A new agenda for the public understanding of science

An Inaugural Lecture given by John Durant, Professor of Public Understanding of Science, on 28 November 1995 in the Clore Lecture Theatre, Huxley Building, Imperial College, London SW7 2AZ

'No period in history has been more penetrated by and more dependent on the natural sciences than the twentieth century. Yet no period, since Galileo's recantation, has been less at ease with it.'

Eric Hobsbawm, Age of Extremes. The Short Twentieth Century 1914–1991, Abacus, London, 1995, p. 522.

I Homage to Huxley

'The politicians tell us, "You must educate the masses because they are going to be masters." The clergy join in the cry for education, for they affirm that the people are drifting away from church and chapel into the broadest infidelity. The manufacturers and the capitalists swell the chorus lustily. They declare that ignorance makes bad workmen; that England will soon be unable to turn out cotton goods, or steam engines, cheaper than other people; then, Ichabod! Ichabod! the glory will be departed from us. And a few voices are lifted up in favour of the doctrine that the masses should be educated because they are men and women with unlimited capacities of being, doing, and suffering, and that it is as true now, as ever it was, that the people perish for lack of knowledge.'[1]

The building we're gathered in this evening is named after the man who penned these words more than a century ago: Thomas Henry Huxley. Huxley was a biologist, a champion of the theory of evolution (he was known to the satirists as 'Darwin's bulldog'), a zealous educationalist and educational reformer, a fine essayist and literary stylist, and a statesman of science. Among many other things, Huxley helped to establish South Kensington as a major site of scientific research and scientific education in London. But far beyond the confines of what were then the School of Mines and the Royal College of Science, he did an enormous amount of campaigning, lecturing and writing in order to promote what he did not but we may perhaps be allowed to call the public understanding of science.

The lecture from which I have quoted was called 'A Liberal Education; and Where to Find It'. It was given on 4 January 1868 to inaugurate the new South London Working Men's College in Blackfriars Road, of which Huxley—needless to say—was Principal. In the audience were the working men of London—artisans and craftsmen, leather traders and felt-hat makers—devout men and free-thinkers alike who had heeded Huxley's call to scientific arms. Huxley's was a radical message. Britain was failing for want of a properly educated populace—primary and secondary education were equally unsatisfactory, and as for higher education, Huxley was scathing: 'and what is to be said to the universities?', he inquired of his attentive working men. 'This', he told them, 'is an awful subject, and one I almost fear to touch with my unhallowed hands'; but touch it, of course, they knew perfectly well that he would; and true to form he went on to castigate Britain's ancient seats of learning for having become little more than what he termed 'boarding schools for bigger boys'.[2] What was needed, in Huxley's view, was a universal and thoroughly reformed education system that would supply Britain's needs both for specialist scientists, engineers and businessmen and for a generally well-educated workforce. Throughout his life, Huxley campaigned tirelessly for science. As his recent biographer Adrian Desmond puts it, he was 'the most scintillating scientific missionary to stand on a soap-box'.[3]

This is Huxley's building and Huxley's College; and 1995 is Huxley's centenary. During Huxley's life-time, there was no chair of the public understanding of science in South Kensington—or anywhere else so far as I know; if there had been, he would surely have been invited to fill it, along with all his other posts. I like to think that Huxley would have been pleased to see such a chair established here in the College a century after his death; though knowing him, he would have been caustic about the time it had taken to get the thing going. Given his views on our ancient universities, I also fancy that he would have been equally pleased—amazed, I dare say—at the recent creation of a second chair in the public understanding of science in the University of Oxford (which, as some of you may perhaps have heard, is risen once again to be rather more than a mere 'boarding school for bigger boys'). These, of course, are idle speculations on my part; but I could not possibly have begun this inaugural lecture without paying my own tribute to Huxley, the one man above all others—in this College, at any rate—who deserves to be called the patron saint of the public understanding of science; would that I were as fine a lecturer or essayist as he.

II Public Understanding of Science Yesterday and Today

It is entirely fitting, then, to look back to Huxley. His example reminds us that ours is not the first generation to care about the place of science in the wider culture. In fact, attempts to popularise science are almost as old as science itself; but through the ages, they have taken many different forms in response to different scientific and social circumstances. During Huxley's life-time, an increasingly self-confident scientific community made a bid for greater recognition in the face of an extensively hostile cultural Establishment. In the 1860s and 70s, science was the Young Pretender—

ideologically suspect, institutionally marginal and politically weak. By contrast, our situation now looks very different. Partly because Huxley's generation won their battle for greater recognition, the past century has seen a veritable explosion of scientific knowledge; and in the wake of this explosion there have come huge technological and social changes. By mid-Victorian standards, at least, the science of our time is well-established, well-funded and well-recognised. Where Huxley and his contemporaries looked forward to a society that would be blessed by the fruits of science and technology, we find ourselves today living in the midst of comparative plenty.

