



Science Communication Conference, 14 & 15 May 2007

Jointly organised by the BA (British Association for the Advancement of Science) and the Royal Society

This report was written by Jennifer Wild with contributions from Alison Begley and Helen O'Brien on behalf of the BA and the Royal Society.

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Science in Society

Keynote speeches

Opening remarks

Professor Francis Balkwill, Barts and The London, Queen Mary's School of Medicine & Dentistry

Francis Balkwill warmly opened this year's Science Communication Conference, highlighting the key aims of the field: to promote public engagement with science and to involve scientists in communicating their work. She assured the audience that the conference would address key issues facing science communication in the UK.

Francis Balkwill spoke briefly about the three streams that would run through the conference: engaging the public to (1) inspire and educate, (2) involve, and (3) engage through the media and PR. She encouraged delegates to attend sessions in each stream. She then informed the audience that the scheduled first speaker, Simon Jenkins, author and Guardian columnist, was ill. She welcomed Sir Roland Jackson to kick start the conference with an overview of challenges in the field.

Keynote address

Sir Roland Jackson, Chief Executive, British Association for the Advancement of Science

Roland Jackson gave an inspirational and engaging address, opening the session with slides of stunning scenery. 'Research shows,' he said, 'that pictures help the audience to focus on what is being said.' Against a backdrop of mountains dotted with a few lucky climbers, he went on to describe the seven challenges facing public engagement in science.

The first challenge is industry and the involvement of industry in this field. 'How do we engage industry better?' Jackson asked. He mentioned an important study in this area, the Royal Society for the encouragement of Arts, Manufactures & Commerce's forum of technology, citizens and the market. This study found that companies equate engagement with communication; they do not distinguish between community involvement and public engagement and they equate public engagement with stakeholder engagement. Few companies have looked at the public at large and all understandably have to consider the timing of engagement because of confidentiality clauses regarding new product development. 'Industry is doing well in one area, however,' said Jackson. They are doing well to encourage students to study science. This is important because these are the people from whom they will be choosing their work force.

The second challenge is education. He said that with education the glass is more than half full. The STEM programme report has pulled things together and education faces three challenges: (1) ensuring we have qualified and inspiring science teachers, (2)

ensuring good access to high quality information, and (3) ensuring a well developed science curriculum in schools.

Evaluation is the third challenge. 'Significant evaluation is rarely carried out,' said Jackson. There seems to be a general weakness in evaluation with no central place for people to look at evaluations and no common framework available to conduct evaluations. He said the field is waiting for the outcome of the Tavistock Institute report which will give guidelines on how to conduct evaluations systematically.

The fourth challenge is policy. Most policy consultation by the government is a stakeholder approach rather than actively engaging the public for their views. Jackson asked, 'To what extent is broader public engagement desirable, and what can it contribute?' He emphasised that policymakers need to be aware of the social, educational and cultural value of engaging the public.

The media poses the fifth challenge. 'It is a truism,' said Jackson, 'that the media are a major force in public engagement in society.' The media offer widespread provision of information, widespread dissemination of ideas and stimulation of debate. What the media do not do, except by proxy, says Jackson, is encourage widespread face-to-face engagement between scientists and other members of society. He said the challenge for the science communication field is to demonstrate alternative modes of face-to-face engagement.

Academia is the sixth challenge. Jackson described the conference participants as being on the sharp end of public engagement, being practitioners who are trying to make a difference in public engagement with science. 'But,' he said, 'we speak a different language to the social science researchers' and asked 'What is the point of academic analyses if there are no lessons for practice? Should we be doing more to influence the academic agenda?' The challenge is how to influence the academic field to engage with practitioners.

The final and seventh challenge is cultural. Involvement in the wider debate of public engagement is still not seen as a fundamental part of being a scientist. Scientists see research and scientific discovery as a first priority followed by teaching. Knowledge transfer is somewhat important, but public engagement is low on the agenda. Ultimately the challenge is cultural: challenging cultures within the science community that are unresponsive to public participation.

A lively speed networking event concluded this stimulating keynote address.

Progress since 2006 – improving our impact

Professor Kathy Sykes, Professor of Sciences and Society, University of Bristol

'It blew my mind how much time it took to prepare,' Kathy Sykes said, emphasizing the enormous progress in the field since the Science Communication Conference in 2006. She likened the diversity of the public engagement community to beautiful but very different flowers that grow separately. Over the last couple of years, many changes

have happened in public engagement with science, but the challenge now is to try to make the flowers grow a bit better together.

To give context to her talk, she briefly described the Science and Society Report (Jenkin Report) put together by the House of Lords Select Committee on Science and Technology in the year 2000. The report crystallised how we think about communicating science, emphasizing that too often science communication is top down, talking at people without listening to them. She went on to say that the deficit model does not work. This model implies that the more information you give the public, the more they will support the science in question. She referred to genetically modified (GM) foods as an example in which the deficit model does not work. Sykes said the more people know about GM, the more concerned they are about it. A key conclusion of the Jenkin report was that dialogue and discussion with the public could not just be a bolt on to organisations. It has to become an integral part of them. Over the last few years, there have been good developments with significant changes in three areas: (1) culture, (2) improving quality, and (3) joining up.

'It's a really exciting time,' said Sykes. Many different organisations, such as the government, the Higher Education Funding Council for England, and the Royal Society, are beginning to think that we can get public engagement embedded in our thinking. Many funding organisations are making public engagement part of the real stuff of what it is to be a scientist and what it is to do science. This is helping to change the culture of science communication and engagement with the public: promoting rather than ignoring it.

The second change is the emphasis on quality. There are initiatives in place that encourage science communicators to listen to each other better, to learn and to evaluate, and to share good practice.

Thirdly, there has been more joining up between scientists and those in the public engagement field. However, there are gaps existing. There are numerous academics in universities and industry who have not yet embraced public engagement. Sykes asked, 'How do we get academics to think harder about better engagement?'

She suggested some helpful avenues to follow: to collaborate, to join up, and to share good practice. She suggested helping scientists and policy makers to listen better to each other, to encourage people to reflect and to evaluate, and to promote interactions between scientists and social scientists and between practitioners and social scientists.

Sykes reviewed the progress in the last year that funding organisations have made in public engagement. There were many: (1) the Research Councils UK (RCUK) now encourage public engagement training for academics, making it a part of conducting research, (2) HEFCE has focused recently on the university's role in meeting the needs of the economy and society at their annual conference in April 2007, (3) the Engineering and Physical Sciences Research Council (EPSRC) formed a Societal Issues Panel, to inform the council about relevant issues in society that need to be addressed, (4) the Biotechnology and Biological Sciences Research Council (BBSRC) now requires that every six months, academics report on what they are doing in business and society, (5)

the National Endowment for Science Technology and the Arts (NESTA) has focused exclusively on innovation, (6) the Wellcome Trust opens its new science building on 21 June 2007. This building brings together science, art and medicine, exploring what it is to be human, providing an ideal mingling place for scientists and the public, and (7) the Joint Information and Systems Committee (JISC) is conducting research on how to better support people at university to engage in business and communities.

This is the first time ever there has been a significant amount of money available for science engagement: £8 million over four years to create Beacons of Excellence. These beacons have come about following recommendations from a previous Science Communication Conference. There will be 5 beacons with a national co-ordinating centre. Their aim is to promote cultural change within universities and to capture evaluation and good ways of engaging the public with science, such as FameLab and Crucible.

Sykes provided an update on some of the achievements the government has made in public engagement with science. For example, the Department of Trade and Industry funds National Science and Engineering Week, which is coordinated by the BA. Sciencewise announced on 1st March 2007 that it will fund a new national discussion on stem cell research. The Prime Minister, Tony Blair, hosted a reception on 13 March 2007 for 100 inspiring young scientists.

Sykes said there has been progress in schools with a new GCSE on how science works. There has also been progress in the world with science festivals, international science media centres and science shops, doubling of EU framework money, and the British Council creating 'regions' which will make large projects possible.

Engaging to inspire and educate

Update on STEM report

Chair: Dr David Stewart Boak, Director of Communications, The Royal Society

Speakers: Professor John Holman, Centre Director, National Science Learning Centre

Yvonne Baker, Chief Executive, Science Engineering & Technology Network (SETNET)

Steve Mesure, Director, The Creative Science Consultancy

This session gave an update on the STEM (Science, Technology, Engineering and Maths) programme using examples of an after schools club pilot programme to encourage participation in science and the Creative Science Engagement Networking Development and Organisation (CreScENDO) project whose aim is to make networks between science initiatives.

John Holman looked at why STEM support is so important in schools and how improving support can achieve the goals of having students attaining and achieving in STEM subjects. It included an update on the STEM programme.

There are two things to achieve through the STEM programme: to have people attaining well, which can be measured in tests; and also to be engaging, which can be measured by people taking up STEM subjects.

What is the need for STEM support in schools?

- There is a need for programmes to recruit more specialist teachers in specific subjects, particularly chemistry, physics and maths. Some non-specialist teachers may want to convert to these subjects and it is important to have CPD (Continuing Professional Development) in place for this. Teachers may also need to renew their teaching skills and keep up with changes in the curriculum. These trained teachers need to be retained.
- Programmes need to encourage schools to offer triple science and another maths GCSE. Having specialist GCSE teaching has been shown to encourage pupils to carry on studying science and maths at A level and beyond.
- Careers awareness and other programmes are needed to enhance and enrich science and maths education, to show pupils what goes on in industry and higher education. It is important to improve awareness of how science can be utilised in careers outside obvious STEM fields and to offer careers advice to pupils at primary age.
- Practical work needs to be supported. This could mean improving facilities, having teachers trained or creating clubs to get students doing laboratory work outside the curriculum.

If a teacher who wants to convert to teaching physics, start a science club, or show how science is employed in industry, and if they can find the support they need, then they will help their pupils in attaining and engaging in STEM subjects.

How do we take what happens outside school and bring it into school to make STEM subjects more relevant? In school the emphasis is on science and maths, whereas outside school the emphasis is mainly on engineering and technology.

The STEM Programme is on track with plans to:

- Establish partnerships and links with institutions and organisations
- Establish STEM communication portals to get information to teachers
- Coordinate teachers' CPD
- Co-ordinate enhancement and enrichment activities, for example, after schools science clubs
- Have a clearer system for decisions on funding schemes
- Better guidance on STEM careers for students - info at a younger age

It is not the intention to create more initiatives but to make them more available to schools.

Yvonne Baker then looked at how STEM support can be accessed by those that need it, looking at one example in particular, that of after-school science and engineering clubs.

Coordination roles were given to SETNET for enhancement and enrichment programmes, to the Science Learning Centres (SLCs) for science CPD, and to the National Centre for Excellence in the Teaching of Mathematics (NCETM) for maths CPD. Emphasis was placed in the STEM report on finding out the impact of initiatives and evaluating their effectiveness and moving from a supply-driven system to a demand-led one.

With these in mind, success depends on:

- Building on foundations - don't get rid of things already in place
- Intelligent networking - creating opportunities for collaboration, consultation events at regional and national level
- Being brave - put unlikely partners together
- Listening to teachers and young people - find out what would turn them on

An example of an enhancement and enrichment programme is the Department for Education & Skills (DfES) funded After School Science & Engineering Club programme.

Funding for a pilot was announced in the 2006 budget. The pilot will lead with 250 clubs across England in schools selected in close consultation with DfES. The lead client is DfES but there is support across all government departments. The consortium delivering this pilot scheme includes SETNET, Science Learning Centres, SSAT (Specialist Schools and Academies Trust), the BA, the Association for Science Education (ASE) and Ecsite. Content partners are the BA, RAEng, and the Young Engineers. More are welcome so please contact Jo Watts at SETNET.

The clubs have many features. They are all multidisciplinary, so the staff are from different areas and STEM subjects. This means that the clubs will not concentrate on any one subject, appealing to the largest number of students. All clubs offer training for leaders and support staff.

There has been great enthusiasm from schools with 216 out of the proposed 250 clubs confirmed by National Science and Engineering Week 2007. Support for club leaders is being put in place and the website is now live. Support is coming from the consortium and content partners, and business and industry are interested in being involved.

Most clubs will start the bulk of their activities at the BA Festival of Science in September 2007. Early work on good practice will be carried out and shared with the other pilot clubs and to other interested schools and other parties.

The third speaker, Steve Mesure, talked about the progress made with the CreScENDO project. The aim of CreScENDO is to co-ordinate and network between the many initiatives.

