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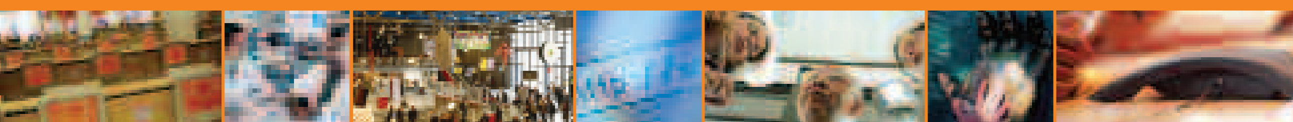
Re-modelling science communication

ESRC Science in Society Programme

internet exhibitions debates reports



science in society

Contents

Preface

The science-society relationship is recognised as no longer being one in which the needs of the public are dictated by those in authority. But what is it to become? How can those in government, science and the private sector manage the science-society relationship more effectively? How can the public in all its diversity become more engaged in the production of science and its role in society?

The goal of the ESRC's Science in Society Programme is to explore and help develop the rapidly changing relations between science (including engineering and technology) and the wider society. These brochures are intended not only to bring together the findings of research projects in the Programme, but also to draw on wider insights into the relationship of science and society.

To that end, although these brochures provide an overview of academic research, they hope to prompt questions that go beyond the academic to the role of science and technology in real lives, in all their diversity.

"Why do some people find some exhibitions difficult to understand or some exhibits difficult to use?"

Foreword

How do we understand science? Is it by scientists talking to us directly or do we learn much of what we know through the news on the television, internet and radio? How we are all affected by science and how we relate to it are fundamental concerns of the Science in Society Programme and the research that is part of this theme has delved into the relationship between people and the science they experience in their everyday lives, in their environment, schooling and experience of the media.

One of the Programme's intentions is to recognise the highly diverse nature of science and the different types of expertise that exist within communities. This includes people who are not scientists, just as much as it includes scientists themselves. This brochure describes research in which non-scientists help to set the scientific priorities in local areas, be it to describe problematic air quality or to map health issues affected by the environment, and to encourage better dialogue between those who have naive understandings of either science or social situations that are affected by science. Both the scientific and the non-scientific communities can benefit from participating in such dialogue and the research projects have contributed much to moving this notion forward.

The brochure also discusses the ways in which we form our understandings of science and how we determine the importance given to social perspectives of science. For example, how do we learn things when we go to museums and why do some people find some exhibitions difficult to understand or some exhibits difficult to use? By observing how people use interactive devices and how they discuss new information with people around them, we can develop a better understanding of the ways in which we can communicate scientific ideas to the wider public.

I hope that you will find this brochure interesting and thought-provoking. I am sure that it will demonstrate the richness and diversity of the social science research that has been commissioned through the ESRC's Science in Society Programme.

Steve Rayner
Director

Executive Summary

The communication of science is proliferating in concert with the burgeoning diversity in communication media – especially television and the internet. This provides a fundamental challenge to 'traditional' methods of science communication, which in the past have often been about scientists and experts conveying their knowledge to others.

Now, there is an appreciation that groups such as policymakers, decision-makers in firms and other organisations, and 'the public' are not simply passive recipients of scientific or other expert knowledge, but active participants in shaping science and related developments. These changes have led to a re-thinking of the notion of 'science communication', raising a number of questions that this document addresses:

- What assumptions lie behind the models of communication that are employed in science and how have these changed in recent years?
- Who are the audiences for science communication activity and how could we widen them?
- Should citizens be encouraged to participate at all levels in scientific decision-making and what skills are necessary to enable this?

Science represents a hugely authoritative source of credible knowledge, but there is also a widespread realisation that scientific knowledge is often limited, contains uncertainties, and is open to influence and use by groups that are pursuing particular interests. In this context, the science that is being communicated needs to be both reliable and socially robust – and it needs to be seen to display these qualities as well.

At the same time, people not only view developments in science and technology through the lens of their specific social and cultural backgrounds, but individuals also often have shifting and ambiguous feelings toward complex developments in science and technology – positive towards some, and sceptical or actively hostile to others.

Research in the Science and Society Programme challenges five common assumptions that:

- the challenge of science communication is a one-way affair, in which scientists convey their knowledge to an 'ignorant' public
- science communication involves 'scientists' on the one hand and a unified and unspecified 'public' on the other
- science policy has entered a more consultative phase
- greater public engagement with science – and vice versa – will result in better science/policy relationships
- decision-makers are clear about the audiences for science outputs.

