THE ROYAL SOCIETY

CELEBRATING 350 YEARS

Royal Society's response to *a vision for Science and Society: a consultation on developing a new strategy for the UK*

The Royal Society welcomes the opportunity to contribute to Government's developing vision and strategy for Science and Society. Our response builds on the Royal Society's submission to Government's first consultation in 2007 on its proposed vision for Science and Society (Royal Society 2007a), and draws on other relevant policy documents referred to throughout. This submission has been approved by Professor Martin Taylor, Physical Secretary and Vice-President on behalf of the Council of the Society.

Introduction

It is encouraging that Government is looking to bring together and learn from experience built up by many organisations and individuals. In the past decade, considerable expertise has developed amongst many stakeholders in ways of strengthening relations between science and society. For example, progress has been made at the Royal Society and elsewhere in public engagement with science, in science communication and in supporting science and mathematics education. The new strategy presents an opportunity for Government to consider activities that sustain and build on existing good practice.

With this in mind, the Royal Society has been in conversation with a range of organisations on the proposed vision and way forward, elements of which will be found in our submission. We recognise this as an opportunity for those working in science and society, including Government, to identify common goals and work together more closely in their delivery. We therefore welcome this new impetus from Government and recognise Government's role in providing strategic parameters, resources and support as we all work toward a mature vision for science and society.

Following broad consensus on a vision for science and society, the detail of achieving that vision can be worked out, perhaps through the development of particular work packages. We do however feel that at this stage the vision itself needs some refinement, and needs to be more closely aligned with other Government policy frameworks and initiatives.

The first part of our response focuses on connections between the vision and other key policy frameworks. We then indicate particular strategies and initiatives undertaken by the Royal Society that have been shown to be effective. Finally, we answer some of the questions posed in the consultation document.

Policy frameworks for Science and Society

While the specific focus provided by the 'Science and Society' strategy is welcome, more effort is needed to explain how this strategy will be aligned and integrated with broader Government frameworks for science and innovation policy. For example, in the 'Science and innovation investment framework 2004-2014', science and society debates merited an entire chapter of discussion (Ch.7). Yet in the recent 'Innovation Nation' white paper, such issues were only addressed in the briefest of terms. There is a danger that science and society is perceived as an afterthought, to be dealt with in its own silo (and through its own strategy), rather than an issue of fundamental importance that should be located at the centre of science and

innovation policy. For example, the Technology Strategy Board (TSB) is an important initiative, tasked with driving public and private sector innovation. The position of the TSB with respect to Government's emerging vision and strategy for science and society requires explanation.

Looked at from another direction, it is also unclear how the Science and Society strategy fits with wider Government efforts to strengthen citizen engagement in politics and policy-making. The recent Ministry of Justice discussion paper on 'A national framework for greater citizen engagement' addresses the challenges of citizen engagement in comprehensive terms, but makes no reference to science and innovation as an arena in which Government and other stakeholders have built up considerable experience of what works and what doesn't. This seems like a missed opportunity, and it would be good for the final version of the strategy to draw out these linkages more explicitly, and for Government to highlight science policy as one area that has demonstrated real leadership in opening up decision-making to the public and stakeholders over the past decade.

The Government's proposed vision

The Government's vision is for a society that is excited by science; values its importance to our social and economic wellbeing; feels confident in its use; and supports a representative, well-qualified workforce.

The Royal Society supports the sentiment of this vision and shares a commitment to achieving the three broad strands that it contains: a society that values and is excited by science, is confident in science and supports a representative, well qualified workforce. These strands resonate with two of our own strategic goals: "**to inspire an interest in the joy, wonder and excitement of scientific discovery**" and "**to invigorate science and mathematics education**." However, as described below, the Government's vision goes only part way to our own for we see science and society issues as part of our goal "**influence policy-making with the best scientific advice**".

Inspire an interest in the joy, wonder and excitement of scientific discovery

The Society has a significant public programme to *inspire an interest in the joy, wonder and excitement of scientific discovery*. Involving over 9000 people in 2007, this programme includes lectures, panel discussions, library talks and a Summer Science Exhibition. The Society's lectures are also webcast live and made available online as video on demand (library talks are available as a podcasts) to allow the widest number of people to access the public programme. The Society's Press Office works to engage wider publics with science through media coverage of the Society's activities, and by drawing attention to research published in the Society's peer review journals.