CreScENDO was commissioned by NESTA in 2005. It was set up to assist in building networks between organisations involved in public engagement in science.

Many of the initiatives identified in the STEM report were set up by individuals. These people identified a need and have delivered interesting and effective projects. However, there has been no coordination to show whether there are other similar initiatives out there. It has resulted in too many schemes duplicating efforts, often competing for the same attention in schools without any collective learning of best practice.

Many people working in higher education who are involved in public engagement are working in isolation. This is because science engagement is often discouraged in their departments and engagement work has a lower priority than research and teaching.

Organisations that could help coordinate these activities often concentrate on their own survival and self sustainability, while those funding the initiatives have not asked for improved dialogue between initiatives.

In a survey of 42 stakeholders only 50% said that evaluation was a condition of their funding award and only 25% attempted to disseminate any evaluation. Out of 9 large public engagement projects, 66% had no knowledge about any of them.

Co-ordinating all the initiatives is like herding cats. But it is possible to find ways for practitioners, managers and policymakers to learn from each other and to build capacity.

CreScENO's aim is to make engagement activities more coherent, brokering networks and dialogue between initiatives which have a common interest (i.e. in the same region, same subject or methodology). Evaluation and lateral networking are tools used to assist this.

As networks are built, clusters of similar STEM activity are formed. These are more likely to be self supporting and sustainable with new ideas and collaborations. This kind of networking can be put in place, ultimately producing better value for money by using the CreScENDO methodology; developing lateral networks; and having face to face discussions with the practitioners and other stakeholders.

How ICT can support informal learning

Chair: Colin Johnson, Vice-President, the BA

Speakers: Tony Sherborne, Creative Director, Centre for Science Education

Vivi Lachs, Curriculum Director, Highwire

This session looked at how ICT can help with informal learning. It looked at how web authoring, video and games can provide motivation to help students engage in science.

Tony Sherborne considered how entertainment - both a narrative and games - can help motivate students to learn science. The talk outlined how to integrate science into these learning tools which can be used in class or outside the classroom.

Humans are natural storytellers; it is matter of finding out how to use stories to enhance science learning. Sherborne asked 'What is the language of engagement?' and 'What are the key narrative points that need to be addressed to produce a good science 'story'?' He said we can't satisfy knowledge requirements without inspiring students to ask questions.

'Mystery' - gets students thinking like scientists. Normally kids carry forward naive beliefs and if they are just given the evidence that their theories are wrong they won't necessarily drop their ideas so easily. We need to make them want to change how they think. He suggested posing the question: how does spontaneous human combustion work? Then putting forward some hypotheses, one plausible and one implausible, giving evidence of both and getting them to test them.

'Character' - puts scientific information back in its human context. How interesting is science without a human context? We need contemporary examples. He showed an example of an animation game of 'I'm a celebrity... get me out of here'. The situation was of four celebrities with a task to get to the top of a mountain. He then asks the question - which celebrity showed the best scientific method?

'Alignment' - the playing strategy should mirror the learning outcome. There are ways that games can go about this the wrong way. He gave an example of a racing game. To get more time on the track you need to answer some maths questions. This reinforces that learning is dull. The science is not integrated into the game. 3D environments can be very striking but they do not necessarily stimulate learning.

A game devised for the Wellcome Trust explores nature and nurture when it comes to the health of OBs (human-like characters). By controlling their environment we can raise an OB from birth to 20. Nature comes into play in their character, sportiness, appetite and obedience. Since the science is intrinsic to the game the learning outcomes are

achieved while playing. These are complex interactions which are difficult to describe in a conventional lesson.

<http://www.wellcome.ac.uk/obs/activity.htm>

'Clarity' - finding the right balance between simplicity and authenticity. Examples are a flight simulator which needs to be lifelike to be authentic, and a game of chess which is stylised and simple. For a game to engage it needs to sit somewhere in between. A game for teenagers could be mastered in 15 minutes, so it is both manageable and challenging. It needs to look authentic but simple enough to enjoy.

Vivi Lachs went on to say how students were motivated to look at difficult topics in science and create videos, animations and web pages around the issues explored.

There were a number of different projects discussed but the main emphasis of this talk was on the 'Genetics and Citizens' project which ran in English, RE, and science classes.

The objectives were that the students become interested, become scientists, pass exams and be informed. The problem is motivation and to increase motivation it was plausible to use the technology the students were familiar with and wanted to use.

The use of ICT here is as an authoring tool, for videos, web pages and animations; there was no teaching of ICT.

The following are examples of projects that the students created:

'Supplying the cell – circulation'

This is a revision project for the group. There was a video model of a circulatory system. The students had to design the model (in this case a train set for the blood system).

This project took longer than it might have taken them to revise in a conventional way, but using this highly motivational tool helped them potentially retain more of the information.

'Genetics and Citizens' project

The aims of the 'Genetics and Citizens' project was to help give the students an understanding of the complex arguments involved in this difficult subject, to look at the subject from a number of different perspectives and to create an analytic framework of questions that could be used when they are faced with any other science topic, debate or controversy.

Initially the whole class looks at the broad issues of money, ethics, cloning and genetic modification. Then the class splits into groups to look at individual themes (GM food, GM and cloned animals, genetic testing, human cloning). These groups make a video documentary about their topic, they are given a storyline and they take different perspectives.

The project ran in schools in foundation class, gifted class, English and RE. The latter two showed that this kind of project can be relevant in a non science subject. All resources can be found free of charge on the website www.highwire.org.uk

Science centres supporting discussion and debate with teenagers

Chair: Colin Johnson, Vice-President, the BA

Speakers: Dr Rosalind Mist, Head of Project Development, Ecsite-uk

Dr Sharon McNab, Science Learning Manager, Glasgow Science Centre

This session looked at how science centres are engaging young people and their teachers in discussion about complex and controversial science issues.

The Doing Dialogue consortium is a collaboration of the Museum of Science and Industry in Manchester, LIFE Science Centre, Thinktank, Glasgow Science Centre, Ecsite and the Wellcome Trust. They work in partnership with science centres, teachers, students, facilitation experts to create entertaining and engaging events for between 100 and 200 students.

Science Centres, such as the Glasgow Science Centre, look at how to market what they are doing. Teachers are involved in developing curricula and have input into science-related events for young people. Scientists contribute to developing events. Their expertise is needed. Facilitation experts help with developing the package.

An example (a debate surrounding the issues of premature birth) was given to show how the event is devised. The event format is directed by specific tasks which end in a group statement. In such an event 100 pupils from 10 different schools, divide into groups of 10-12 with a trained facilitator. At the beginning of the day the event starts with a basic knowledge task. For example, marking the different stages of growth of an unborn baby. The facilitator's role is to discuss the size of the babies and talk through decisions.

The students are then asked to look at how other people feel about the issues being discussed. For example, opinions on whether life saving interventions should be made for babies born prematurely. The facilitator's role is to discuss why people are having these opinions. The students have to look more deeply at questions involved.

Finally the students are asked to give their own opinions. Discussing in a group allows them to express their thoughts about the subject covered.

A summary statement is given by each group, and is presented back to the 100 pupils taking part. This section has been evaluated as one of the highlights of the pupil's day. It allows creativity in how they report back.

These events benefit all involved. Science Centres host these dialogue-type activities. The experts have returned for further debates and have enjoyed the interaction and challenging questions posed by the students. The teachers are making repeat trips to the science centres, some have changed their teaching approach and they can use the free online resources. While the students themselves become engaged with the topic, they achieve an understanding of the difficulty that policymakers face when making these decisions.

There are further debates and workshops around the country:

- Glasgow Science Centre and Our Dynamic Earth - GM Crops - Food for Thought
- Nuclear Energy - Supporting The Committee on Radioactive Waste Management consultation (Dialogue by Design)
- Sita - Waste and recycling (Thinktank, Centre for Life, MOSI)
- Inside DNA - Moving debate and dialogue into upcoming exhibition (Ecsite-uk & At-Bristol, supported by The Wellcome Trust)

A lively discussion with the audience followed in which delegates queried the role of teacher versus facilitator and whether there were any advantages to having facilitators lead the groups. The speakers agreed that by not having the teachers in the groups, there is more of a chance to engage students who may not give honest answers in front of their teachers. Further, it is an opportunity to show teachers what their students are doing. When it is run in schools, teachers are used instead of facilitators.

A good resource for materials is <http://scizmic.net/>

Improving the image of science and engineering among young people

Chair: Dr Nigel Eady, Science in Society Officer, the BA

*Speakers: Dickon Ross, Editor of Flipside, Institution of Engineering & Technology
Dr Elsa Ekevall, Engineering Super Powers, University of Strathclyde*

This session showcased two projects which seek to inspire positive perceptions about science and engineering among young people. The two speakers described their projects which are both funded by NESTA and managed by the BA. Discussion following the talks touched, in particular, on long term impact and where best to focus resources.

Dickon Ross spoke about *Flipside* (www.flipside.org.uk), a magazine for 12-14 year olds (Key Stage 3). The magazine is targeted at school libraries and deliberately seeks to interest kids in science and engineering in a more subtle way than other schemes and projects. It is consciously glossy, current, entertaining and picture-led.

Market research conducted before the launch using a dummy copy of the magazine proved very useful, especially as children are very honest about what they think. This data shaped the magazine and confirmed that a magazine in itself was a good idea, despite suggestions that a website could perform the same role just as easily and much more cheaply. Other key aspects of the magazine are the fact that it is neither branded with the word 'science' nor curriculum-linked, avoiding the criticism that it is like homework.

The content of the magazine includes movies and music, games and gadgets, sport and adventure, celebrity and scandal (amongst other things) and, of course, anything, 'Yuk!' However everything has a thread of SET running through it. The content is also picture-led, surprising, humorous, factual, fun and grown up whilst not being 'educational' with a capital E!

After about a year of the magazine, some research was done with school librarians to assess impact. The high return rate of the questionnaires was very encouraging and in general the data showed that kids love the magazine. In fact there were no negative

comments. The responses also provided some helpful steers on content and showed that the readership is approx 200-250,000.

To the great surprise of the editorial team, Tesco expressed interest in selling the magazine in their stores. This was too good an opportunity to miss as this kind of exposure is hard to achieve even with good marketing. To be able to compete in the marketplace the magazine content was doubled in size and it became a regular monthly publication with a competitive cover price. This was a great coup for the team but with a small marketing budget it was not possible to sustain a place on the newsstand in the long term. Therefore the magazine has returned to the school library model. It continues to be provided free to these and other outlets as well as being available on subscription.

Elsa Ekevall from the University of Strathclyde then spoke about the *Engineering Super Powers* project (www.engineeringsuperpowers.org). The project makes use of children's interest in superheroes to teach them about biomedical technologies and scientific concepts.

The release of major blockbuster movies, such as *Spider-Man* and *the Incredibles*, has renewed interest in superheroes but few have super powers that are conceivable today; usually the science of superheroes is determined by artists and writers. This project however takes a very different approach. Around 100 school pupils in Scotland have teamed up with bioengineers to create their own superheroes with special powers based on biomedical science. The project is aimed at 10-12 year olds and first year at secondary school.

The pupils, bioengineering students and teachers are developing a resource pack, which will allow other pupils, teachers and parents to learn about current biomedical technologies and explore future possibilities. A storyboard artist helps develop comic strips with the pupils to bring their super powers to life. During this process, the pupils develop knowledge and understanding of scientific concepts, experience a truly multidisciplinary area of science and have ownership of their involvement in the process.

In the questions and discussion that followed, there was much interest in the selection of content and approach for *Flipside*. It was suggested in the audience that the magazine is too strongly oriented towards boys. Dickon Ross countered that about a third of *Flipside* readers are estimated to be girls, which he feels is a healthy proportion. He argued that it's not possible to create a magazine for both boys and girls. Had the magazine targeted girls, which in itself would have been hard when the competition in girls' magazines is very fierce, then no boys would read it, whereas the other way around, a lot of girls are still interested.

There was debate about the merits of aiming schemes at pupils rather than teachers. Audience members from both industry and the Research Councils said that traditionally, for cost-benefit reasons, the bulk of funding went towards schemes that were aimed at teachers, since pupils grow up and move on but teachers generally stay in a school for many years and therefore investment in them is more likely to have long term impacts.

The difficulty in measuring the long terms impacts of any individual scheme was acknowledged, though methods to try and address this issue were felt to be important.