And yet we, too, are every bit as concerned as Huxley was about the relationship between science and the public. Somehow, in spite of the enormous progress of science, we remain convinced that our culture isn't dealing with science as it should. This, surely, is why 1995 is not only the centenary of Huxley's death but also the tenth anniversary of Britain's public understanding of science movement. For it was in 1985 that a Royal Society working party chaired by Sir Walter Bodmer issued an influential report simply called *The Public Understanding of Science*.[4] The Bodmer report alerted the scientific community, in particular, to the need for far greater efforts to communicate with the public about its work. Within a year of the report's publication, the Royal Society, the Royal Institution and the British Association had collaborated in the establishment of the Committee on the Public Understanding of Science, or *COPUS* (this, incidentally, is the only socially acceptable acronym of the phrase public understanding of science that is known to me; most others—including, I fear, all acronyms of the chair we are inaugurating this evening—tend to sound like medical complaints); and the next few years saw a whole series of new initiatives—practical activities, research programmes, training programmes, and so on.[5]

This is not the place for a systematic review of all that has been done under the banner of the public understanding of science over the past ten years; but I do want to record in passing that—for me, at least—one of the more significant responses to the Bodmer report was the decision of the Science Museum and Imperial College to collaborate in the establishment of a joint post in the public understanding of science. For it was this post that brought me to South Kensington in 1989, and which led eventually to the creation of the chair in the public understanding of science which (as I seem to keep saying) we're inaugurating tonight. In addition to Science Museum staff who work in the public understanding of science, there are now two full-time Lecturers and some three dozen post-graduate students working in the (essentially identical) field of Science Communication in Imperial College. In passing, I hope I may be forgiven for taking particular pleasure in the way that our post-graduate MSc Course in Science Communication has blossomed over the past few years, and in the way that a community of people working in this new field has grown up across the University of London. As will be obvious to my colleagues in the audience, my own thinking has been influenced a great deal by the collaborative work on which we're now engaged together.

In summarising at least some of what we've been doing, practically speaking, I'm trying to make the point that much has been accomplished over the past decade. In particular, the public understanding of science movement has been pretty good at mobilising the scientific community to become more active in communicating with the public. If I had to take just a single example to illustrate the trend, I would pick the astonishing impact of first-rate scientists who have taken to public speaking and popular writing for increasingly eager general audiences. Just last week, as it happens, Professor Stephen Hawking was to be found speaking about cosmology to a packed audience of some 10,000 people just up the road here in the Royal Albert Hall. It's doubtful, I think, whether even just a few years ago it would have occurred to anyone that they might fill the mighty 'Albert Hole' not just to hear Placido Domingo or Luciano Pavarotti (or, you may recall, to watch Japanese *sumo* wrestling) but also to hear an eminent theoretical physicist and cosmologist talking about his work. And it's not just popular lecturing that has become increasingly prominent. There's currently something of a boom in this country in popular science book publishing and popular science broadcasting; and there has been a veritable explosion of festivals and other initiatives designed to increase the public profile of science. *COPUS* deserves a good deal of the credit for what has been achieved over the past decade.

But before we're tempted to become too self-congratulatory, I think it is important to acknowledge some weaknesses within the public understanding of science movement. One weakness has been a tendency towards what I would call a 'top down' approach—that is, a tendency to view things from the point of view of the scientific community rather than that of other key groups (such as mediators and audiences); and another, related weakness has been a tendency towards what might be termed a celebratory approach to science and technology; that is, a tendency to concentrate on all of the undoubted benefits that science brings to society at the expense of any very serious consideration of disbenefits or costs.[6] Both of these tendencies are the understandable result of the fact that for the most part scientists themselves have been in the vanguard of the public understanding of science movement. Pretty obviously, scientists tend to view things from their own perspective (who doesn't?)—hence what I termed the 'top down' approach; and equally obviously, scientists tend to believe in science (why else, after all, would they do it?)—hence the focus on the benefits of science.

What I'm trying to say here is that the scientific community should not be blamed too much for tending towards what I've called the top-down and the celebratory approaches. At the same time, I want to suggest that so long as it confines itself to what might be termed the missionary role—going out, if you like, and looking for converts—the scientific community risks failing to address some crucially important issues to do with the changing place of science and technology in our culture. In fact, the main theme of my lecture this evening is that, with undoubted successes behind us, the time has now come to move on in the public understanding of science. What we need is a new agenda and a new programme.