"Many of the parties involved in science communication have expressed a desire to engage the public with science in new ways"

Two complementary themes emerge from research:

Engaging Science and Other Knowledge: Many of society's most pressing challenges now have a scientific component – for example climate change, terrorism, and the loss of biodiversity. But these challenges are not purely scientific – they also involve wider sets of knowledge and the perspectives of those involved, and are heavily influenced by their visions for the future of society. How can these widely different forms of knowledge be brought together effectively?

New Ways and Places for Communicating Science: Many of the parties involved in science communication have expressed a desire to engage the public with science in new ways. This wish to enhance debate about advances in science and technology provides opportunities for sites such as museums and zoos. At the same time, people are becoming more sophisticated in their use of media. The explosion in the use of new media such as blogs, podcasts and the web over the last ten years raises numerous challenges for designing effective mechanisms for communicating science.

A further theme that runs through much of the research is that of complexity and uncertainty – in the topics that science is trying to grapple with, the social contexts in which it is being discussed, the ways that might be adopted for communicating science, and the science itself.

Key Insights

These themes are explored through the lens of a range of research projects conducted within the Science in Society Research Programme, leading to ten key insights for decision-makers:

- Science and technology cannot be viewed as neutral forces in society to be decided upon by experts. Appeals to 'sound science' as the basis for decisions fail to provide sufficient appreciation of the political nature of science and technology.
- These observations enhance the significance of science communication. It is not a simple matter of 'communicating' science to a more or less receptive 'audience'.
- The increased power of science and technology calls for proportionate increases in our wisdom to control and use them to beneficial ends. People need to become expert in making informed judgements about scientific claims, individuals and institutions.
- Engagement between scientists and non-scientists can help, but should not purely be about achieving acceptance for the latest piece of science or technology. Engagement often challenges the direction of developments in science and technology.
- It is arrogant and counter-productive to dismiss 'lay' perspectives out of hand – for example on the causes of breast cancer or on what constitutes good air quality. Rigorous debate about science and competing perspectives is essential, especially if it helps to generate understanding of why people see science the way they do and how their experiences feed into their scientific perspectives.
- Media portrayals of science and technology are unhelpful when they are simplistic. How can journalists report 'novel' scientific developments without succumbing to the tendency to hype the 'next big thing'?
- Science communication is always immersed in complex cultural contexts, and cannot be separated from developments such as globalisation and growing social mobility and diversity. Nevertheless, attempts at science communication have often been very similar across these diverse contexts. It is possible to re-think styles of communication and to move from a generic approach to a more targeted approach.
- Complex socio-environmental problems, such as the causes of breast cancer, raise a series of challenges to scientific approaches that currently provide the dominant explanations. The science community is advised to re-visit their evidence, assumptions and methods, not least to address perceptions around validity and legitimacy.
- Sometimes those who criticise aspects of science and technology are labelled 'anti-science'. Yet vigorous debate within science is seen as desirable – even essential. What is the difference? It is more helpful if scientists and science policymakers understand public engagement with science to be what it is – complex, influenced by many factors that vary from case to case, and in many instances positive.
- Public engagement can also impose a rigorous, extended form of quality control on science that brings in a wider range of criteria than might be used within the scientific community – such as desirability. Where scientific and technological developments potentially have great impacts on the future of society, it is entirely rational for people to bring wider perspectives to these debates – indeed, it is irrational to think that only scientific considerations are relevant.

The overall conclusion to emerge from this research is that scientists benefit when they see the communication imperative as an inherent part of their work. This is especially the case when they get beyond 'natural' linear models of communicating 'from us to them' in the style of 'we speak and you listen'. This perspective calls for a more engaged two-way process in which scientists and scientific organisations such as funding bodies are challenged to think more broadly about the social context of science and in a more sophisticated way about the basis for public engagement with science.

While it is increasingly recognised that science communication is a two-way process in which both scientists and the public are challenged to think differently, the reality has yet to catch up with the rhetoric. The social context within which science takes place is now acknowledged to be highly significant, raising the stakes around the need for more effective public engagement in order to lead to democratic, legitimate, effective decisions.

Introduction

Scientists have communicated among themselves for as long as there has been a recognisable activity called 'science' – that is to say several Centuries. Communication about science to popular audiences is hardly novel either. Britain's Royal Institution has been running public lectures and scientific demonstrations since the early 19th Century. Indeed, Humphry Davy's lectures were so popular that the crush of carriages in Albermarle Street led to it becoming London's first one-way street. Important scientific books, especially works of natural history, such as Darwin's *Origin of Species*, were not just consumed by specialist peers, but by wider readerships. However, it is true that the audience for such fare was mainly confined to the well-to-do and educated classes, although great Victorian institutions such as London's Science and Natural History Museums and the London Zoo opened their doors to wider audiences.