The reasons why pupils move away from science subjects were briefly explored. This is an area in which ESRC may be about to do some research. Whilst some audience members suggested the predominant ages at which this fall out occurs, another member of the audience warned against trying to tie this sort of information down saying that there is significant variation in different science subjects and that it is a 'leaky pipeline' with pupils leaving science from the earliest stages of education all the way through to those 'dropping out' following science degrees.

Finally the need to promote transferable skills was highlighted. The fact that the Engineering Super Powers project was working across subject areas, including with arts subjects was lauded. It was suggested that showing that science is part of the general education of children is vital. It was felt that the links this project has made with, for example, English departments were excellent. The popularity of the scheme has led one school's English department to work with the science department to write stories about the superheroes being developed by pupils.

Engaging to involve

How can public engagement affect policy?

Chair: Sir Roland Jackson, Chief Executive, the BA

*Speakers: Professor Celia Davies, Visiting Professor, London School of Economics
Andrew Dillon, Chief Executive of NICE (National Institute for Health and Clinical Excellence)*

Professor Sandy Thomas, Foresight

This session looked at how public engagement can link into policy, using the NICE Citizens' Council and sciencehorizons as examples.

Andrew Dillon explained the difficulty of establishing which values should be taken into account when providing guidance on promoting good health and preventing and treating disease in a society which is multi-ethnic and diverse.

To address this challenge, he described the NICE Citizens' Council. The Council discusses topics such as age, and whether it should be a factor in deciding treatment, and how NICE should advise on the often expensive funding of treatment for rare diseases. The Council is made up of 30 members of the public who broadly represent NICE's constituency of England and Wales. Membership is largely stable to enable continued discussions but there is a turnover of 10 people every 1-2 years. Importantly the Council is at arms length from NICE; an independent organisation selects the Council members and facilitates their meetings.

The Council meetings last 2 days, and expert witnesses are available to help inform the debate. But applying the outputs of the Council is still 'unfinished business'.

Celia Davies described her research into the impact of the NICE Citizens' Council. She and colleagues have written a book on the subject entitled 'Citizens at the Centre: deliberative participation in healthcare decisions' (Davies, Wetherall and Barnett, Policy Press, 2006).

Celia Davies opened by saying it was very courageous of NICE to commission an independent evaluation into the effectiveness of the Citizens' Council. She described her work as an ethnographic study. Over a 2 year period, repeat interviews took place with the citizens and a team observed the meetings and held informal discussions. All sessions were fully transcribed.

The research highlights some potential issues with the forum:

- a.) During the first meeting, only 10% time was spent in 'measured deliberation' – this did rise to 28% in later meetings
- b.) The question 'What is clinical need?' did not make sense to the citizens in the same way it does for NICE. It might have been better to question the citizens by saying, 'We have this question – what do you think about it?'
- c.) There was a wariness of dissent, with people sometimes moving quickly to consensus to avoid conflict.

Pippa Hyam described how sciencehorizons aims to evaluate different ways of engaging with people about potential issues thrown up by future advances in science and technology. Data is being gathered for comparative analysis from three strands of public engagement in topics such as genetics and how to manage what can be done in medicine and issues around security, access, privacy and the holding of information.

- 1.) A deliberative panel of 30 people discuss the issue for two days. On day one, delegates are given a sciencehorizons information pack on the issue. On day 2 invited experts attend for the panel to question.
- 2.) Professional facilitators take people through the discussion at organised events primarily in science centres. 12 events have taken place with a target of 50.
- 3.) Science packs are sent out to interested groups for them to discuss and then send back findings to a central database. 2500 packs have been sent out with responses from 100 groups. The target is 500 responses.

The results are to be formally presented at the BA Festival of Science in York in September 2007. Ways of using the results to inform policy have not yet been established. Identifying relevant policy makers is difficult but there will be a seminar in June for people in government to help address this.

Sandy Thomas described the Horizon Scanning Centre, which deals with potential science and technology issues across government. It is part of the Foresight Directorate, set up to help the government anticipate uncertainties. 'Horizon scanning' is used to inform priority setting, help develop training for the civil service, target project work and create strong networks with stakeholders.

The 'horizon scan' produced topic areas such as energy technologies and advanced materials and robotics. These were used as inputs for discussion both amongst experts and members of the public through initiatives such as sciencehorizons. The outputs from both sets of discussions will be brought together to form overall insights. Some of the headline results concern the rise of the expert patient and unease over geneticists 'right to tinker'.

Discussion with the audience ensued in which questions focused on how the Citizens' Council gets feedback and the impact of their influence on policy. Regarding feedback, two Council members present the Council's finding to the board of NICE. High level managers of NICE such as Andrew Dillon go to the Council sessions at the start and end to get feedback.

Andrew Dillon said that it is difficult to disentangle the decision making process regarding policy. However, he believes that a proposal to the Department of Health about expensive treatment of rare diseases was influenced by the results of the Council's report on the issue.

International perspectives on engagement strategies

Chair: Dr David Stewart Boak, Director of Communications, The Royal Society
Speakers: Stephen Parker, Partnerships for Science Communication, European Commission,

Professor Ian Scoones, Social, Technological and Environmental Pathways to Sustainability (STEPS) centre Co-director, Institute of Development Studies

This session looked at opportunities for science communication in Europe and the developing world.

Stephen Parker discussed funding opportunities for European-wide science communication projects.

The European Union funds collaborative activities to help with things such as science communication through its Seventh Research Framework Programme (FP7) Science in Society Work Programme. The funding available is divided into three areas:

- 1.) *More dynamic governance of the science and society relationships.* The setting up of forums for natural scientists, social scientists, philosophers and historians to try to understand science culture within Europe. The desired output is an agenda for subsequent actions and the proposed budget is Euro 800,000.
- 2.) *Strengthening potential and broadening horizons* (not discussed in this presentation).
- 3.) *Science and society communications.* This is aimed at adding a European dimension to the work of science museums and activities such as science festivals and science weeks. The proposed budget is Euro 2,798,000. A second strand is available for collaborative research into Science Communication, looking at the cultural differences in how the public gains understanding through TV and radio science programs across Europe.

There are prizes for science communication, including Science Communicator of the Year, Science Writer of the Year and Audio-visual Documentary of the Year. The closing date for these prizes is July 17, 2007 and nominees must have won prizes in their individual countries to be considered.

For applications and more information, go to <http://cordis.europa.eu/FP7/dc/index.cfm> and follow the Science in Society link.

A discussion with the audience took place about what works on a European level rather than a national level. Dr Parker said that for FP7 funding, there has to be a good match between the objectives of the call and the potential project. Having a 'European Dimension' means that, applicants have to demonstrate added value through collaboration. They should also answer the question, 'Why it is a European issue and how your project will tackle it?' Dr Parker advises science communicators and researchers to go to international conferences and identify possible collaborators.

Ian Scoones's presentation was entitled 'Science and Citizens: the challenges of public engagement'.

The talk addressed the global challenges of science communication in the developing world. Many of the relevant issues, such as the threat of bird flu in Indonesia or the effects of climate change on Africa, have high degrees of uncertainty. These are questions not just of science, but also of politics. Because the issues are potentially

controversial politically and the uncertainties are complex, there is a need for greater public engagement, through deliberation, negotiation and debate.

The challenge is to make science and technology work for the poor. Scoones sees this challenge as three different science races:

- 1) *The race to the top*. The argument that science and technology contribute to economic growth and will automatically bring developmental benefits, for example the large positive impact of mobile phones. Citizens are seen as consumers.
- 2) *The race to technological fix*. The philosophy is that the challenge can be met through science and technology and is often the approach taken by philanthropic organisations such as the Gates Foundation. Citizens are seen as beneficiaries or people with needs to fulfil.
- 3) *The slow race to citizen solutions*. A process which involves citizen engagement to create science and technology solutions which have genuine benefits. Citizens are seen as active participants in the solutions.

There are potential problems with the first two races. For example, following race 1 or allowing the market to 'sort things out' can lead to lock in of the wrong technology or certain groups becoming excluded in the rush for growth. By following race 3 we can overcome public mistrust in science policy and gain greater citizen engagement . More information can be found at www.steps-centre.org.

The audience asked questions about what is happening at the ground level and how Scoones addresses public apathy. At the ground level, Scoones said that NGOs and civil society groups have arranged around issues such as GM crops, and this has opened up into a wider debate about farming and rural future. There is a need to get a lead from cross departmental groups such as science and technology ministries on issues such as opening up priority setting.

Work done by the British Council with science festivals and science centres in Thailand and Brazil was discussed. The emphasis of these events was enthusing and inspiring young people. There is now the prospect of moving into China with work on climate change.

With respect to public apathy, Scoones said that this is less of an issue in the developing world where citizens' groups have not historically been offered the opportunity to have input. There is scepticism and mistrust but not apathy. Apathy may appear later in the process.

There was then a discussion on the possibility of linking development funding to requirements for public engagement. Input from the audience suggested that the Government is considering this.

Members of the audience shared the following relevant links:

PCST Public Communication of Science and Technology – meets every 2 years and has a journal to help networking:

www.pcst-10.org the website for the next conference to be held in Sweden in May 2008
www.pcst2006.org the website of the last conference held in Seoul, Korea, May 2006

International Science shops network:

EU finance was used to set up this organisation to mentor science shops and grass roots science across the world.

www.scienceshops.org - also visit this site for the Living Knowledge conference, Paris, August 30 – September 1 2007

Science and Development Network: www.scidev.net

European Science Events Association: www.euscea.org

Training challenges presented by science in society

Chair: Nicholas Hillier, Communications Manager, Academy of Medical Sciences

Speakers: Nicholas Russell, Director, Science Communication Group, Imperial College London

Dr Jeff Thomas, Senior Lecturer, The Open University

The session discussed current science communication training provision and asked how it might develop. In particular, does this provision meet the growing demand for 'science in society' specialists?

Nick Russell noted that most students on the MSc Science Communication course at Imperial College are scientists wanting to train for a job in the media, in particular as science journalists or documentary film makers. The course is designed to suit this need and around 75% of graduates obtain a position of this type. But further, Russell noted that through a mix of practical and theoretical content the course encourages critical reflection on science in society. This enables graduates to see science in its wider context and be better at their chosen tasks. Russell finished with two hopes for the future: that communication professionals, especially in the media, develop a more informed critical eye; and that those who work at the public interface for science organisations feedback to those organisations public views on science.

With respect to purpose, a common assumption is that there will be a sustained demand for science communicators serviced by current training courses. But is there now a more urgent purpose to promote amongst scientists a greater awareness of science in society issues and develop skills in debating broader aspects such as ethics and the nature of science? On method, what is the appropriate training level (diploma, MSc, other); what are the optimal means of delivery (face-to-face, text, web-based); need provision always be award-bearing; how might delivery be developed to engage a wider range of participants?

Thomas discussed these and other issues through focusing on two current courses, at Birkbeck, University of London and particularly at the Open University (OU). The OU MSc in 'Science in Society' is achieved by part-time study, normally over three years, and aims to cater for science communicators and scientists who want to broaden and

deepen their interest in science. The part-time Birkbeck diploma runs over two years and encourages critical appraisal of the aims and methods of science communication.

Both mix face-to-face and distance learning, but the OU course is predominantly delivered at distance. Thomas noted that distance learning relies on online, TV and textual provision but that this does not harm the quality or experience of learning and may even enhance it. For example, online conferencing and debating is less hierarchical and more frank, and distance necessitates creative solutions to learning challenges such as working collaboratively in groups. The OU Masters qualification is achieved by part-time study, normally over three years, and aims to cater for science communicators and scientists who want to broaden and deepen their interest in science. The part-time Birkbeck diploma runs over two years, contains a higher face-to-face element and encourages critical appraisal of the aims and methods of science communication.

The discussion began by reinforcing the need to tailor provision for two distinct audiences: communicators and career scientists. With respect to the latter, there is little training provision for scientists who want to engage directly with public audiences, rather than through the media. But it was suggested that there is little incentive for scientists to train for or undertake this form of engagement. However, it was broadly agreed that there is now some momentum for change (e.g. the Beacons initiative). Yet Russell noted that at Imperial College there remains little support from science departments and few resources for science undergraduates wishing to take courses in cultural studies, humanities, languages and the like.