III Unease About Science

My starting point for a new agenda may seem a rather odd one; but it's this: paradoxically, in the midst of unprecedented scientific and technological progress our culture is beset by doubts and uncertainties. As the historian Eric Hobsbawm points out in his magisterial review of the twentieth century, *Age of Extremes*, 'No period in history has been more penetrated by and more dependent on the natural sciences than the twentieth century. Yet no period, since Galileo's recantation, has been less at ease with it.'[7] Superficially, at least, it doesn't seem difficult to work out what Hobsbawm means by this. Ours is, after all, the century of astonishing scientific and technological progress coupled with appalling scientific and technological peril. It is the century of relativity theory and radionuclides, of plastics and plastic explosives, of antibiotics and atomic bombs, of DNA and DDT, of agro-chemicals and *Agent Orange*. The two most brutal totalitarian ideologies of the twentieth century—Nazism and Stalinism—have both used science and technology for their own political purposes. No wonder, then, that Hobsbawm should title the scientific chapter of his book: 'Sorcerers and Apprentices'; and no wonder, also, that he should find our century uniquely uneasy about science.

There is, though, something more to be said; for our cultural unease goes beyond even our experience of the extraordinary power of scientific knowledge for good and evil. Ours is the first century that has really incorporated science and technology into the fabric of its culture. As the fruits of science have cascaded from laboratories into homes, hospitals and high streets, so scientific expertise has been steadily elevated to a position of presumed authority not far short of that traditionally accorded to kings and priests. As the sociologist Anthony Giddens has observed, the proliferation of 'expert systems'—systems of technical or professional accomplishment that organise large areas of our lives—is a defining characteristic of modernity; and in our modern culture, science has become the highest and purest form—the ideal type, if you will—of the expert system. This is important because, as Giddens points out, what the public expects of experts is reliable advice or assistance; and what experts demand of the public is trust. We are required to trust experts because under the conditions of modernity none of us has, or can ever hope to have, direct access to all of the specialist knowledge upon which expertise depends; but the flip-side of the coin of trust is doubt:

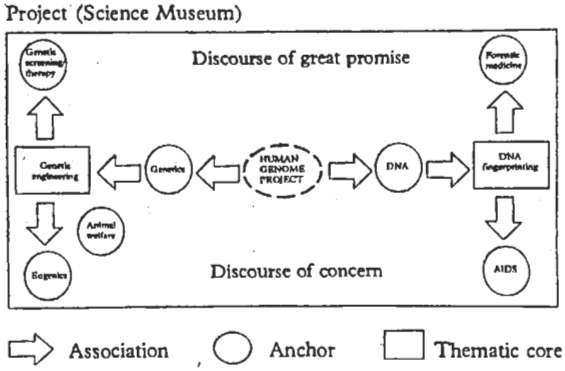
> 'Science..[says Giddens]..has long maintained an image of reliable knowledge which spills over into an attitude of respect for most forms of technical specialism. However, at the same time, lay attitudes to science and to technical knowledge generally are typically ambivalent. This is an ambivalence that lies at the core of all trust relations, whether it be trust in abstract systems or individuals. For trust is only demanded where there is ignorance—either of the knowledge claims of technical experts or of the thoughts and intentions of intimates upon which a person relies. Yet ignorance always provides grounds for scepticism or at least caution.'[8]

Here, then—this time from an eminent sociologist, rather than an eminent historian—we have words like *ambivalence*, *scepticism* and *caution* that are expressive of unease about science; but now the unease of which we're speaking is not a response to particular abuses or misuses of science but rather a structural response to the very position of science in modern society. We are required to trust scientists and scientific expertise, Giddens is telling us—to be frank, we have little choice in the matter; and by the same token, we are inclined to be cautiously sceptical about them. We look for signs that science is delivering what it promises; but we're alert to the possibility of misjudgments, mistakes or side-effects. For we do not have access to all of the evidence on which scientific judgments are made; and so what else can we do?

Perhaps an analogy with medical practice may help here. Doctors are experts of a certain sort, and their expert knowledge gives them considerable power over patients' lives. In order to benefit from this power, patients are required to place a certain amount of trust in doctors; but at the same time, they are well advised to exercise a certain wary caution. After all, particular doctors may or may not be fully competent; and even if they are competent, they may not be in possession of adequate knowledge or effective treatments. Patients' caution is not to be confused with disbelief in or disrespect for the powers of modern medical science; it is not to be equated with irrational preferences for powdered platypus beaks or python oil over the latest pharmaceuticals. Rather, cautious scepticism is simply what any sensible person is inclined to exercise when dealing with professionals who have the kind of power that doctors have over their patients' lives. In a sense, such scepticism is the best compliment that patients can pay to the importance of medical expertise.

