy, the Government could increase the public's confidence in policy making.

Case study: Public Engagement Fellowships

All too often, the voice of engineers is too quiet in policy discussions, public debate and other public engagement. As part of its *Ingenious- Engaging Citizens; Engaging Engineers* grants programme, the Academy has launched a new source of funding which will support and foster a new generation of excellent early/mid-career engineers to explore the implications of engineering for society, develop excellent engagement skills, and proactively build dialogue and networks with the public and policy makers. This scheme will help to build bridges between engineering and the policy makers.

5. A society that supports a representative well-qualified scientific and engineering workforce

5.1. The continued supply of new recruits to a well qualified scientific and engineering workforce is strongly influenced by the exposure young people have to science and engineering topics. The ability to make this happen relies ultimately on the quality and number of well-qualified science teachers in schools; teachers who understand the importance of engaging with high quality, relevant, extra-curricular activities that offer hands-on learning experiences and who embrace the new progression routes into science and engineering careers such as the new 14-19 Diploma in Engineering.

5.2. Careers in science or engineering are under-pinned by the science, mathematics, design and technology learned at school. Progression into graduate roles requires good attainment at A Levels or their vocational equivalents. This in turn requires success with GCSEs. So young people have to plan their entry into the science and engineering professions. This means engaging with the very young (probably in primary schools where first ideas on eventual careers are often set).

5.3. The Vision needs to recognise that the engineering workforce is the sum of the crafts-people, technicians and engineers. The engineering community needs to ensure that the routes into technician and other roles are well defined and achievable. Communicating the positive role that skilled people make to engineering is an important part of public engagement with engineering: a component that is often forgotten by public engagement practitioners who are based in universities or in professional institutions.

5.4. With the numbers of 18 years olds in the UK set to fall, it is important to recognise that many of the engineering skills required to drive society forward must be developed in workers who are already in the workforce. Effective communication of the benefits to be gained from adult workers undergoing further (and higher) education and training is required.

5.5. The Royal Academy of Engineering ,through its work with the London Engineering Project and the 14-19 Diploma in Engineering has developed approaches to engage with those who are currently under-represented in engineering: women, people from BME groups and people from the lower half of the socio-economic scale in particular.

5.6. What further support do teachers need to help young people understand how science works, how government works and how the media works?

5.6.1. Secondary school students should be taught science, technology, engineering and maths subjects by staff who are thoroughly trained and well-versed in the subjects that they are teaching. Teachers need support in helping young people understand science better. A science teacher who never practised in research or in industry will rely mostly on what they were taught at university, which may be incomplete or out of date. Therefore, teacher CPD is vital. This is especially important for teachers who are teaching outside their specialist area. The Science Learning Centres clearly have a role to play and should be encouraged to provide courses on how science is dealt with in industry, research, government and the media. The new secondary curriculum, with its emphasis on the real world context for the subjects taught in school, is also important. Awarding bodies should be exhorted to produce curriculum support materials that exemplify this with interesting examples of how science and engineering influence developments in science.

5.7. What more do schools need to enhance the science curriculum to make it more exciting and relevant?

5.7.1. Effective initial teacher training and ongoing workforce CPD is needed to overcome the general lack of experimental science in many schools. Science also needs to be linked to engineering so that practical outcomes of science theory may be seen in the products, artefacts, systems, environments and inventions that surround children every day. We also

need to encourage school STEM departments to share good practice, specifically where schools are working with similar groups of students in their own boroughs.

5.7.2. The expert bodies, E4E (Education for Engineering) SCORE and ACME, will provide a clear and united voice to Government and the devolved Assemblies, ensuring they receive the highest quality advice on STEM education so the education system produces people who are well equipped to keep pace with technological changes in society.

Case study – the IET's Faraday

The IET Faraday is a free resource aiming to encourage students to study and remain studying STEM subjects. It is a web based resource with an annual theme.

The teaching and learning materials have primarily been designed for Key Stage 3 and the new Engineering Diploma and include an extensive range of support materials to fit all UK curricula. The 2008 website has a theme of Engineering in Sport and features specially made films based around cutting edge sports technology and the engineers behind it, with associated flexible teaching and learning materials. The site also offers an interactive 3D game, a blog and the chance to win prizes by entering the Faraday competition. In addition to this, schools from all over the UK will be invited to send teams of Year 8 students to participate in locally held Faraday Engineering Challenge Days. Three teams will be chosen to take part in the national final, which will be held in London during the first UK Young Scientists and Engineers Fair in March 2009.

Case study – IET's Flipside

Flipside magazine is a picture-led glossy magazine, published by the IET, aimed directly at young teenagers. It covers music, movies, sport, adventure, wildlife and gadgets - but all with an undercurrent of science, engineering and technology. It is designed to improve images - to show that engineers aren't people who fix your car but design your mobile phone, write your computer game or even work with popstars. And scientists don't all wear white coats and hang around in labs - they might go into space, explore the depths of the oceans or work with dangerous animals in Africa. *Flipside* is not aimed at teachers and it is not meant to be linked to any curriculum because it's not meant to smack of schoolwork – readers pick it up because they want to rather than feel they should. The magazine is sent to every secondary school library in the UK as well as paying subscribers. Independent market research now shows it has a readership of around 300,000 and readers say it is more likely to make them choose a science or engineering career.