It was broadly agreed that scientific training enhances skills of argumentation, but delegates discussed how to teach or otherwise get across the skill of listening. Thomas described how online discussion forums promote 'listening', for participants need to take turns and take time to consider others' contributions when formulating responses. One delegate noted that teacher training is, in part, a matter of teaching listening skills and that communication and education departments could coordinate elements of training. A delegate also noted that media training promotes listening skills.

Finally, delegates discussed methods of accrediting study and continuing professional development training in a way that might be accumulative; suitable for communicators early in their career; and which might indicate to potential employers progress made to date. It was suggested that the OU modular approach might be an option.

Consulting the public on drugs

Chair: Clare Matterson, Director-Medicine, Science & History, Wellcome Trust

Speakers: Dr Diane Beddoes, Fellow, Office for Public Management

Dr Robert Frost, Policy Officer, Academy of Medical Sciences

Robert Frost spoke about drugsfutures, a public and stakeholder engagement project commissioned by the Academy of Medical Sciences as part of their *Brain science, addiction and drugs* study. Funded by Sciencewise, drugsfutures was run by a consortium led by OPM.

Foresight published a report in 2005, *Drugs Futures 2025?* based on 15 'state-of-science' reviews looking at scientific advances in this area. The project focused on recreational drugs, medicines for mental health and cognitive enhancers. The Academy of Medical Sciences was then approached by the Department of Health to take forward Foresight's work.

The *Brain science, addiction and drugs* study is being conducted by a Working Group convened by the Academy. The science had been reviewed by Foresight and so the Working Group was asked to consider the societal, health, safety and environmental issues raised by the advances described in the Foresight report. *drugsfutures* was commissioned as the public engagement component of this study. There was also a separate call for evidence by the Academy.

The Working Group will now produce one set of recommendations for policy and research needs for the future, due to be published by the end of the year. The Academy will present its findings to the Department of Health, which has committed to responding within 18 months.

drugsfutures

The aim of the public engagement component of the *Brain science, addiction and drugs* study was to explore attitudes on drug use and to engage with the public in shaping the research agenda in this area. This was a deliberative process and had independent evaluation.

The Working Group were involved throughout the *drugsfutures* project. An important issue in planning was managing expectations from the participants and the Working Group. Dr Diane Beddoes, OPM, spoke about the launch of *drugsfutures* in January 2007 at the Dana Centre, London. The launch event involved discussion groups and theatre and was attended by recruited participants and members of the public attracted through advertisements.

Diane Beddoes outlined the overall project:

1. Face to face activities:

- workshops – 5 regional one day sessions on five themes identified by the working group. These had a diversity of participants. Good communication between the consortium and academics was key to their success.
- outreach groups – 19 took place. Participants included drug users in user services and those outside this system.
- 'brain box' – an in depth deliberative workshop at the start of the project to identify issues for discussion at the workshops and a second workshop at the end of the programme.

The Academy staff and Working Group members attended these sessions and so feel committed to the results.

2. Online consultation by Dialogue by Design (using the same stimulus material as the face to face activities)
3. Media campaign by ThinkLab Ltd

Materials

1. Briefing notes were produced to give background information on certain drugs, for example, as identified from the first brain box session.
2. Perspectives
 - science writer wrote the future scenarios used
 - workshops included experts including scientists, social scientists and ex-users
3. People found the discussions useful to widen awareness and enable cross-fertilisation of ideas
4. Facilitation was also important for supporting discussion and challenging people

Recorded information

1. Electronic voting was useful at the beginning of the workshop to get a sense of where people were and at the end to see if this had changed
2. Workshops included participant presentations on topics
3. Brain box participants kept individual logs
4. Session notes
5. Film of the sessions

Planning

Participants had lots of information on drugs (school education, government campaigns, and media) and so arrived at the sessions with certain views on the topic. However, cognitive enhancers are not so well known and participants were unlikely to have opinions on these already. This shaped the consultation process.

The roles of the consortium members need to be more clearly identified at the start.

Learning

The project has only just been completed but learning will come from:

1. Feedback from the Academy's Working Group

2. Evaluation report
3. Team review
4. Academy's final report
5. Policy response

Next steps

1. The drugsfutures findings have been submitted to the Working Group and will be disseminated to attendees via a website.
2. Working Group members attended events and had input as the project progressed
3. The Academy will publish a final report of the study at the end of 2007.

The audience showed a lot of interest, asking questions about how participants were recruited, the role of experts in the workshop and when the success of drugsfutures will be apparent. Diane said that most experts came for the full day. Some introduced themselves, others gave presentations and then answered questions from the public as they arose. Regarding recruitment, a research agency handled it. Twenty-five participants per workshop were paid to attend. These workshops were then 'topped up' with around 5 people from the outreach events. Participants for these outreach events were found through contacts and advertising. The success of drugsfutures, Rob revealed, is dependent on how well it is integrated into the Academy's report. If this is done well and is transparent then it has worked. The impact of the report itself to policy makers is outside their control.

Engaging through the media and PR

Stem cell research in the media

Chair: Fiona Fox, Director, Science Media Centre

Speakers: Dr Stephen Minger, Director, Stem Cell Biology Lab, King's College London

Professor Sarah Franklin, Director, BIOS Centre, London School of Economics

Alok Jha, Science correspondent, The Guardian

Angela McNab, CEO, Human Fertilisation and Embryology Authority

Fiona Fox introduced this session with a positive view of stem cell research in the media. She said in comparison to the public's response to GM crops and nanotechnology, stem cell research is doing well.

Stephen Minger highlighted the unique relationship his lab in London has with the media. His lab at King's was one of the first that the Human Fertilisation and Embryology Authority licensed to derive human embryonic stem cells in 2002. Since then, his team has derived different stem cell lines.

Minger said being in London creates interesting opportunities for stem cell researchers compared to his colleagues in Sheffield, Bristol, Newcastle, and Southampton. 'The media regularly camp out on my doorstep,' said Minger. This is perhaps because they know Minger through his research and also the London Regenerative Medicine Network he formed with his friend, Chris Mason. This network has 4000 members, including journalists from New Scientist, the BBC, and The Guardian. They meet once a month for an evening of science with two to three speakers from academia and the commercial sector.

Minger said he has always been a strong proponent of regulatory policy in the UK. Over the last few months, there has been an interesting debate on interspecies hybrid or more accurately, 'interspecies somatic transform embryos,' inaccurately called, 'cybrid,' 'hybrids' or 'chimeras.' Minger explained that the reason for creating interspecies embryos relates to the fact that very few groups have ever created a human embryo from cloning using a human egg. Wong's data in Korea have been discredited. Minger thought it was inappropriate to try to encourage women to donate eggs when the procedure from which to create human embryos is inefficient. After the briefing in January 2007 at the Science Media Centre on this subject, he thought the press handled the topic very well and were incredibly supportive of what his team wanted to do. He said the scientific community had a positive reaction to the media coverage of this issue.

Minger then played a clip from 'Have I Got News for You' to show 'the man on the street reaction' to stem cell research. It was a tongue-in-cheek comedy sketch, highlighting a distorted perception of interspecies hybrid with pictures of a half man - half cow, a funny sketch which contrasts with the good coverage of stem cell research in the mainstream scientific press.

Minger concluded his talk with his view of why stem cell research is viewed positively in the UK compared to the US. He said the strict regulations in the UK are important and

also the fact that the debate takes place in a way that is free of emotion. This is different to the US where it is a highly emotive subject.

Sarah Franklin spoke of major shifts in popular culture over the years. She showed iconic photographs of the human foetus by Lennart Nilsson taken in the 1960s. Nilsson's images, she said, like the photographs of Earth taken by NASA space explorers, emphasised human vulnerability and individuality. The photographs also signified human technological achievement and ironically had been used to oppose technological interference with human fertilisation and embryology.

Franklin spoke of the shift in popular culture in terms of pro and anti embryo research, as well as among the mainstream public. A new visibility of technology defines the shift, the 'helping hands of science'. A consequence of the shift, says Franklin, is that the media has moved its focus to the question of enhancement and design.

Franklin clarified that like preimplantation genetic group diagnosis (PGD) and in vitro fertilisation (IVF), stem cell therapy is less orientated toward enhancement than toward repair. Like PGD and IVF, human embryonic stem cell (hES) derivation aims to combine cutting edge science with clinical applications. The history of media coverage of these previous therapies suggests that an emphasis on social hope is likely to prevail over objections to scientific experimentation with human embryonic material.

Angela McNab spoke of the responsibilities of the Human Fertilisation and Embryology Authority (HFEA) and how strong regulatory systems contribute to public confidence in stem cell research. She said a core responsibility of HFEA is to listen to the public's views. McNab highlighted what HFEA is doing to foster easy access to accurate information. She said HFEA has an enhanced website, which has a lay summary of ongoing research. The website also has outcomes of applications, updates of ongoing research, yearly progress reports, and information about public meetings and conferences.

McNab highlighted key issues with hybrids. One that stood out is the 'yuk' factor, the instant reaction your next door neighbour has to the subject. However, when hybrids are explained properly, this reaction dissipates, emphasising the importance of clear and accurate information in the media.

HFEA is coordinating a consultation approach to hybrids. The organisation has created a written consultation document, which is available on their website. There are deliberative groups taking place across the UK and a public meeting is taking place on Tuesday 26 June. It will be undertaking an opinion poll with over 2000 participants. One key question HFEA is addressing with the public is: 'Do you think that the HFEA should in future issue licences to allow research using human chimera embryos?'

McNab stressed that the media must avoid emotive headlines, give clear explanations, identify the issues and work together with all channels of information. The media must inform, said McNab, and ensure the story is about science.

Alok Jha, science correspondent at The Guardian, took a provocative stand, emphasising that it is good to have bad press coverage. It encourages good stories to be written and debate to happen. There should be a healthy debate between the journalist and scientists, said Jha. Scientists are a community of people and journalists have to be honest about what scientists are doing.

Jha said he worries that scientists and journalists can get too close and clarified that he, like other journalists, serve the public. Although he agrees with scientists on this occasion, he is not always going to agree with them. There has to be respect between scientists and journalists and scientists have to be more available to talk. Jha emphasised that the only way the public will agree with what journalists are writing is if they are honest about what scientists are doing.

Jha referred to his former colleague, Tim Radford, who said that debate and argument are always a good opportunity to tell people about something. Jha agreed journalists do sensationalise science. 'They're meant to otherwise no one would read it.'

This session stimulated questions from the audience which led to further clarification about key issues. One included the clarification of embryonic versus adult stem cells. Minger explained that adult stem cells are derived from tissue, such as the liver, heart, or pancreas obtained from a 7-8 week old foetus (that has been terminated) through to any adult age. Embryonic stem cells are derived from 6 day old human embryos created by IVF.

Embryonic stem cells in particular are not committed to tissue type but can form every cell type in the body. Opinion polls in the UK show that 70-80% approve of embryonic stem cell research.

Discussion then moved to language and whether there would be an attempt to standardise the language with reference to interspecies embryos so we know what we are all talking about. Minger agreed we need to have defined terms. He said there is general misunderstanding of interspecies embryos. In fact, we have regulated research for years where we have mixed human and animal cells together. He said we have mice with no immune systems and we have given them human bone marrow cells and used them to test new drugs. He said we have 26,000 strains of transgenic mice which have human genes in them, many of which cause diseases. This approach is the standard model of studying disease.

The session concluded with audience and panel members agreeing with one another: the media in the UK has covered stem cell research well.

Scientists working in the media

Chair: Sue Nelson, Broadcaster

*Speakers: Professor Marcus du Sautoy, Professor of Mathematics, University of Oxford
Professor Jim Al-Khalili, Professor of Public Engagement in Science, University of Surrey
Dr Jason Hall-Spencer, Senior Lecturer, University of Plymouth*

'Will the term media tart come up?' Sue Nelson queried before introducing this session's speakers.

Marcus du Sautoy, who holds a senior media fellowship with the Engineering and Physical Sciences Research Council (EPSRC), explained how reading a popular book about mathematicians was key in getting him to think about pursuing a career in mathematics. The book communicated insights into the life of a mathematician that went beyond his day-to-day lessons.

Du Sautoy's senior media fellowship is called 'Maths for the Masses' in which he communicates what he does and the excitement of his subject to the general public. His first contact with the media was several years ago at a formal dinner at University of Oxford. He was sitting next to the features editor of The Times who, after listening to what he did, said 'That sounds really sexy. Can you write me an article?'