I think this kind of scepticism is endemic in public attitudes towards science and technology today. Let me give you a few examples from our recent research that illustrate the sceptical cast of public attitudes to scientific expertise today. First, a couple of years ago we received a grant from the European Commission to enable us to investigate British public attitudes towards the Human Genome Project, the international programme of work aimed at first mapping and then sequencing all of the genes in the human genome. Interviewing groups of six or seven people at a time, we found a general pattern of ambivalence about this whole area—it was seen simultaneously as an area of great promise and concern (see figure 1).[9] On the side of promise, there were for example the prospects for the better understanding and treatment of genetic disease; and on the side of concern, there were the spectre of eugenics and the multiple difficulties

Figure 1. British public attitudes towards the Human Genome Project (Science Museum)



associated with the availability of larger and larger amounts of personal genetic information.

A second piece of evidence pointing to the ambivalent nature of public attitudes towards science comes from an entirely different source. Over the past three years, my colleague Dr Martin Bauer has been leading a study funded by the Wellcome Trust on the way in which the British press has been reporting science and technology over the past 50 years. Our Media Monitor Project contains a random sample of daily and Sunday national newspaper articles on science and technology from 1946 up to 1990 (we're currently collecting the sample from 1990 to the present). The articles have been collected, coded on a standard set of measures, and archived in the Science Museum Library.[10] The data from the codings has been put into a computer, and we can now analyse it statistically in order to reveal trends in newspaper reporting. For example, we can see how over the past 50 years the emphasis of newspaper reporting has shifted away from the physical and towards the biomedical sciences, particularly in the popular press (see figure 2); and we can follow the spotlight of media attention as it moves from one strategic technology to another (see figure 3).

Figure 2. Academic fields in popular papers, 1946–1990 (Media Monitor, Science Museum)

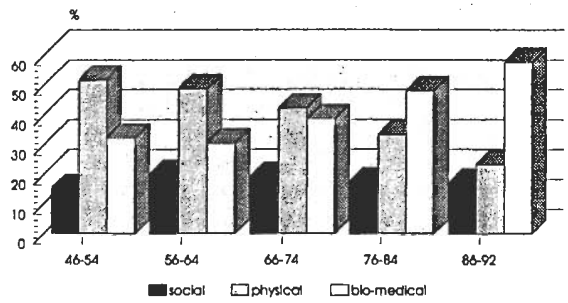
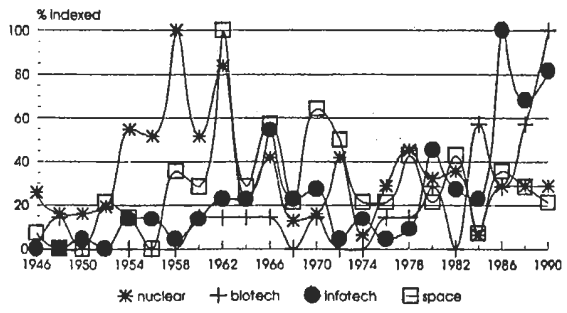
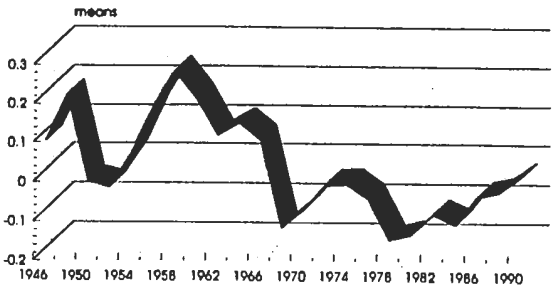


Figure 3. Strategic technology in British press, 1946–1990 (Media Monitor, Science Museum)



Of more immediate interest here, however, is the fact that our codes include measures of the attitude adopted by journalists to the science that they report. We call these attitudes 'evaluative tone'—a positive evaluative tone means that the reporter concentrates on the benefits or advantages of science; and a negative evaluative tone means that he or she concentrates on the disbenefits or costs of science. A neutral evaluative tone means that roughly equal emphasis is placed on benefits and disbenefits. Pulling out evaluative tone for the post-war period (see figure 4), we find a significant trend from positive (c. 1950–1965) to negative