As well as communicating science, the Royal Society is looking to deepen public engagement. We share with Government the aspiration to establish science as an integral part of our culture. Science underpins much of our culture already, not least in enabling many aspects of modern life, and we feel that this contribution needs stronger recognition.

On the Government's part, greater engagement between the Department for Innovation, Universities and Skills (DIUS), and the Department for Culture, Media and Sport (DCMS) may assist in the delivery of this aspiration. For the Society, as we move toward our 350th anniversary, we are planning an ambitious programme of activities to celebrate the achievements and contribution of science to our broader culture.

The centrepiece of our 350th anniversary celebrations will be a nine day *Summer of Science* festival to be held at the Southbank Centre in July 2010. This will incorporate an expanded and enhanced Summer Science Exhibition with an accompanying public programme of lectures, debates and concerts as well as family and school workshops. Our anniversary programme includes partnership activities with major London museums and galleries to highlight the often neglected role that science plays in the cultural life of the capital. We are also working with over 60 museums and galleries across the UK on a celebration of local scientific heroes – from pioneers of the Industrial Revolution to contemporary scientists finding solutions to today's problems.

Invigorate science and mathematics education

Achieving the goals identified within the vision will rely on a continued emphasis on partnership working and high quality evidence, no more so than with respect to education. The Society has been pleased to see closer working relationships between DIUS and the Department for Children, Schools and Families (DCSF), and has welcomed opportunities to be more engaged in their work. As part of the Society's own strategic goal to *invigorate science and mathematics education,* we have identified working in partnership and drawing on the best available evidence as fundamental. We want to ensure that STEM education supports a socially equitable curriculum, encourages those with talent to achieve their potential, and provides young people with an accurate and engaging experience of mathematics and the sciences. We have therefore committed to:

- strengthening the base of robust research on issues in science and mathematics education by awarding Education Research Fellowships to excellent individuals;
- providing independent, expert and influential advice to policymakers on improving science and maths education in schools and colleges through the work of the Royal Society Education Policy Unit;
- amplifying the positive impact of the science and maths communities on education by taking a pro-active role in partnership working, specifically, enhancing the influence of the Advisory Committee on Mathematics Education (ACME); and increasing the impact of the Science Community Representing Education (SCORE) partnership by conducting collaborative projects, making joint statements and stimulating debate among the science community.

We are also developing our programme of activities for schools and colleges by:

- supporting our researchers in engaging with schools, linking more scientists and engineers with schools through our Partnership Grants scheme;
- raising the profile of cutting-edge science with teenagers through our Summer Science Exhibition;
- challenging young people's notions about science and scientists through a series of innovative events during our 350th anniversary year.

Limitation of the proposed Government vision

The Government's vision is only part of our own for science and society. We see two limitations in particular: that the vision treats science as a homogenous activity and underplays its rich diversity; and that the vision leaves little room for reflective and critical forms of public engagement with science. These limitations need to be addressed in the development of a final version of the strategy.

Although the Government's definition of 'science' is broad, and includes the full spectrum of natural, physical and social disciplines, it is important that this differentiated understanding is reflected in the way it develops approaches to science and society. It is well known that publics are, for example, differently excited by and

concerned by science depending on what is under consideration (e.g. the science; the question that is asked; the balance of benefits, opportunities and uncertainties). Public attitudes, enthusiasm and wariness can also be shaped by myriad factors including: the speed of scientific and technological development; the uses to which science is put; the ability of regulatory and institutional structures to keep pace with change; perceived benefits and risks; ethical dilemmas; the behaviour of government, policy and regulatory institutions; and the stance adopted by the media and non-government organisations.

It is difficult therefore, to claim that people are (or should be) excited or concerned by science *per se*, because people react differently to *particular* advances (Royal Society 2007b).

We see gaining a richer understanding of these complex relations between science and society, and between publics and science, as serving an important function in our goal to *influence policy-making with the best scientific advice*. Historically, decision makers have viewed science issues principally from a scientific perspective, but there is now an acceptance that social and ethical perspectives are also fundamental (Royal Society 2007a). Recognising this, the Society has led the scientific community in undertaking effective public and stakeholder dialogue so that policy makers and the science community are able to take account of a diversity of views. Such dialogue exercises have informed the Society's policy work, as well as that of Government. The influential 2004 report by the Royal Society and Royal Academy of Engineering on *Nanoscience and nanotechnologies: opportunities and uncertainties* remains a leading example of how to combine a technical appraisal of new technologies with an exploration of their social and ethical dimensions (Royal Society/Royal Academy of Engineering 2004).