Du Sautoy said that he felt too terrified to go into print in front of his colleagues, and so did not call the editor. Three years later, however, he found himself sitting next to the same features editor from The Times at a similar formal dinner. The editor remarked that he had never written the article. A debate broke out over dinner in which the mathematicians argued that what they do is too complex to be explained to the public. The journalists argued that the professors were using public money and should consider why they would not explain their subject.

Shortly afterwards, Du Sautoy wrote his first article for The Times. He offered two key pointers for academics thinking about communicating through the media: (1) be prepared for criticism from others; not all people will enjoy what you are writing about, and (2) do not leave science to work solely in the media. 'Just being a media tart devalues your place in the media,' Du Sautoy said. He stressed that it is important to keep a balance between conducting science and communicating it.

Like Marcus du Sautoy, Jim Al-Khalili also holds an EPSRC senior media fellowship. He conveyed that it is important for scientists to pursue media activities and that attitudes toward media work within academia are changing.

Al-Khalili was first involved in science communication 10 years ago. He held an advanced research fellowship with the EPSRC and was invited to give the Institute of Physics schools and colleges lectures. His colleagues warned him that it would take too much of his time and he would lose out on research. Al-Khalili ignored their advice. He enjoyed the lectures which set him off on a fulfilling career path. He now holds a joint professorship in physics and one in public engagement in science. He too emphasised the importance of not leaving science to communicate it.

The UK is a world leader in science communication, Al-Khalili said. Research councils and universities are increasingly supporting academics to communicate their work. Specific fellowships offer departments money to cover teaching commitments, which frees up scientists to work with the media.

Al-Khalili dispelled myths about the media to encourage more scientists to communicate their work. He said the media is not here to attack or ridicule academics; they have no interest in making academics look good or bad. They want a story. He said, 'As long as you know what the media is looking for, then you can provide it.'

Jason Hall-Spencer rounded up the session, exemplifying how media interest in his work had a direct impact on policy regarding deep sea conservation. Hall-Spencer gave a talk at the 2005 BA Festival of Science. He showed that there were deep sea coral reefs off the coast of Ireland and they were getting smashed to bits by fishing trawls preventing other fish from feeding amongst them.

The story hit the headlines and he was interviewed on radio and television, saying it was, 'Thrilling to talk to a wide audience to say what the problem was.'

Hall-Spencer said that because of media exposure he was able to telephone the government to access data. This led to protecting pristine areas of deep sea coral reefs that were previously unprotected. This is how the media helped to change policy.

A positive discussion ensued, which focused on encouraging scientists to maintain a balance between their work in media and academia. Du Sautoy emphasised that academics staying in science are more credible in the media than young scientists who leave science to pursue only media work. He said that the media is glamorous and gives a real buzz, but working only in media runs the risk of early burn-out.

A member of the audience highlighted the distinction between a scientist who communicates science and a science communicator. The panel agreed both are respectable careers.

Using new technologies to reach new audiences

Chair: Sue Nelson, Broadcaster

Speaker: Dave Patten, Head of New Media, Science Museum

Reflecting on this session, the Chair thought it exceeded expectations.

Within about 15 minutes the audience was agog at the different technologies and ways to communicate among peer groups and interested parties. Patten started with webcasting and podcasting but then shot off into cyberspace to talk about social networks and it was quite clear that most of the audience had never heard of the things he mentioned. Nelson, the Chair, described feeling like a cavewoman in response to the technology he spoke of, despite having broadband and a Palm pilot.

'The session was a real dark horse,' said Nelson. People were awestruck at the end and would probably have liked to have heard more. Questions and answers were enthusiastic, revealing that everyone had enjoyed and learned something.

Engaging the media in engineering

Chair: Jane Sutton, Communications Manager, the Royal Academy of Engineering

Speakers: Dr Scott Steedman, Vice President of the Royal Academy of Engineering

Lyndal Gully, Engineering Press Officer, Science Media Centre

Savita Custead, Director, British Natural History Consortium

This session aimed to discuss the particular communication challenges involved in engaging the public and the media with engineering.

Scott Steadman described the role of the engineer as 'creating the physical fabric required for people to enjoy life.' He said that in the face of difficult challenges, it can be tempting for the public to look back on the days before the industrial revolution, and say 'It used to be so simple'. In this way they are closed to new engineering ideas.

Another problem is overcoming superstition, for example, the misunderstanding of exactly what was being genetically modified for GM food led to the story of potential 'monster super weeds'. Steedman said that engineers must help people realise their views are superstition and then get beyond those views using facts. If people still want to hold onto their superstitions then that is more the field of religion.

Steedman finished by talking about the need for 'joined up thinking' in the Climate Change debate. He highlighted an article from the Evening Standard, with the headline 'Global Warming Beatable: the verdict of 2500 UN scientists' saying that there is a problem if engineering is missing from these reports and articles – nobody has yet worked out if the technologies required can be scaled up to 'beat' global warming and it is wrong to put out a message that the problem is solved.

Lyndal Gully presented some research which showed that although 45% of the public associate the term engineer with a 'builder/mechanic/fitter', 24% also associate it with 'expert/skilled/clever'. The public are interested in engineering issues, such as solutions to climate change and new faster methods of transport, and so engineers should look at headlines not as a threat, but as an opportunity.

She suggested that, 'We'll get the media to 'DO' engineering better when engineers 'DO' the media better.' It is time for engineers to seize the agenda and talk about the positive results of their work. The Science Media Centre has held press briefings on road pricing and flood defences at which engineers have spoken to the press. It is important to react quickly to events to get the views of engineers into the media. Views of engineers were included in the coverage of the Cumbrian rail crash and stories about liquid explosives. The Science Media Centre publishes leaflets for scientists and engineers about dealing with the media, and holds 'Introduction to the Media' days for those who want to know more.

Savita Custead talked about the 'Engaging Cogs' initiative which aims to get people thinking about engineering. They run live events (5 so far), linking into networks that already exist and on-line debates at www.engagingcogs.org. A podcast of the first event in London is available to download from iTunes.

There was then a discussion about the media not using the term engineer in headlines or stories. The Science Media Centre felt that engineers focus too much on whether they are called engineers by the media and not enough on the important contribution they have made to the accuracy of the story. Journalists will continue to use terms like scientists/boffins/experts to describe engineers and if this is an issue it is up to engineers to put the word 'engineer' in their title – as a way to ensure the word appears in the story.

The engineering community was considering setting up a separate Engineering Media Centre and approached the SMC about the best way to go about this. The SMC advised against this as journalists do not distinguish between scientists and engineers and there are no 'engineering correspondents' on any national media outlet, only science and environment.

There was a definite feeling in the room that the 'Engineer's day has come' with the movement of the climate change debate away from the science of if it is happening to the engineering of solutions. Engineers need to be more proactive in talking to the media, especially if they want to be involved in shaping the climate change debate.

There was then a discussion about how engineers can get involved with the climate change debate. It would be helpful if engineers could come to a consensus about what should be done on issues such as building design and transport. If the engineering institutions could speak with one voice on biofuels, wind power and nuclear energy and the facts behind scaling these technologies up to the required levels to combat climate change then it would be a very powerful message. Engineers need to start coming up with opinions. Now that there is a consensus amongst scientists that climate change is human-induced, the opportunity is there for engineers to move the debate towards solutions.

To finish, Lyndal Gully reminded the group that the trick with the media is to talk to them when they are interested. They are now interested in the engineering solutions to climate change.

Communicating climate change

Keynote speeches

Climate change in the political arena

Chair: Vivienne Parry, Broadcaster

Speakers: Professor Tim O'Riordan, Emeritus Professor of Environmental Sciences, University of East Anglia

Professor Brian Hoskins, Professor of Meteorology, University of Reading

Dimitri Zenghelis, Senior Economist, HM Treasury

This session explored challenges raised in the Stern Review in relation to science communication and public engagement, specifically how to develop a shared understanding of climate change and how to shape preferences and behaviour.

Brian Hoskins kicked off assuring the audience that the scientific basis for the warming effect of greenhouse gases on the Earth was solid. The level and number of greenhouse gases in the atmosphere has been increasing at a rate consistent with human activity.

The Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report 2007, said that 'Global warming is unequivocal' and the latter half of the 20th century 'is likely to be warmer than any comparable period in the past 1300 years.'

Hoskins said that projections for future climate change require specifications of a scenario for human activity. We also need a model of the relevant physics, chemistry and biology of the Earth that is developed on the basis of theory, observation and detailed monitoring. This model needs to be tested on weather, seasonal climate, and the impact of climatic events such as El Nino and Pinatubo.

To determine projections of climate change impacts, we need models of the aspect of interest, such as sea level, crop or river models. These may or may not be fully integrated with the climate model.

Increasingly runs of many models are performed to estimate the likelihood of particular outcomes. There is overwhelming evidence that human activity is perturbing the climate in a significant way. However, there is uncertainty in knowledge, models, observations, and future projections. Natural variability (chaos) means that extreme events cannot usually be ascribed to human activity though they may be more likely because of it. Although there is overwhelming consensus of climate scientists, this does not mean they are correct.

Many quote extreme results and potential impacts with unwarranted confidence. Major, abrupt changes in the climate system are possible that we cannot predict. Sceptical questioning and probing is essential in climate science as in all science.

Scientists communicating about the climate must also communicate uncertainty and risk and consider the different perspectives (economic, political, ethical, religious) of the people involved. Certainty in the media makes scientists feel uncomfortable.

Dimitri Zenghelis, the second speaker, briefly introduced the Stern Review and some of its conclusions. It was commissioned by the Chancellor of the Exchequer to assess the evidence, and build an understanding of the economics of climate change.

Zenghelis showed charts of the projected impacts of climate change with a 0 to 5 °C rise in global temperature. There is lots of uncertainty with things like precipitation. With a rise of 3 °C, there would be up to 60% more people at risk from hunger, with half the increase in Africa and West Asia. More than one billion people would suffer water shortages, many in Africa. Between 20 to 30% of species would face extinction and the onset of irreversible melting of the Greenland ice sheet would begin.

New evidence allows climate scientists and economists to apply probabilities to projections. He asked, 'How do these temperature possibilities map on to potential damages and what are the options for action?' Spreading the message and having it understood is the way forward.

A climate change policy must take into account carbon pricing, research and development, related market failures and behavioural change. An effective policy must be consistent with other policy goals, specifically capital growth and energy security. He emphasised that we need a policy that is long-term and one that we can agree on an international level.

Zenghelis ended his talk on a rhetorical flourish. He said it is absurd to doubt climate science. It is reckless to think that we can adapt to changes in the climate without taking action now. It is possible to feel despondent when considering the costs of action and mitigation but that is not an excuse for inaction. Finally, he said it is unethical to give too little weight to future generations. People who do so have washed their hands of the problem. He said if you do not fall into one of these four camps, then you will want to take the subject of climate change seriously.

Tim O'Riordan, the third speaker gave an overview of the three key points he had picked up from the previous two speakers: (1) we must invest now in reducing carbon emissions because there could be tipping points in the climate or long-term catastrophes that we cannot predict and will radically change the world of our grandchildren, (2) once we get beyond a 3 °C rise in global temperature, the probabilities of specific impacts get tighter. He stressed that we must stabilise at a 2 °C rise and get President Bush to sign such an agreement at the G8 summit in June in Germany, (which subsequently he did not do, but committed the US to a UN negotiating framework) and (3) what we do today affects the world in 80 years. It is hard to get people to think 80 years into the future. We must persuade people to act now to reduce carbon emissions.

O'Riordan argued for more political integration between policy, energy and comprehensive sustainable development. He said the current government is trying to find technological solutions and is aiming to become carbon neutral by some mythical

time in the future. 'Big deal,' said O'Riordan. Norway is aiming to be carbon zero in 2050 and other countries will surely follow, at least in rhetoric and aspiration.

The main point O'Riordan highlighted was the need to change culture. He said real science is the science of culture change. He said if we move to carbon debit cards, this will throw up in people's minds, 'Is the science right?' He asked, 'What can we do now?' One point of action is to get people to go to low energy light bulbs on mass.

It is important to realise that the success of Stern and Gore lie in the connectivity of excellent science and equally excellent communicators. This must be a partnership which is extended and enhanced.

A stimulating discussion ensued with the audience, in which delegates questioned cultural changes and how to ensure behavioural change across society that would support reducing carbon emissions.