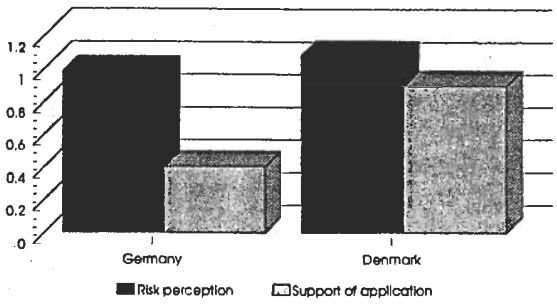
Figure 4. Valuation tone in scientific articles in British press, 1946–1990 (Media Monitor, Science Museum)



(c. 1965–1980). It seems that through the post-war period newspaper coverage of science has moved from the celebratory to the critical, and then back towards what can only be described as the ambivalent. Similar results to these have been obtained in a systematic study of media coverage of science in Germany, suggesting that what we're seeing here is of more than local, British significance.[11]

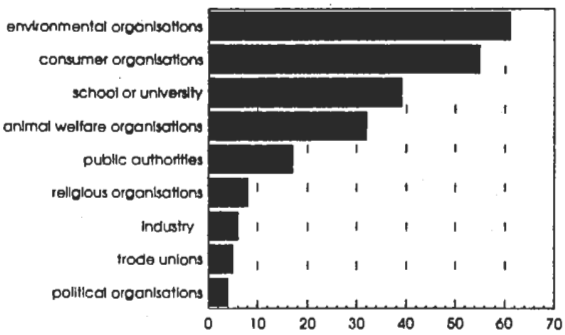
The third and final piece of evidence I shall cite here is a recent study of public perceptions of biotechnology across the entire European Union. This time, we're dealing with identical so-called *Eurobarometer* surveys conducted across all twelve member states of the European Union (the data is from 1993, incidentally). Once again, I don't have time to go into any detail; all I want to do is to draw out one particular, and superficially enigmatic, finding. In both Denmark and Germany—two of the most highly industrialised European member states—the public tend to judge the risks associated with the use of recombinant DNA technology to be fairly high; but despite this, the Danish public seems rather more willing than the German public to support the continued use of recombinant DNA technology (see figure 5). The obvious question here, of course, is: why should people who share a common perception of a technology as being rather risky nonetheless differ in their willingness to see it developed?

Figure 5. Risk perception and support of biotechnology in Germany and Denmark (Eurobarometer 1993)



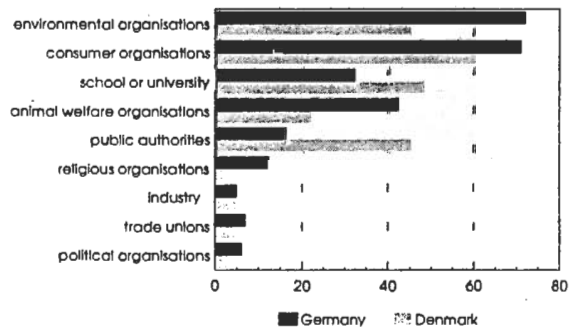
One possible answer is given by the results on another question in the *Eurobarometer*, which asked respondents to rank the degree of confidence that they felt in different social and political institutions to provide them with reliable information. Across the entire European Union this question produced rather striking results, with environmental and consumer organisations emerging as the most trusted institutions, and industry, trade unions and government emerging as the least trusted institutions (see figure 6). When we

Figure 6. Respondents' choice of most trusted information source, European Union average (Eurobarometer 1993)



look at the data for Denmark and Germany, however, we see that on average the Danish public has much greater trust than the German public in the reliability of its public authorities as sources of information about biotechnology (see figure 7). Reasonably enough, the people who have greater confidence in the institutions that are responsible for managing a risky technology are the people who are more willing to see that technology develop.

Figure 7. Respondents' choice of most trusted information source, Germany and Denmark (Eurobarometer 1993)



In this sort of survey data, we are getting a glimpse of something important in the changing relationship between science and the public. For this relationship is not simply to do with knowledge and ignorance; it is also to do with trust and distrust; and, needless to say, with the various compounds of trust and distrust that are best described as ambivalence. The importance of these issues is highlighted in a book by the German sociologist Ulrich Beck which deserves to be much better known in the English-speaking world. In *The Risk Society* (which sold 60,000 copies in Germany in its first five years—not many, by Hawking's standards; but quite a few by the more modest standards of academic social science), Beck tries to discern the shape of things to come for industrial society. He argues that we are in the process of moving from what he terms classical industrial society to 'the (industrial) risk society'. In classical industrial society, Beck argues, the forces of wealth production dominate public debate and political decision-making; but in the risk society, he suggests that a series of new and increasingly global risks are coming to dominate instead. As Beck puts it, in the risk society, 'the commonality of anxiety takes the place of the commonality of need'.[12]