In more recent times, especially in the post-war period, popular science periodicals, books, and programmes on radio and television conveyed a steady diet of exciting, fantastic and futuristic science and technology to mass audiences in both Britain and the United States. Scientists mostly welcomed such coverage as it was seen to encourage political support for big national science and technology programmes.

The last decade and a half of the 20th Century, however, saw a marked change in the focus, style, and content of popular communication about science and technology. The tone of such communication from scientific institutions and government agencies changed sharply from triumphal cheerleading for the 'white heat of technology'[1] to a steady diet of reassurance, offered to what they increasingly perceived as a generally sceptical and disillusioned public Scholars including Ulrich Beck and Anthony Giddens argued that widespread concern was endemic in society in late modernity (Beck, 1992). In 1985, the Royal Society published the report *The Public Understanding of Science* by Sir Walter Bodmer, which encouraged scientists to engage more directly with the public (Bodmer 1985). This report was the starting point for a whole new academic discipline and many experiments in science communication.

1 Harold Wilson, oration to the Labour Party Conference, 1963

"More than one poll suggests that the public has repeatedly voiced a very high level of confidence in science and technology"

In the same year that public concern about BSE emerged in Britain, 1987, the Government's Office of Science and Technology joined with the Royal Society to set up the Committee for Public Understanding of Science, better known as COPUS. A social science journal dedicated to the Public Understanding of Science was established in 1992. A new profession of science communicators emerged; dedicated to the accurate translation of scientific expertise into popular wisdom. Quick to follow were master's degree courses in science communication and university professorships in Public Understanding of Science, of whom the best known is undoubtedly Richard Dawkins, who was appointed in 1995.

Ironically, analysis of public opinion poll results suggests that the idea, popular among some politicians and scientists, that Britain and the US have been beset by an anti-science or anti-innovation culture[2] is misguided. In fact, more than one poll suggests that the public has repeatedly voiced a very high level of confidence in science and technology. Consistently we find that 70 to 80 per cent of the British public agrees with positive statements about science, while 85 per cent agree that "scientists and engineers make a valuable contribution to society"[3]. (These are figures to be envied by those engaged in the business of government – confidence in civil servants lies in the middle of professions ranked – cabinet ministers at the bottom.) Furthermore, there is very little evidence of a connection between understanding of science and support for it. What evidence there is seems to point in the opposite direction. For instance, a 1999 survey on the public's understanding of science in the USA shows that while Americans' confidence and interest in science and technology is very high, their understanding of basic science facts and principles remains distressingly low (*Science & Engineering Indicators 2000*).

2 Speeches given by Tony Blair at the European Bioscience Centre, 20th November 2000, the Royal Society, London, 23rd May 2002 and King's Centre, Oxford, 3rd November 2006

3 eg MORI polls, May 2002, and September-November 2004

Deficit Models of Communication

Much of the science communication activity of the past two decades has reflected what soon became known among social scientists as the 'deficit model' of public understanding of science. In its initial formulation, the deficit model described the idea that public concern about science and technology was due to exaggerated public fears, born of lack of knowledge about what science actually had to say about areas of concern, such as BSE and other issues that were often related to human health or the environment. These included electromagnetic radiation (including mobile phone masts) and, later, foot and mouth disease and the MMR vaccination.

The solution to public ignorance was seen to be more effective public communication of the content of science through specialised science communication programmes. However, public concerns about these issues were not visibly reduced by such attempts at public education. The deficit model was duly adjusted. The problem, so it seemed was not lack of knowledge of the content of science so much as lack of understanding of the processes and limitations of science; for example, that science can never conclusively prove a negative proposition. The solution remained robust – better science communication. More recently we have experienced a third incarnation of the deficit model as science communication does not seem to have chased away public concern about selected health and environmental issues. Now, it seems that the deficit is not of information, nor of understanding, but of public trust. However, the solution that is often advocated remains better science communication to demonstrate the trustworthiness of responsible public and private institutions.

Deficit models invariably frame the public as passive receivers of information. However, social science research has long recognised that individuals and institutions operate in a much more active mode, both seeking and filtering out information according to whether it fits with their own experiences and preferences. In everyday life, people routinely have to make decisions on the basis of imperfect knowledge; they combine what knowledge they have with other forms of judgement, such as whether they trust the organisation that is advocating a particular course of action. In addition, a recurrent objection to the 'scientific' approach is often that people feel that their perspectives and knowledge, which often are shaped by their life experiences, have been ignored or denied. These are much more difficult challenges than ones that can be addressed purely through communication strategies.