Science and innovation: Responding to the challenge of climate change

Chair: Vivienne Parry, Broadcaster

Speaker: Malcolm Wicks, MP, Minister of State for Science and Innovation

Malcolm Wicks' central message was that 'we must all work very hard to bridge the gap between science and society.' Science should be at the mainstream of public discourse. He said science and innovation are central to the economy and that, indeed, the big questions facing society are scientific ones. Climate change is one example, which requires scientific excellence combined with public intelligence and engagement.

He welcomed this conference, commenting that the issue of climate change is the greatest long-term challenge the world faces. The effects of climate change will affect the world's other great problems, like food and water insecurity, poverty, conflict and disease. He encouraged scientists and science communicators to ensure they present science accurately and separate it from the hype. 'There is a danger,' he said, 'that some of the dialogue could be separated from some of the science.'

Wicks said we need to understand, present and disseminate the complexity of climate change to the wider public. We need an effective policy to provide a framework for effective solutions to be developed. Scientific communities have an important role in disseminating information to the wider public.

The scientific case for action is clear. The debate is no longer whether to act but to determine how much to do and how quickly. 'The challenge is huge,' said Wicks, 'because of world energy demand which will increase by over 50% by 2030.' He also reminded the audience that the issue of energy is also increasingly bound up with the notion of national security.

Wicks agreed that action must be taken by all parts of our society. The individual has to play the key role for personal action. In the UK, he reminded delegates, we have come a long way in a short time. Since 1990, CO₂ emissions have fallen by around 6%; all

greenhouse gases have fallen by 15%. He assured us that we are on target to double the Kyoto target of 12.5% reduction of emissions in greenhouse gases during the period 2008 to 2012.

It is important, from a public engagement perspective, to demonstrate how environmental objectives can be achieved while obtaining a vibrant economy and a fair society.

It is essential to make people aware of the link between their behaviour and the issue of climate change. It is vital for the government to have policy in place to act effectively. Wicks said that 40% of CO₂ emissions are from actions taken by individuals. The public needs assurance that their actions are worthwhile.

Wicks ended his talk with an appeal to young people: 'By becoming tomorrow's scientists and engineers, they will be able to tackle the challenges we face. What better career is there for a young person?'

In the face of this challenge, Wicks' message was that we are neither hopeless nor helpless and that the science community must promote the message of the central role of science and innovation to bring about solutions.

Discussion followed with the audience about whether the government was doing enough and the impact of the recent Channel 4 programme, 'The Great Global Warming Swindle,' which downplayed climate change and human activity.

Communicating uncertainty

Chair: Sheila Anderson, Head of Communications, Natural Environment Research Council

Speakers: Professor Sir Howard Dalton, Defra

Professor Joanna Haigh, Imperial College London

Dr Dave Reay, University of Edinburgh

Bob Ward, Risk Management Solutions Ltd

This session explored how uncertainty could be communicated effectively among different audiences including policymakers, climate sceptics, the public and the media.

Howard Dalton acknowledged that science is a dynamic process in which there will always be levels of uncertainty. He said it is important to communicate with policymakers about how science can be used properly. However, he advised that it is important to engage in debate about uncertainty and to recognise that social and economic factors, in addition to scientific knowledge, contribute to policies.

Any new area of scientific endeavour is open to a variety of different interpretations. Policymakers are under pressure to make decisions quickly and may press scientists for information that they are unable to give immediately. The government is currently putting policymakers and scientists together to communicate and better understand each other's roles.

Dalton said that in relation to climate change, the government must put policies in place to cope with what is going on with the planet. However, the science informing these policies is open to debate and absolute proof of a particular outcome is often lacking. Science always points to further research and this is not what policymakers want to hear.

One of the challenges science faces is that uncertainty is interpreted as incompetence. This is a big issue for the media who rely on 24 hours of reporting. He gave the example of the recent bird flu incident in which Defra provided a number of different views of the origin of the disease. He said 'It would be easy for the casual television viewer to think Defra didn't know what was going on.' Defra was, in fact, in a process of working through a number of recent arguments and findings on the issue.

Dalton advised that the government must be brave and must be able to say when they do not know the answer and to explain why they do not know, in addition to saying what they are doing and how they will address that level of uncertainty. He said it was important to convey that any uncertainty is due to genuine uncertainty and not due to scientific incompetence.

He closed his talk with the key question in considering uncertainty in science: 'How certain is certain?'

Joanna Haigh, an atmospheric physicist, then shared what she had learned about communicating uncertainty in her area of expertise, the Sun and how it links to climate change.

Haigh said that uncertainty is intrinsic to geophysical systems and that the natural atmosphere can have large uncertainties. However, she said we should avoid treating uncertainty as though we have no knowledge at all. She said there are uncertainties but we can put ranges on them, then consider variability and outcomes within these ranges.

Haigh advised it is important to stay focused and not to get drawn into complex speculations when communicating uncertainty, to explain what we do and do not know.

Haigh discussed the use of analogies to communicate uncertainty and talk about risk. She concluded that it is probably better to avoid relying on analogies because of the problems involved in identifying quantitatively similar situations; for example, is it feasible to compare the probability of global warming happening with that of Manchester United winning the Premiership?

Finally, she said it is important to keep perspective, to ask 'what is important to communicate?' when considering uncertainty in climate change.

David Reay, an expert in greenhouse gases, shared how he communicates uncertainties. He said in the past he had downplayed uncertainties as there was a big temptation to do so. However, after he gave a climate change presentation at the Cambridge Science Festival and a little girl asked him, 'When am I going to die?' he realised that in downplaying the uncertainties in the science, he had disempowered her.

Reay reviewed why we end up with so much uncertainty in climate science and concluded that 'We are the biggest unknown,' he said, 'and a key part of the uncertainty.' This is the message he believes is important to convey in his climate change talks.

The session then moved into an interactive forum with a staged mock interview between a journalist and scientist. Bob Ward asked the audience to critique the interview. The interview was given twice: the first time as an example of how not to communicate uncertainty and the second time on how to communicate uncertainty.

It was a fun exercise. Everyone agreed that in communicating scientific uncertainty, it is important to avoid using lots of jargon, making sweeping statements, discounting other research, rubbishing other scientists and failing to consider the full picture.

Engaging to inspire and educate

Climate Change in the national curriculum

Chair: Sir Roland Jackson, Chief Executive, the BA

Speakers: Michael Reiss, Professor of Science Education, Institute of Education

Colin Izod, Director, Big Heart Media

The first part of the talk by Professor Michael Reiss looked at how the National Curriculum, particularly in science, might be taught so as to include climate change and at the benefits of studying this topic.

Colin Izod's contribution was to put forward an example of a project aimed at engaging young people with the issues of climate change.

Michael Reiss explored how teaching climate change in school could help develop the scientific skills of critical thinking and evaluating evidence. The controversial issues involved help students understand the nature of science and how scientific 'facts' are produced. These skills are transferable beyond science subjects and allow students to think critically about other information they are given.

In addition, because climate change is both accessible to students at all levels and a popular topic in the news, it is an example of how science is relevant to students' lives, is motivating, and can encourage them to continue studying science.

Reiss provided further reasons why it is important to teach climate change:

Recently other industrialised countries have shifted their curricula to include socio-scientific issues. However, there are a smaller proportion of students going on to study 'hard' subjects in many industrialised countries, including the UK, than used to be the case. Climate change is seen as a way of interesting students to continue to study all science subjects.

Climate change is interdisciplinary and so can show students how different science subjects such as biology, chemistry, physics and earth science interconnect.

Climate change does not have a huge depth of science behind it, so it is accessible to students of all ages. The nature of science and how scientific knowledge is produced can be explored by students by looking at controversies in climate change. These controversies could include the causes and extent of damage we are doing and the result and importance of this damage.

There is a political edge to the climate change debate. Students can look at the extent to which scientific knowledge is objective and unproblematic. They can look at how political considerations, such as who funds research, can affect what action is taken.

Because climate change is frequently in the news, it provides a good example of science when students frequently complain that the science they learn in school is irrelevant and

uninteresting. There is huge human interest involved, which is more motivating for students.

Reiss suggested areas to consider:

1. The science of climate change.

This can include the history of climate change, including how the Earth has been both hot and cold in the past. This is conventional science while the science of contemporary climate change includes human action.

2. The role of science education in teaching about climate change. Climate change is a topic through which students can better understand how scientists work.

3. The contribution of sustainability education.

Included in the science are the social aspects of climate change and the global human impact.

4. Teaching about ethics in science.

Questions can be posed to students, such as, 'Should we do something?'

The Defra/DfES pack

This is a good resource, sent to English secondary schools, for use in science, geography and citizenship lessons. The press release is available here:

http://www.dfes.gov.uk/pns/DisplayPN.cgi?pn_id=2007_0071

There were clear conclusions from this talk. Climate change in the National Curriculum fits with the major goals of teaching science. It has the potential to lead to greater numbers of pupils carrying on studying science post-16. It can improve students' appreciation of the role ethics plays in socio-scientific issues, and can help them to make ethically informed decisions. It has the potential to improve sensitivity to impacts we all might have on the planet and on other people. It allows students to make better judgements as they learn the relative consequences of certain actions.

Colin Izod talked about the Cape Farewell Education Project. Cape Farewell is a series of sailing voyages into the Arctic, through routes that were previously icebound but are now passable. This is an ongoing project bringing artists, scientists, teachers and students together to address and raise awareness of climate change. There have been three voyages so far, bringing those involved to the Arctic where documentaries, artwork and recordings are made.

In May 2003 the first Cape Farewell voyage set off. It was funded by NESTA to create a resource, 'The High Arctic', for a new geography GCSE syllabus, Geography 21.

The second voyage was in September 2004, and was mainly funded by the Arts Council, supporting the work of the artists on board. On this voyage the Nuffield Curriculum Centre commissioned a resource 'Life in the water', about the place plankton takes in the Arctic food chain and how this will change with global warming.

In March 2005 the third voyage included Ian McEwan, Antony Gormley and Rachel Whiteread.

The next Education Voyage is due to set off in September 2007 and will include twelve 12-16 year olds from the UK, Germany and Canada. They will sail to Svalbard in the Arctic with scientists and artists and each will be encouraged to think about what they, their schools and communities can do about climate change. Izod explained that this voyage could [should?] also act as a catalyst for cross-curricular teaching.

It is hoped that this voyage will engage not just the students involved but also their entire schools, getting teachers from different departments to collaborate. The experiences and materials collected from each student will be broadcast on the web.

It is hoped the students will find creative ways to explore climate change. Some examples on previous voyages include: looking at the politics involved by claiming a small island which had appeared out of a melting glacier; and making sound recordings of the animals encountered.

All the resources can be found on the website www.capefarewell.com

Discussion with the audience suggested that students are confused about the difference between theories, findings and facts. They assume that because something is a theory that it isn't correct. Teachers need to guide pupils, give them the information, history, and logic of science. Then they must allow them to look through resources and try to spot the flaws.

Another delegate suggested that perhaps philosophy of science should be taught at a younger age. There is a gap in how students are taught or 'not taught' to think. One delegate wondered, 'Do teachers feel they have to know everything before they get into this?'

Further discussion with the audience led to conclusions about teaching climate change science: to inspire students to carry on and to enable people to better understand and critique what is presented as science.

How to target individual choices and actions

Chair: Dr Matthew Harvey, Manager, Science in Society, The Royal Society

Speakers: Trewin Restorick, Director Global Action Plan

Matt Prescott, Director, CarbonLimited, RSA

Antony Turner, Managing Director, CarbonSense Ltd

This session showcased projects that educate, engage and inspire individuals and organisations to change their choices and contribute toward mitigating climate change.

Trewin Restorick described three broad lessons from Global Action Plan's work on changing environmental behaviour. First, communicators need to consider the nature of their communication. Climate talk is replete with jargon which is difficult for people to understand and to engage with. Moreover, there is too great a reliance on written forms

of communication. Restorick described other modes of communicating. For example, the activity based Carbon Gym aims to demonstrate the link between people's daily lifestyle and climate change. The energy bike, for instance, shows the energy burnt by a computer left on standby or the difference in energy required to power low and high energy light bulbs. Restorick explained that it is difficult for people to connect their behaviour and climate change, but different modes of communication can demonstrate the link.

Second, behaviour change is better embedded and more likely if people are encouraged to make their own decisions and especially if they work in groups. Third, people need positive feedback. For example, people initially disliked a scheme where they had to weigh their rubbish, but became encouraged once they could see what they could achieve. Results from across various Global Action Plan projects include an average 43% reduction in waste across 151 schools and an average 7% reduction in electricity consumption in participating households.