5.8. What can the science and business communities do to tell young people about the career opportunities that science education opens up in all work areas?

5.8.1. The deployment of younger Science and Engineering Ambassadors into schools is key. As role models for science and engineering, they can provide first-hand evidence of where science education can lead. An increase in the depth and quality of training for these SEAs would pay dividends.

5.8.2. Raised awareness of science and engineering in primary school is also essential. There should be a science champion in every primary school - science co-ordinators are already in place, but they are not always science or engineering graduates.

5.8.3. The new STEM directories are key to ensuring enrichment activities are co-ordinated and effective. But more needs to be done. Presently, there is too little impact evaluation undertaken in the sector to be able to tell what interventions work best. The evaluation strand of the Government STEM Programme needs further work in order to make a more persuasive argument for the further use of (expensive) evaluation.

Case study: Whynotchemeng?....

In 2001, chemical engineering at UK universities was in dire straits. Just 940 undergraduate students began studying the subject that year, with fewer than 5,000 applications made.

Since then, the subject has been revitalised with a 70% rise in applications and 55% growth in admissions. Last year a record 1,455 students began chemical engineering degrees at UK Universities – a figure that is likely to be topped this year.

This extraordinary revival can be traced back to the launch of the Institution of Chemical Engineers' *Whynotchemeng*? schools and careers campaign. *Whynotchemeng?* is funded by both IChemE and corporate sponsorship. The campaign relies on both active volunteers, keen to pass on their experience and enthusiasm to schoolchildren and college students and financial support from industry. Companies, including Foster Wheeler, BP, Shell and Tate & Lyle, all donate money to the campaign, in recognition of the contribution it makes to ensuring a steady supply of high-quality chemical engineering graduates

5.9. What can business do to make sure that its efforts in enrichment activities are co-ordinated and effective?

5.9.1. The Royal Academy of Engineering leads the Barrow-in-Furness Engineering Project. This is an example of how the enrichment activities of business (BP and BAE Systems in this case) can be co-ordinated in order to maximise impact. The Royal Academy of Engineering has committed itself to raising the profile of engineering careers and engineering education in the schools and colleges of Furness. It coordinates the input from BP and BAE Systems so that the pupils receive a structured programme of enrichment activities. In this way one intervention builds on those that went before. This is to the benefit of business as well as the young people involved.

Case Study: The UK Young Scientists and Engineers Fair

The UK's inaugural Young Scientists and Engineers Fair is to take place in March 2009. This high-profile landmark three day event is targeted at young people (11-19) and their teachers to celebrate and raise awareness of science and engineering, their role in society and the diversity of career opportunities available. The fair will provide a national platform to showcase young people's science and engineering projects, announce and celebrate the results of several national science and engineering competitions and provide a suite of activities to engage young people in science,

engineering, technology and maths with six floors of inspiring shows, exhibitions, demonstrations and workshops.

Through the events at the Fair, young people will discover the huge range of opportunities that exist for those with science and engineering qualifications in the UK.

The fair is funded from a number of sources with sponsorship by Government, business and industry forming a key element of the funding strategy and is timed to take place just prior to National Science and Engineering Week that runs from 6th to 15th March 2009. The fair is a collaboration between a significant number of STEM organisations.

5.10. Is there a different way to teach science subjects which could help overcome the issue of under-representation of some groups?

5.10.1. We need to make sure that science is taught in a way that is directly relevant to young people and the specific underrepresented groups. Sometime this is as simple as just knowing your audience and by making sure that you reference ideas/products/contexts and cultures that they can identify with. The LEP (the Academy's London Engineering Project) has developed an approach for running gender and culturally relevant engineering activities.

5.11. How can the science community and employers show society that they welcome and embrace diversity, including women, ethnic minorities and older people?

5.11.1. There is value in showcasing good practice in the community and industry. The UK Resource Centre for Women in Science Engineering and Technology (UKRC) has good examples of where communities and industry welcome and embrace women from all backgrounds.

6. Tools for measuring progress

6.1. The Academy/ Engineering and Technology Board report entitled *Public Attitudes and Perceptions of Engineering and Engineers 2007* provides a UK-representative picture of public awareness, understanding and views of engineering and engineers as well as establishing a solid baseline measurement against which to track changes and measure impact (www.raeng.org.uk/pa).

Submitted by:

Mr Philip Greenish CBE
Chief Executive
The Royal Academy of Engineering

Prepared by:

Richard Płoszek
Senior Policy Advisor
24th October 2008

ANNEX A

List of signatories.

British Computer Society
Chartered Institute of Water and Environmental Management
IET
Institute of Acoustics
Institute of Cast Metal Engineers
Institute of Healthcare Engineering and Estate Management
Institute of Marine Engineering, Science and Technology
Institution of Agricultural Engineers
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Engineering Designers
Institution of Gas Engineers and Managers
Institution of Highways & Transportation
Institution of Lighting Engineers
Institution of Mechanical Engineers
Institution of Railway Signal Engineers
Institution of Royal Engineers
Institution of Structural Engineers
Institution of Water Officers
Royal Academy of Engineering
Royal Aeronautical Society
Royal Institution of Naval Architects
Society of Environmental Engineers
TWI