If Beck's point seems rather abstract, then just think for a moment of recent national debates about, say, the safety of eating cheese, eggs, or British beef; or recent international debates about the safety of civil nuclear power programmes, the problem of global warming, or the fate of the *Brent Spar* oil platform in the North Sea. In these and many other cases, we see arguments about risk increasingly dominating public debates about particular sciences and technologies; and on each occasion that questions of risk move to centre stage, we find along with them questions to do with trust and confidence. One important reason why professional and lay estimates of risk so often differ from one another is that lay perceptions frequently embody informal or intuitive assessments of the trustworthiness of particular institutions responsible for the safe management of risk. In this sense, not least, the concept of risk dissolves the boundaries between science and the wider society; for technical and social judgments are both equally relevant to the business of lay risk assessment. This, presumably, is why Beck himself suggests that, 'in their concern with risks, the natural sciences have involuntarily and invisibly *disempowered themselves somewhat, forced themselves towards democracy*' (emphasis in original).[13]

IV Towards a New Agenda

The time has come to ask what all of this means for the public understanding of science. Under what Giddens calls the condition of modernity, I believe that we must take seriously the reality of public unease about science and technology; and this means that we must take seriously the issue of trust. Our current agenda for the public understanding of science is dominated by the twin aims of inspiring interest and fostering learning. There is absolutely nothing wrong with these aims, of course; but I suggest that alongside them we should add the aim of cultivating trust between scientists and non-scientists. For trust is the crucial medium of exchange in our society: with it, almost anything is possible; without it, almost nothing can be done. Trust is never granted as of right; rather, it is earned in the course of relationships. So our new agenda for the public understanding of science must concentrate on the creation of relationships which build trust. Trust is difficult to win, and easy to lose. So our new agenda must forget quick fixes and concentrate on the longer term.

Constructing a new agenda for the public understanding of science around the notion of trust involves learning to think about our subject in an entirely different way. Rather than thinking of the public as 'the great unwashed'—the proverbial men and women on the top deck of the Clapham omnibus—we need to think of it as an arena or forum in which scientists and non-scientists meet as equals to consider questions together openly and honestly.[14] Rather than thinking of understanding as formal knowledge—the sort of thing that students are taught in class—we need to think of it as mutual appreciation between equals who have respect for one another's various competences, interests and points of view. And rather than thinking of science as a closed body of definitive truths that are handed down to the public from on high, we need to think of it once again as 'public knowledge'; as a body of evolving

findings whose scope, limits, applications and implications are always open to public scrutiny, public debate and public criticism.[15]

I am not arguing that everyone is a scientist, or that every belief about the natural world is equally valid; and I am not suggesting that everyone should have a point of view about the value of the charge on the electron, the structure of nylon, or the physiological function of alcohol dehydrogenase. Obviously, much of science is uncontroversial and undeserving of public debate. My point, however, is that when all the completely unproblematic findings of the day-before-yesterday have been dealt with, we're still left with a great deal of science which is in the public domain precisely because it is problematic. It is just this kind of science that the public understanding of science movement needs to engage with more closely, because it is just this kind of science that is of the greatest public interest and concern.[16] The real question is: how should we deal with problematic science in ways that engender trust? And the answer, I suggest, is this: by creating forums for public participation in science; that is, settings in which scientists and non-scientists can engage in genuine dialogue about the issues on an equal footing with one another. For in my view, it is through dialogue that relationships of mutual trust are most often built—in the words of the BT advertisements, 'It's good to talk'.

There will be sceptics, I am sure, who will find the ideal of public participation in science absurdly utopian. Is it really possible, they will ask, to engage the public in serious debate and decision-making about some of the most complex matters facing our society today? Surely, they will say, we must leave these things to the experts? To such sceptics, I offer two replies—one theoretical, the other practical. First, the theory. In our society, the ideals of democracy and justice rest on a fundamental faith in the ability of the public to cope, even in the face of the most complicated and difficult issues. We do not argue against elections or trials by jury on the grounds of the supposed incompetence of voters or jurors; and this for the very good reason that to do so would undermine the foundations of democracy itself. In the same sense, and for the same reasons, I do not think that we should argue against public participation in science. So much for theory, what of practice? Well, the fact is that interest in public participation in science is growing around the industrialised world; and to my knowledge, wherever the ideal has been put into practice the experience has been positive. In other words, my practical response to the sceptics is: please don't tell us that it can't work, because we've tried it and it does.