Matt Prescott began by outlining difficulties with current climate change policies and messages. For example, much communication is too fatalistic and it is difficult to see any advantage in behaviour change; there is too much finger pointing and allocating blame; favoured policies treat individuals with different needs as a homogeneous group. In response, the RSA is currently experimenting with and piloting the idea of personal carbon trading. Prescott argued that this is a policy and education option for mitigating climate change that overcomes some of these shortcomings. Each individual receives a carbon allocation to 'spend' on activities and choices that entail carbon emissions. If a person 'overspends', they buy carbon credit from someone with credit to spare. Prescott suggested the scheme would lead to informed decisions because emissions become something tangible – a currency or commodity. Prescott noted that an incentive would be needed for those who were reluctant to sign up: being able to compare ones own performance with others might help and one RSA study showed 61% support for financially punitive schemes. The success of the Oyster card scheme on London transport might act as an analogue for how the system could work.

For Antony Turner, the invisibility of carbon is the crucial problem in communicating climate change. The first task therefore becomes to make the invisible visible. Turner showed the importance of a strong visual image. For example, CarbonSense uses the image of a purple balloon equivalent in size to 1kg of carbon dioxide to make carbon 'visible'. Turner also showed how simple graphic illustrations can reveal the relationship between atmospheric temperature and carbon.

With the problem visualised, the task then becomes to take people and organisations on a 'carbon journey'. For example, most organisations are 'carbon unknown' but with a little effort they can become 'carbon managed'; that is they can reduce carbon outputs where it is easy to do so. Some organisations then seek to be 'carbon neutral'. But Turner believes the real challenge is for organisations to become 'carbon positive'; that is, the whole organisation 'gets' the carbon story and acts accordingly. CarbonSense has worked with, for example, BT in developing this sort of approach.

The discussion began by asking if any particular pieces of legislation might assist in encouraging behaviour change. It was suggested that for any legislation to be effective, a sufficient number of people had already to be 'on board'. Rather than legislation, it was pointed out that regulation might be an effective tool to address organisational pressures that counter individual effort. For example, Prescott noted that the RSA is working on a project with partners in the USA to regulate energy companies that make energy cheaper the more one uses.

Delegates discussed further pressures that work against individuals. For example, 'green' products and services, such as in transport and food, are not usually the cheapest. Possible responses to this challenge included the introduction of 'carbon labelling' to inform choice, the need for widespread carbon literacy and the introduction of 'choice editing'. This removes the possibility of making 'bad' choices. Australia, for example, is committed to having only energy efficient light bulbs available to consumers.

The discussion then turned to investment choices made by business; in particular, how businesses might choose which products to develop and invest in. The notion of carbon neutrality is beginning to receive criticism, and whilst carbon offsetting is better than no response, offsetting schemes vary in their quality and fall short of an ideal response (such as working toward being 'carbon positive'). Carbon calculators are being developed, but figures generated by those currently available do not necessarily correspond.

A challenge for science communicators is to choose which aspects of the 'carbon story' to tell. Opinion differed around whether communicators ought to all utilise the same illustrations, or whether communicators should make decisions based on materials they feel most comfortable with. Turner preferred the latter, and felt that whichever illustration is chosen, the key challenge is to unpick consequences from actions, and then show how they are linked. Prescott pointed out that any message or story needs to relate to the concerns and contexts of the audience. Restorick focused on the messages of others, arguing that communicators need to react quicker and with more strength to messages that seek to overplay doubts and uncertainties.

The discussion finished by considering the changing nature of communities. It was broadly agreed that communities are becoming more disparate but that working with communities *as* communities is the most effective model for change.

Engaging to involve

Policies to influence personal preferences

Chair: Professor Nick Pidgeon, Professor of Applied Psychology, Cardiff University

Speakers: Professor Mike Hulme, Director of the Tyndall Centre

Professor Paul Ekins, Head of Environment Group, Policy Studies Institute

Jill Rutter, Director of Strategy & Sustainable Development, Defra

Mike Hulme began the session by discussing the limits of science for motivating action on climate change. He argued that science works well to reveal problems in society, but rarely drives personal behaviour and does not dictate public policy.

Climate change tends to be seen as an environmental problem rather than a social, economic or security issue. Environmental science is repeatedly deployed to reveal the impacts of climate change. The analysis is then easily extended to say what is dangerous and what should be done. Hulme states that scientists are limited in terms of talking about this because danger is subjective, defined by values and individual experience. It is out of the realms of science. For example, a 2 °C change in climate is not generally perceived as dangerous in the comfortable North. In the places where this change in climate does have an effect, people are often powerless to make a change.

If the stated risks don't deliver enough sense of danger, the risks are amplified until they do. But Hulme argues that wrapping the science up in a scare story won't achieve the desired outcome. People need to be motivated but not frightened.

Hulme concluded that an ethical consensus for action is required, but we need to be aware of the limits of science in providing this. Climate change is not merely a scientific and ethical phenomenon – it is also social and cultural. The subject needs not to be 'sexed up'. This disengages and disempowers, with detrimental consequences for science and for society.

Paul Ekins is an economist who heads the environment group at the Policy Studies Institute. Ekins spoke about environmental taxes as a way of influencing personal preferences. He explained that prices have a fundamental effect on the function of the economy. Prices are not the only way to influence public action, but it is difficult to pursue a public policy agenda if prices tell the opposite story.

To have an effect on emissions, energy and energy intensive items must become more expensive. Environmental taxes seek to change behaviour and consequently decrease environmental damage.

The libertarian view is to tax rather than ban items such as incandescent light bulbs, flat-screen TVs and patio heaters. This means that these items are available if crucial, or if desired for a special occasion. It also allows for technological improvement that might improve the environmental impact of these items. Under some circumstances, for example the recent plastic bag tax in the Republic of Ireland, the policy will completely remove some items from circulation.

As an example, Ekins described how fuel taxes, commonly thought to be an ineffective environmental tax, have a big impact on fuel use. A recent study reported at the recent European Tax Forum on Sustainable Development has shown that if EU fuel duty had been similar to that in the US over the last twenty years, Europe would use twice as much road fuel as it currently does.

Another benefit of environmental taxation is that it generates revenue. This can be used to decrease other taxes. For example, in the 1990s, the fuel tax led directly to a decrease in income tax. The connection between the two, however, was rarely made. Revenue from taxation can be used for several purposes. Environmentally friendly activities can be subsidised; people can be informed and educated about 'green alternatives'; people who lose out through taxation, for example those in poor houses, can be compensated; businesses can be supported in making changes to their practices.

Jill Rutter argued that scientific evidence is a crucial context for debate, disagreeing strongly with Mike Hulme's earlier points.

Rutter described the shift in style of environmentalism. She sees old environmentalism as tackling big sources of pollution, cleaning water and air under direct command and control of government, and having an immediate effect on people. New environmentalism targets multiple small sources of pollution. It is less easy for government to take control of as it interferes in lifestyle choices.

Most approaches are very long term, but Rutter argued that there are a cluster of things that can lead to a change in behaviour, allowing individuals to break their unsustainable habits.

Firstly, government needs to enable people to make a change, for example by offering services like kerbside recycling, as well as sharing information. They also need to encourage change through taxation, and reward and penalty schemes. Particularly difficult for government is engagement, as government communications are often seen as untrustworthy. And, despite what Mike Hulme says about scientists not having a role here, scientists are much more trusted as communicators than bureaucrats are. Policymakers also need to exemplify good practice, leading by example and making sure that policy is consistent.

Central to this approach is catalysis – making the changes possible and practical for people to take part in.

Defra has several current initiatives acting on these principles, including *every action counts*; *tomorrow's climate, today's challenge*; and *act on CO₂*. Not everyone responds to these signals and initiatives in the same way. People have different priorities – some are more willing or more able than others to alter their habits.

A wide-ranging discussion between the panel and delegates was chaired by Professor Nick Pidgeon. Several delegates felt that scientists should raise their voices in subjects such as climate change. Others argued that scientists could not be expected to act as

moral arbiters, a role formerly occupied by religion or politics. The danger then, as Mike Hulme argued, is that scientists have more influence than is appropriate. This role asks scientists to adopt strong value-driven positions which is far removed from the conventional ethos of science.

The role that scientists could take over climate change was compared to the influence the epidemiologist Richard Doll had on social attitudes to tobacco smoking. He researched the effect of smoking and advised people not to do it. However, as a delegate pointed out, we're only legislating on smoking now, nearly 60 years after Doll began working on tobacco. However, climate change is a more complex issue than smoking has turned out to be, and the effects are public rather than private hazards.

One delegate pointed out that science communicators are often uncomfortable communicating the science of climate change. This is because it is a broad subject covering many branches of science. He argued that scientists, policymakers and communicators should be forced together to reach consensus and plan of action.

It was concluded that there was a central role for people with a foot in both camps, who could understand the science but also see the most effective way to communicate that to non-specialists. This role should be filled by science communicators.

Engaging non-traditional voices

Chair: Sue Hordijkenko, Director of Programmes, the BA

Speakers: Dr Nigel Eady, Science in Society Officer, the BA

*Dr Laura Bowater, Teaching Fellow, University of East Anglia,
Barbara James, public participant*

This session showcased the community x-change as an example of a project that seeks to involve non-traditional voices in an engagement process around science issues. The three speakers described their involvement in the project from the perspectives of a project manager, a scientist and a public participant. Discussion following the talks in particular touched on methods for reaching non-traditional voices and working with policy makers.

Nigel Eady gave an overview of the project focusing on the way in which people became involved in the project. He then went on to describe some of the results and outputs of the process and the strengths and weaknesses of the community x-change.

The community x-change (www.the-ba.net/communityxchange) is a two-way engagement process, seeking to allow both non-specialists and specialists the space to discuss issues of concern. The process draws on Citizens' Jury approaches but without using the legal language and framework. Whilst many processes of these types are either top-down, whereby government or other stakeholders define the remit, or bottom-up, where participants decide the topic for discussion, this process seeks to hold these two strands together and address issues of concern to both parties. The project could be described as 'a policy-focussed approach to engagement that gives non-scientists and scientists the opportunity to have a voice on science and technology, as well as other issues of concern'.

The aim is that the people involved in the workshops over-represent the under-represented. A key objective is to 'improve practices of dialogue, particularly those that allow currently excluded voices to influence policy' as well as 'developing the capacity of our elected representatives, policy makers and the media to engage with participatory processes'. The first year of this three year project was based in East Anglia and the top-down issue was climate change.

Whilst it is easy to recruit people for a process by sending an invitation in the post to those on the electoral roll, this makes a number of assumptions. Not least those who respond will be literate, will be 'signed on' and most likely will not feel marginalised or isolated. It was therefore decided that 2 outreach workers would spend time in East Anglia meeting individuals and community groups to invite them to join the process. People from BME (Black, Minority Ethnic) backgrounds, the young, the elderly and those in sheltered housing were targeted. The final group included 10 people from the outreach work and 15 people from the electoral roll – wards in Norwich & Lowestoft of socio-economic status were selected. Six young people from a community video project also attended to help produce a video of the workshops in the place of a written report. Eight scientists also took part in the workshops as ordinary citizens rather than as experts.

The final group consisted of 39 people. This diverse community included BMEs, non-English speakers, young people, the disabled and ex-offenders.

The group discussed local issues to do with public transport and the lack of facilities for young and old people as well as climate change, including the possibility of flooding. One of the most informative and moving parts of the workshops were two dramas which gave the opportunity for the group to explore their feelings. The first addressed community & exclusion and the second flooding. This resulted in some of the richest comments on climate change. For example the following statements were made, 'I feel helpless [about climate change] as the USA is doing nothing [about it]' and, 'I can't even influence my local community [so how can I have an impact on a global issue like climate change]'.

Videos of the workshops will soon be available online. A series of at least eight events based on the outputs of the workshops are being run throughout 2007 across the UK, including in Edinburgh, Derby and Cardiff.

As well as raising awareness of climate change, a particular strength of the project has been the diverse group of non-specialists involved, with a very high level of engagement throughout the workshops. Many participants were delighted to be involved in a process where their views were listened to and appreciated. The challenge is to enable the group to have a legacy and to ensure that their views are, at the very least, heard by our elected representatives.