The Government, in *A vision for Science and Society* and elsewhere, supports public engagement for policy-development. Paragraph 4.6 of the *Vision* document argues that 'Everyone should have the opportunity to play a relevant part in making the best possible decisions for public policy through engagement with science'. We would like this to be a stronger focus of the vision. Government and political bodies, amongst others, have an opportunity to work with public and other groups to develop science and technology policies and research trajectories. There is a better chance that society will value and be excited by science if it feels a sense of ownership about its direction. The Government's own Sciencewise Expert Resource Centre for Public Dialogue in Science and Innovation (Sciencewise ERC) is an important step in this direction, and needs Government's full support as well as the resources to expand its work.

Scientists need more regular opportunities to talk about the choices they are making, and the purposes to which their work might be directed. Whether it is the prospect of a new generation of nuclear power stations, the convergence between nano and biotechnologies, or novel forms of human enhancement, our capacity for innovation will continue to present us with dilemmas as well as opportunities. But it is our belief that Britain's hope of becoming the best place in the world to do science rests on giving scientists and engineers the freedom and incentive to debate these issues with wider society. Developing a more substantial and authentic debate on these questions is in the best interests of science, and of an enlightened democracy.

Response to some questions from *a vision for Science and Society*

Chapter 4

How can scientists further improve and professionalise engagement with the public? How is good practice by scientists engaging with policy-makers/policy-makers engaging with scientists celebrated and rewarded?

What additional mechanisms should be put in place to enable policy-makers and scientists to better interact (Chapter 5)?

A good grounding in the concepts of science is important for everyone, not just for tomorrow's scientists and engineers. At the same time, scientists, engineers and policy-makers need training, opportunities and support to reflect on the social, ethical and political dimensions of their work.

The Royal Society has previously said that any research quality assessment exercise must be able to capture excellence in activities such as public policy involvement or involvement in public engagement and outreach work (Royal Society 2008a). Researchers who, for example, produce fewer research papers, but who provide excellent evidence and advice to policymakers &/or who take time to discuss their research with the public should not be at a disadvantage in the assessment system. Such scientists need support, reward and recognition.

The Society has well established communication and media training courses that enable scientists to explain their work effectively and memorably to non-specialist audiences and provide them with the skills to handle media situations effectively and with confidence. A total of 77 scientists were trained on the Society media and communication skills courses in the financial year 2007/2008. These courses are offered free to Royal Society Research Fellows and at subsided rates to all postdoctoral scientists. The Society is the preferred communication and media training provider for EPSRC and STFC.

Alongside its media and communication courses, the Royal Society piloted a professional development course on the social and ethical dimensions of science in February 2008. Delivered in partnership with the Open University, the course was well received by participants and received a positive independent review. Following the loss of Government funding for our Science in Society Programme, we are currently looking at the feasibility of continuing this course. In addition, we have piloted an intensive training course for scientists interested in supporting schools and colleges, and look forward to developing this provision in partnership with other organisations.

A possible future work programme might look strategically at the training and development needs of the sector, and concomitant reward and recognition. This could include appraising formal and informal opportunities for science and engineering students in higher education to discuss the wider societal aspects of science. It may also include exploration of mechanisms by which funders, universities and business could include aspects of public engagement, communication and discussion of ethical issues in the training and professional development of scientists.

What contribution can science centres make to the science and society agenda?

The Royal Society believes that science centres have the capacity to play an important role in developing scientific literacy in young people. In 2007, the Society submitted evidence to the House of Commons Science and Technology Committee inquiry into the funding of Science and Discovery Centres in which it stated that science centres have the potential to help deliver the Government's vision for science and innovation through attracting young people to science subjects and scientific careers and increased public engagement with science and technology. The Government's strategy set out in *Science and Innovation Investment Framework 2004-2014: Next Steps* (2006) highlighted the importance of partnerships between science centres and other stakeholders such as universities, learned societies and Research Councils in

demonstrating to young people some of the exciting and inspiring opportunities that studying science can lead to. It is encouraging then that science and engineering clubs, for example, one of the commitments for Collaboration and Partnership, are already part of the UK Network of Science Centres and Museums (Ecsite-UK).