I have time for only a few examples of participatory initiatives in the public understanding of science. At the Public Agenda Foundation in Washington, John Doble has undertaken fascinating experiments involving comparison of the ways in which representative samples of scientists and non-scientists deal with complex policy questions such as the threat of global warming and the safe disposal of solid waste. His verdict? 'The public's judgment about both issues...is strikingly similar to the scientists' views. Further, the few areas of divergence seem rooted more in value differences than in expertise.'[17] Now of course, it's only fair to point out that the convergence of scientists' and non-scientists' views in response to the same information is not conclusive evidence of the competence of the non-scientists—conceivably, both groups could be equally incompetent. What is perhaps more significant is that Doble found no evidence that his non-scientific respondents were seriously handicapped or prevented from coming to a considered judgment by virtue of their lack of technical knowledge.

Coming a little closer to home, the Danish Parliament has pioneered a new form of public participation in science: the consensus conference. A consensus conference is a dialogue between lay people and experts in which a panel of lay volunteers conducts an investigation of a scientific or technological issue, cross-examines experts, and arrives at a point of view which is published and presented at a press conference. Since 1987, the Danish Board of Technology has run a series of consensus conferences on subjects such as human molecular genetics, food irradiation and childlessness. A succession of lay panel reports has been presented to the Danish Parliament, and it seems that in several cases these reports have influenced the course of public debate and public policy-making. (It is worth reminding ourselves here that we have already noted that the Danish public has a relatively high level of confidence in the Danish public authorities; it is an interesting question how far the consensus conference initiative of the past eight years may have helped bring about this enviable situation.)

In 1993, the Dutch organised their first consensus conference; and last year, the Science Museum obtained support from the Biotechnology and Biological Sciences Research Council for the organisation of the first UK National Consensus Conference on Plant Biotechnology.[18] Our experience with the UK consensus conference bears out fully Doble's findings in the United States. Although our lay panel volunteers had no prior acquaintance with plant biotechnology, they rose to the challenge of learning about this complex subject, and acquitted themselves well both in the cross-examination of experts and in the writing of their final report. I do not pretend for a moment that consensus conferences are 'the way' to involve the public in science; for of course there is no one right way to do this. Already, in fact, a variety of participatory models are on trial in different parts of Europe and North America—in addition to consensus conferences, the list includes citizen advisory committees, planning cells, citizens' juries and deliberative opinion polls.[19] In all of these initiatives, there runs a common thread of concern to find new ways of closing the credibility gap between science and the public by fostering citizen involvement in science and technology policy-making.

It is worth noting that in the electronic age public participation in science does not always have to involve bringing scientists and non-scientists into the same room. One member of our research group, Colin Finney, is currently researching the potential of the World Wide Web to facilitate dialogue about scientific issues. Currently, Colin is running an electronic 'consensus conference' about genetic screening. Visitors to his Web site can read information, contribute to discussions, ask questions, fill in a questionnaire and even vote in a poll of discussion issues.[20] The point of this system is not to obtain statistically valid public opinion data (the visitors to this site are obviously

self-selected and hopelessly unrepresentative) but rather to explore the potential of the new electronic networks to facilitate new forms of debate and discussion. So far as public participation in science is concerned, the World Wide Web constitutes a potentially vast new forum for debate; and it would be a brave research student who would predict to what kinds of use this and similar electronic forums may be put in the future.

A great deal of imagination and hard work will be needed to turn the ideal of public participation in science into a practical programme. We should be looking, I suggest, for many different ways of involving people in the science and technology that affects their lives. In this context, it is surely significant that the most widely discussed new technology of the day (the so-called *Information Superhighway*) is a highly interactive and involving technology. In the Science Museum, where planning has begun for a major new development—the Wellcome Wing—to be devoted to contemporary science and technology, electronic networks are just one ingredient in what is intended to be a far more participative set of facilities than anything we've yet seen in science museums and science centres. In the Wellcome Wing, the Museum hopes to create a new kind of forum—an arena for genuine engagement and exchange about the kind of society we want to build with the help of science and technology. Frankly, in our present situation anything less than this would constitute a wasted opportunity.

V Coda

I began this lecture with Thomas Henry Huxley. In some ways, little seems to have changed in the century that separates us from him. Still today, we worry as he worried about Britain's place in the league table of industrialised nations; still today, we complain as he complained that 'ignorance makes bad workmen', and that 'the people perish for lack of knowledge'. But in one way, at least, our situation is very different. For we have the cultural experience of a century of extraordinary scientific and technological developments. These developments have brought science and technology into people's lives in ways that Huxley's generation never dreamed of; but their very pervasiveness and power have served to undermine the rosy optimism of the Victorian age.