Laura Bowater, a scientist at UEA, then spoke about her involvement in the project. She said that often scientists are under-represented in society or are viewed as being strange. She noted that one participant had commented as an aside that they were

surprised the scientists at the workshops didn't have two heads and three arms. She had enjoyed taking part in the workshops as an ordinary citizen and she now realises how much science communication is done with those who are interested. She is determined in the future to engage with underrepresented groups.

Barbara James, a participant recruited for the workshops through the electoral roll commented on the workshops. She had thoroughly enjoyed the process. Highlights for her were that from 12-71 years of age everyone contributed and barriers were quickly broken down. There was also a great mix of ethnic backgrounds. Everyone treated everyone else with respect and people's eyes were opened as well as doors of opportunity. She finished with a challenge to science communicators to remember those who can't read and write – in 1999, 8% of her housing estate did not have these basic skills. She reminded people to make information on projects available in hard copy and not just on the internet.

Questions then touched on impacts on policy of this process. Laura and Barbara both said that there have been changes in recycling policy in Norwich, which could be attributed to the attendance of the local councillor responsible for environmental management being present at one of the workshops. It was acknowledged that clearly it is hard to track policy changes to any one meeting but both participants felt this had been a positive step. The empowerment of the group to be able to contribute to these sorts of processes was also mentioned as a key outcome.

Engaging through the media and PR

Audience's reaction to the BBC's climate change session

Chair: Dr David Stewart Boak, Director of Communications, The Royal Society

Speakers: Phil Dolling, Executive Producer, BBC

Dr Tammy Boyce, Senior Research Fellow, Cardiff School of Journalism

Ade Thomas, Managing Director, Green TV

This session looked at ways in which audiences engaged with the BBC's season of climate change programmes shown earlier in 2007, and considered more widely how to engage viewers in the climate change debate.

Phil Dolling spoke about the BBC's recent climate change programme, 'Britain under threat,' a documentary of the findings of the BBC Climate Change Experiment, which aired on 21 January 2007. This interactive experiment relied on tens of thousands of people downloading software from the BBC website to run climate prediction models on their home computers, and highlights the scientific value of engaging viewers in the climate debate.

Using the climate prediction results, the BBC showed snapshots of future Britain in 2020, 2050 and 2080. Sir David Attenborough presented the programme, a co-production between the BBC and The Open University. More detail on the results of the experiment is available from <http://www.bbc.co.uk/sn/climateexperiment/>

The OU/BBC website, <http://www.open2.net/>, also features articles exploring differing views on the concept of climate change. Visitors to the website can take part in an interactive holiday journey planner to compare how environmentally friendly different modes of transport are.

Dolling spoke of the BBC's Appreciation Index, a measure of how much viewers watch with attention and whether they made a special effort to watch the programme. He also gave viewing figures. The programme did well and the number of bums on seats was about 4.9 million. Somewhat less than Coronation Street (9 million) but still impressive, clearly highlighting the success with which the BBC engaged the public on this issue.

Tammy Boyce introduced herself as the academic who reflects on what the BBC has produced, analyses it and goes out and talks to audiences to ask what they thought about it, not the next day but some time afterwards to gauge the long-term influence of the programme.

The BBC climate change series 'exemplifies the power of broadcasting and sets the standard for around the world for what the public service broadcaster can do,' said Boyce.

Why does the BBC do it? Boyce said they are interested in entertaining entry-level science among 24-34 year olds so that in the future they will engage in more

mainstream science programming. But, she asked, what is the purpose of these programmes for audiences who have some knowledge of the issues?

Boyce showed some findings of qualitative research one of her students had completed. They asked, 'Do people already interested in the environment use the media to inform themselves? How can they use the media?' She found that people say the media did not influence them, but if you talk with them longer, they reveal, in fact, that it does.

Some say they worry they will watch climate programmes and go away feeling horrible. This raises questions about the purpose of the programmes shown on climate change: Is it to inform people about the effects of climate change and possible solutions?

Does the BBC do a good job in prompting people into action? Boyce revealed they get criticised for not taking that extra step, but she feels it is not their job to get people to take action.

Through their research, Boyce and her students discovered that people respond to these programmes on a personal level, and suggested that perhaps the question for the broadcasters is how to talk about things in a personally relevant way. It is difficult to know what people find personal.

Overall, people like programmes that are encouraging, they do not want education. The BBC has an informative approach that works because it is not overlaid with information. It has cool pictures and is entertaining with a strong narrative.

Boyce encouraged the media to focus systematically on solutions, rather than catastrophic effects of climate change. If the focus is only on the effects of climate change, she hypothesised that the public will become bored. 'But,' she said, 'I could be wrong.'

Ade Thomas, the final speaker, said that he would like to see more of climate change in everyday programmes, such as Eastenders. The way we live our lives is part of the solution to climate change. It therefore makes sense to introduce lifestyle changes through mainstream programmes.

Thomas was key in setting up green.tv, launched in partnership with the UN and Friends of the Earth. This broadband television channel for environmental films presents both sides of environmental arguments and encourages debate.

To make green.tv as popular as the well-surfed YouTube, Thomas says we must combine the emotive power of television with the engagement power of the internet.

The chair of the session, David Boak, asked delegates to think about how to engage viewers in a meaningful way with the programme makers and whether this was possible outside of the internet medium. It was a stimulating discussion. There was widespread consensus that climate change must be mainstreamed into everyday programmes and that television must find a way to elicit climate interest in the 9 million viewers of Coronation Street, for example.

How climate change is reported in the media

Chair: Fiona Fox, Director, Science Media Centre

Speakers: Richard Darlington, Media Manager, Institute for Public Policy Research (IPPR)

Richard Black, Environment Correspondent, BBC

Dr Max Boykoff, Research Fellow, Oxford

This session aimed to explore how climate change is reported in the media.

Richard Darlington opened the session by talking about a about the IPPR report 'Warm Words: How are we telling the climate story and can we tell it better?' on the way climate change is being communicated and discussed. Newspaper articles, TV and radio programmes, websites and advertising in late 2005/06 and were analysed and the authors concluded the coverage was 'confusing, chaotic and contradictory'.

The dominant form of reporting was either to take a very pessimistic, alarmist view or to take a small actions view, with a list of things the individual can do to counter climate change. It was also common to get a combination of these two approaches, with a main alarmist article and an accompanying box with a list of potential individual actions.

The problem with the alarmist approach (called climate porn by the IPPR) is that it can alienate people who feel the problem is just 'too big' for them to cope with. Mr Darlington finished with some advice to science communicators: 'Deal with the media the way you find them, not the way you would want them to be' and 'Don't offer a problem without a solution'.

Richard Black subtitled his talk about how climate change is reported in the media: 'How is anything reported in the media?' 85% of the climate change stories appear in the 'quality' or broadsheet media, with only 7% of the stories in much more widely read 'popular' media. Mr Black suggested that the reason for this is that newspapers are commercially driven. They know their readership and they give them 'what they want'.

Mr Black observed that there are more stories now on climate change than there were 15 years ago, and that climate change is no longer just being covered by science journalists. For example, business journalists are writing about climate change and air travel or biofuels and health journalists are writing about links between climate change and asthma. He observed that the increase in the number of radio and TV channels driving down budgets and the increasing trend to buy and sell news stories across the world, are not going to help produce quality coverage of climate change.

Max Boykoff talked about his research on 'Mass Media coverage of Climate Change: Analyses in the US and UK'. He said there has been a sharp increase in the number of articles covering climate change since 2004 in both the US and the UK.

Boykoff described the pressure on journalists writing news stories; in particular the 'journalistic norm' of writing a balanced story. For climate change, this has involved including the views of a climate change sceptic in a story. Boykoff suggests that as the

consensus amongst scientists has formed around the belief that climate change is human induced, this effort to write a 'balanced' story by including the views of sceptics has in fact introduced a bias towards the sceptical view, by giving it equal weight. Boykoff's research suggests that the prevalence of this bias has reduced since 2005, especially in the broadsheet newspapers, although it could still be a problem in the tabloids and on TV in both the US and the UK.

Fiona Fox started an open discussion, saying that the Science Media Centre now does not offer the media climate change sceptics. Lyndal Gully (Science Media Centre) said that in her experience, the newspaper journalists no longer look for the views of sceptics but that there are requests from TV. A view from the floor was that if there are scientists out there who are sceptical and who have published work in peer reviewed journals then they should be allowed to speak to the media.

Richard Darlington said that the media is a tool to change the world. He suggested that the public don't really know or care about peer reviewed journals, and so the scientists should get out there and win the argument against the sceptics.

Richard Black said that it was the journalist's job to make science comprehensible to the public, and it shouldn't be about scientists performing for the media. It should be about scientists having something worth saying, not necessarily being good at saying it. Although he cautioned that the quality of science coverage may deteriorate as budgets are cut and the number of specialist science journalists drops as a result.

There was a comment from the floor about newspapers using their comment pages to push their own often sceptical agenda, and Max Boykoff was asked if he had looked at climate change specifically in 'Comment' sections. Boykoff agreed it would be interesting to research comments on climate change.

There was then a discussion about climate change imagery. Richard Black said that we need to get past the images of polar bears and melting ice. He gave the example of the BBC using interactive graphics to allow people to choose a future energy budget by combining different proportions of nuclear, renewable and fossil fuels etc, calculating the bill and the emissions. This enables people to play with the issues.

Closing remarks

Speakers: Sir Roland Jackson and Dr David Stewart Boak

The report writers covering the three strands of the conference (engaging to inspire and educate; engaging to involve; engaging through the media and PR) summed up the main messages they had heard over the two days.

Jennifer Wild reported on the media and PR strand. She said one of the main messages was for young scientists: stay in science and communicate with the media, rather than leave science to work solely in the media. The media needs experts. Scientists in this strand expressed issues with finding time for media work in addition to research and teaching commitments. However, there appears to be a cultural shift within academia. Engaging with the public is becoming a valued activity and there are funding opportunities to support academics to do this more.

Alison Begley reported on the education strand. She gave a brief update on the STEM report and said overall the response has been positive. She said it appears that integrating science with learning tools helps to engage teenagers with topical science-related issues. However, more evaluations of projects need to be in place. There has been success in engaging young people with climate change issues.

Helen O'Brien reported on the 'engaging to involve' strand. She said that the UK appears to be very good at doing its own thing in terms of engaging and involving. She also considered how the media is covering climate change. Typically journalists want to have a balance in their story, reporting a sceptic's viewpoint alongside the latest findings. However, this mode of reporting is not representative of the consensus in the climate change field and perhaps we can move past this way of reporting the issue now.

David Stewart Boak of the Royal Society said there were many points for reflection. He focused on two: encourage the UK to engage with our European partners in this field and encourage training for scientists. He specifically supported thinking carefully about how to communicate uncertainty, and to take a step back to embrace the wider issues in our work. He reminded delegates that the Royal Society sees science communication as important and provides funding and training for scientists.

Roland Jackson made two points. One was in relation to policy. He said a new orthodoxy has emerged in relation to public engagement with a real commitment from the government and public bodies to engage in public consultation. This has taken the shape of two strands: (1) identifying organisations like stakeholder groups and consulting with them, and (2) a more open public engagement process on a broad scale like sciencehorizons or, on a narrower scale, the NICE citizens' panel. He questioned whether these two strands represent a converging orthodoxy and asked, 'Does this model of public consultation lead to similar results? Are we getting different views from our stakeholder and public approach?'

Jackson's second point was that there was a cry from people to share evaluations. He said it is difficult to find out where evaluations have been published. He said the

Tavistock Institute is working on standardising methods of evaluation, but we still need to share evaluations of projects in this field.

Kathy Sykes added that there was a clear message of wanting to get the voices of people heard better in developing regions. She said many of the issues we are trying to address are global issues. She picked up on the training issue and said that in addition to training scientists in how to communicate uncertainty, scientists need training in listening, reflecting, and discussing.

Boak asked 'Who should own the agenda of climate change? Should the government own it, the media, private sector, environmentalists, or the science community? Or should it be a collective ownership by all of these stakeholders?'

A delegate made an important point. We need to ensure that the next time a large issue, such as climate change, hits the agenda, systems are in place so that society can get involved easily.

Boak made one final point, reflecting that the conference grows in strength every year. He warmly thanked the speakers and delegates for their contributions. Roland Jackson encouraged further networking in the field and on that note, closed a successful, productive and inspiring conference.