Chapter 5

What more can the education community do to develop scientific literacy in young people?

Through the STEM programme, the STEM education community have been making significant efforts to improve the impact of projects to develop scientific literacy in young people, in particular, the greater co-ordination of enrichment and enhancement (E&E) activities. In September 2008, STEM Directories in each of Science, Mathematics, and Engineering & Technology were published, providing a listing of nationwide and regional E&E schemes for schools and colleges. This initiative is designed to provide teachers with a coherent picture of the E&E activities on offer, to identify gaps in provision, to enable providers to identify and learn from good practice, and also to increase the breadth of appropriate provision. Continued commitment to this programme of activity, with strategic leadership provided by the Science Community Representing Education (SCORE), the Advisory Committee on Mathematics Education (ACME) and the Royal Academy of Engineering, should provide positive impacts for teachers and young people.

The Royal Society has shown sustained commitment to a unique and successful E&E initiative since 1996 through its Partnership Grants scheme, with some 60,000 pupils taking part since 2000. Last year the Partnership Grants scheme awarded 49 grants totalling £95,886 to 26 Primary schools and 23 Secondary schools or sixth form colleges, enabling them to work with a scientist or engineer on imaginative and relevant science projects. These projects often include the school or college's local community and parents.

The Society also supports several other successful initiatives including the Nuffield Science Bursaries for Schools and Colleges and the BA's UK Young Scientists and Engineers Fair.

In addition to these initiatives, each year the Royal Society hosts the Summer Science Exhibition, a chance for several thousand visitors to engage with cutting-edge science, technology, art and history of science exhibits over four days, at the Royal Society's premises in central London. Over 1,000 schools visitors attended the exhibition in 2008, with evaluation showing significant impact on their interest in and knowledge about science.

How can good practice in public dialogue be embedded across Government?

We would extend this to other institutions involved in funding and undertaking science research and involved in science policy. There has been significant progress in embedding public dialogue in policy work over recent years, including at the Royal Society and in Government, and in recognising that engagement is part of making good science policy. There has also been progress in supporting scientists to engage in two-way dialogue. Government needs to embed and extend its work in following good practice in dialogue for policy-making. The recently launched Sciencewise-ERC is a positive step in this direction and close attention should be paid to its effect.

Embedding and tackling institutional culture change is the subject of a current Sciencewise ERC project 'Assessing organisational readiness for undertaking dialogue and other engagement methods'. The outcomes of this project may inform responses to this question.

Chapter 6

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

The Society believes that the Science Learning Centres and the National Centre for Excellence in the Teaching of Mathematics have, along with other providers of continuing professional development (CPD), a key role to play in providing CPD for all science and mathematics teachers, and that CPD is important for teachers to be better prepared and more confident in teaching about 'how science works'. However, more must be done to encourage and enable teachers to take advantage of the number and range of opportunities for CPD that are open to them.

The Society's recently published 'state of the nation' report on *Science and mathematics education, 14–19* (Royal Society 2008b), found that the considerable amount of educational reform in England over the past 12 years has not yet resulted in the desired improvements in attainment or levels of progression in core science subjects and mathematics. Clearly, then, time must be allowed for the new science GCSE courses to bed in, and for the system not to be subjected to unnecessary perturbation.

Quite apart from changes in curricula and qualifications, the effectiveness with which the science curriculum is taught depends on there being sufficient high quality and suitably qualified teachers. The Royal Society's 'state of the nation' report on *The UK's science and mathematics teaching workforce* (Royal Society 2007c) highlighted that the Government's recruitment targets in science and mathematics have consistently been missed since 2000/01, and that there are enormous gaps in the statistical record that make it impossible to gain a true picture of teacher numbers and flows. Increasing teacher recruitment and retention in these subjects must continue to be a high priority for the Government, and efforts to achieve these must themselves be supported by improvements in data collection, modelling and use.

How can we measure future demand for science skills in the UK?

Measuring the future demand for science skills is much easier said than done. The Society's recent report, *A higher degree of concern* (Royal Society 2008c), considered the demand for STEM graduates in the UK. We found that it is very difficult to estimate numbers of researchers, professional scientists, technologists, engineers and mathematicians needed overall, and that it is even more difficult to estimate the numbers needed in specific disciplines.