The public understanding of science movement represents an important response to growing public ambivalence about science and technology in the late-twentieth century. Much good has been done, and the continuing commitment of major scientific and technological institutions like Imperial College to the business of encouraging scientists to be better communicators is vitally important; but on its own the mere re-packaging of scientific ideas and information for popular consumption is unlikely to maintain public confidence in the scientific enterprise. What we need are initiatives that take seriously the concerns that significant sections of the public have about the impact of science on society. Such initiatives will only be undertaken by people who are willing to take risks; by scientists, for example, who are confident enough of the rightness of their cause to engage openly with the public about aspects of their work that are important precisely because they are morally, legally, socially or politically vexed. I believe that public participation is the next great challenge for the public understanding of science.

Notes and references

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2 Huxley, op. cit. (note 1), p. 101.

3 A. Desmond, *Huxley. The Devil's Disciple*, Michael Joseph, London, 1994, p. xvii.

4 The Public Understanding of Science, Royal Society of London, 1985.

5 For a review of these initiatives in the wider context of European efforts to bridge the gap between science and the public, see J. Durant, 'Public Understanding of Science and Technology: A European Audit', in: B. Schiele (Ed.), *When Science Becomes Culture. World Survey of Scientific Culture*, Editions Multi-Mondes, University of Ottawa Press, Boucherville Quebec, 1994, pp. 205–355, and especially pp. 331–349.

6 For an analysis of the historical roots of this celebratory approach in the USA, see: B. Lewenstein, 'Public Understanding of Science in the United States after World War II', *Public Understanding of Science*, 1 (1992), pp. 45–68.

7 E. Hobsbawm, *Age of Extremes. The Short Twentieth Century 1914–1991*, Abacus, London, 1995, p. 522.

8 A. Giddens, *The Consequences of Modernity*, Polity Press, Oxford, 1990, p. 89.

9 J. Durant, M. Bauer, & A. Hansen, 'Public Understanding of the New Genetics', in: T. Marteau & M. Richards (Eds.), *The Troubled Helix: Social and Psychological Implications of the New Human Genetics*, Cambridge University Press, Cambridge and London (in press).

10 See M. Bauer, J. Durant, A. Ragnarsdottir & A. Rudolfsdottir, *Science and Technology in the British Press, 1946–1990. Final Report to the Wellcome Trust*, Science Museum, London, 1995.

11 M. Kepplinger, *Kuenstliche Horozonte. Folgen, Darstellung und Akzeptanz von Technik in der Bundesrepublik*, Campus, Frankfurt, 1989.

12 U. Beck, *Risk Society. Towards a New Modernity*, first published as *Risikogesellschaft: Auf Dem Weg eine Andere Moderne*, Suhrkamp Verlag, Frankfurt am Main, 1986; English edition, Sage, London, 1992, p. 49.

13 Beck, op. cit. (note 12), p. 58.

14 The foundational text for this way of thinking is J. Habermas, *The Structural Transformation of the Public Sphere. An Inquiry into a Category of Bourgeois Society*, translated by T. Burger, Polity Press, Blackwell, Oxford, 1989; but see also

F. Neidhardt, 'The Public as a Communication System', *Public Understanding of Science*, 2 (1993), pp. 339–350.

15 See J. Ziman, *Public Knowledge*, Cambridge University Press, London, 1968.

16 Compare this point with the related argument of S. Shapin, 'Why the Public Ought to Understand Science-in-the-Making', *Public Understanding of Science*, 1 (1992), pp. 27–30.

17 J. Doble, 'Public Opinion about Issues Characterized by Technological Complexity and Scientific Uncertainty', *Public Understanding of Science*, 4 (1995), pp. 95–118.

18 For a brief account of the UK initiative, see S. Joss and J. Durant, 'The UK National Consensus Conference on Plant Biotechnology', *Public Understanding of Science*, 4 (1995), pp. 195–204. For a fuller treatment of the European experience with consensus conferences to date, see S. Joss & J. Durant (Eds.), *Public Participation in Science*, Science Museum, London (in press).

19 For discussions of these models, see: O. Renn, T. Weber & P. Wiedemann (Eds.), *Fairness and Competence in Citizen Participation. Evaluating Models for Environmental Discourse*, Kluwer Academic Publishers, Dordrecht, Boston and London, 1995; and J. S. Fishkin, *Democracy and Deliberation: New Directions for Democratic Reform*, Yale University Press, New Haven, 1991.

20 The electronic consensus conference may be found at http://www.scicomm.org.uk/biosis/human/consent.html