Predicting future demand requires consideration of both the domestic and the international situation, taking account of both the public and private sectors. Existing data are patchy and can be an unreliable basis on which to form future expectations. In addition, any attempts to forecast needs may subsequently be thwarted by unforeseen events. Consequently, the science base must retain flexibility so that it is better able to meet unforeseen needs and take advantage of new opportunities. This will require, among other things, the maintenance of capacity in core sciences.

For the UK to compete as a major knowledge-based economy we believe the higher education sector in the UK must comprise:

- an excellent and vibrant university research base, with a wide spread of subjects;
- a sustained supply of STEM professionals, including school and college teachers, university faculty, researchers and technicians, with appropriate skills, knowledge and experience; and
- a good mix of discipline backgrounds, crucially including STEM skills within the general graduate workforce. There will also be a need for individuals with interdisciplinary skills.

The constantly changing nature of the workplace means that it is not necessary for UK higher education institutions to produce specific numbers of graduates in each STEM area, as there is often a good deal of movement between specialisms over the course of a person's working life. Also, workers should be able continually to expand and update their skills and qualifications, through lifelong learning in the shape of employer-sponsored education and training. To a significant extent therefore, a key requirement is for a higher education system that produces graduates who possess strong core scientific skills, and who are able to adapt and be flexible over the course of their working lives. Any review of employer demand for STEM graduates must take account of quality as well as quantity issues. Additionally, a consideration of the skills, attributes and qualifications needed in STEM industries, and in the UK economy in general, must address the entire workforce, rather than focus solely on graduates.

Is there a different way to teach science subjects which could help overcome the issue of under-representation of some groups?
How can the science community and employers show society that they welcome and embrace diversity, including women, ethnic minorities and older people?

The Society's recently published report, *Exploring the relationship between socioeconomic status and participation and attainment in science education* (2008d) included analysis of existing datasets for evidence of a link between socioeconomic status (SES) and participation and achievement in science, a review of existing studies and literature, and the results of focus groups with young people, parents and teachers about their perceptions of this issue. The analysis found that evidence for a direct causal relationship between SES and participation and attainment in science is inconclusive, and that the main barrier to participation in science by young people of low SES is poor prior attainment.

The report highlighted that there are instances of successful pedagogies and interventions supporting young people from low SES backgrounds to be high attainers in science, and those individuals and organisations responsible should be given more opportunities to share their good practice with others.

In 2004 the Society produced 'Taking a Leading Role' – a good practice guide for all those involved in role model schemes aiming to inspire young people about science, engineering and technology. Research has suggested that positive role models can play a major part in challenging the stereotype of science and engineering between unsuitable for some groups. This resource included practical advice for scheme organisers, role models and schools & teachers in how role model schemes can better engage young people, especially girls and those from ethnic minority backgrounds, in SET. The resource (and associated research) is fully downloadable from our website at www.royalsociety.org/rolemodels

Annex B: measuring progress

How should we measure progress? What indicators do we need to measure success?

Programme and project evaluation is well established in many organisations. Again, a Sciencewise ERC project is looking at the evaluation of public dialogue to assess methodologies and the impact on policy and participants. There is also an opportunity to learn from and connect the evaluations of major engagement activities such as the Beacons for Public Engagement (e.g. for impacts on academics, students, institutions, publics); Sciencewise ERC projects (e.g. for influence on policy); ECSITE and the Science Festival (e.g. impact on audiences). This is a good target for a future work package.

Overall societal impact is much more difficult to define and measure or record. The Royal Society supported a workshop in November 2007 to take stock of longitudinal data sources (surveys and other data streams) on indicators of public engagement with science, including literacy, attitudes, interest, perceptions, mobilisation and other engagement indicators (Royal Society 2007d). The workshop sought to present evidence of changes over time in public engagement with science; discuss the strengths and weaknesses of existing sets of indicators in serving as 'cultural indicators' in a global comparison; and present entirely new concepts and avenues for the construction of such indicators, including alternative data streams. Bauer (2008) provides a note on the workshop and follow-up activities. This is very much an academic and grass-roots activity that may benefit from central support and investment. The Society is happy to connect Government with those involved in this work.

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