"Science policy has entered a more consultative phase with respect to science communication"

Communication and Engagement

For example, a significant finding of the research by Laura Potts (see pages 27 to 29) is that shared ideology, norms or worldviews – the ideas through which people make sense of society and their role in it – are strong predictors of alliances between different stakeholders or communities of interest. These communities act as filters on information and trust that derive from the sense that people have of how the world works, and their part in it, from ideological positions they may have about how and why science is done and how it is funded, the political pressures brought to bear, and such factors as the close relationship, for instance, between the pharmaceutical industry, medical research and government.

Models of communication range from the simple 'transmission model', where information flows from one person to another – usually from the scientists to 'the public', to more sophisticated understandings where receivers of the message have 'agency' in the way they understand and interpret the message. Essentially, more recent models of communication emphasise the importance of both the sender of the message and the receiver, and also pay attention to the milieu in which the message is sent. It is often claimed that science policy has entered a more consultative phase with respect to science communication. Indeed, one observer writing in the 1990s seemed to suggest that the present decade would be one in which science communication became synonymous with public engagement and participatory democracy.

A paper authored under the auspices of the ESRC Public Understanding of Science (PUS) Programme (Healey 1998) put forward a view of change in PUS issues and institutions. This suggested that three models of public understanding of science co-existed in the contemporary UK. These had different dates of origin, but served as competing rhetorics or repertoires justifying action. They can be summarised as:

The Enlightenment Model (typical date 1975)

- Cultural and economic drivers: exploiting assets
- Science gains legitimacy from government/ the crown
- PUS means diffusion amongst the elite
- 'Trickle-down' only to wider publics

The Economic Model (typical date 1993)

- Economic drivers: creating assets
- Science and government gain legitimacy from industry
- Publics seen largely as economic constraints
- Communication one-way via traditional media

The (Emerging) Democratic Model (typical date 200x)

- Sustainability: conserving social and economic assets
- Publics (citizens and consumers) legitimate other actors
- Participatory processes predominate
- Media become interactive
- Changing institutional landscape: research councils well placed to build trust

The economic and the democratic models are held to be in particularly sharp competition in the contemporary UK.

In recent years, there has been increasing experimentation with the use of techniques such as citizen's juries, consensus conferences and the appointment of lay people to scientific advisory committees. The 'GM Nation?' debate is probably the most prominent UK example of this (Horlick-Jones, Walls et al. 2006). It might be tempting to assume that as a result of such experiments, we have entered a new, more consultative phase of science and technology governance. However, researchers such as Forrester and Snell (2006) conclude that, despite some progress, most scientific institutions and science-based policy processes remain largely insulated from citizen engagement (see also Irwin 2006). Rather, they tend to be characterised by a series of one-way communications between the three major spheres of actors – the policy-making community, the scientific and other expert communities, and various 'publics'. Thus, information may be shared in more than one direction, but not at the same time, and, as a result, common, mutual understanding of different perspectives is rarely reached.

The form that engagement takes can often pre-determine its outcome. Paul Dorfman and colleagues investigated this with respect to consultation by local government, for example (Dorfman, Beattie et al. 2006). Their research suggests that the choice of consultation methods and communication strategies chosen, and the integration of stakeholder feedback into decision-making processes are affected by local authority's perception of the stakeholders' relative abilities, their grasp of science, and their status (eg whether they are required to be consulted by law). Although it is often assumed that greater public engagement with science will result in better science-policy relationships, the fact remains that it rarely has a demonstrable influence on policy decisions.

We are frequently told that the deficit model is old hat and that science communication must be a two-way street – a conversation rather than a lecture. To the extent that science communication becomes a genuine two-way street, it begins to merge with public engagement and participatory decision-making through mechanisms such as consensus conferences. The Science in Society Programme explored these kinds of approaches under the heading of *Science in governance and the governance of science* and the findings are described in a companion to this brochure. But the reality behind much of the rhetoric of public engagement and two-way science communication is that the deficit model, in one or another of these guises, is often to be found in the practice of many science communication programmes and the organisations that sponsor them.

It is therefore arguable whether or not the first decade of the 21st Century has been one of democratisation of science communication, but it is certainty true that it has seen the greater professionalisation of the field. By 2000 science communication had moved on to what Forrester and Snell (2006) characterise as the 'science-in-society' phase, where the term has become synonymous with science communication through public engagement. It has become commonplace within science and science policy to think of the 'public perception' dimensions of science and technology as challenges of communication: how can science be more effectively communicated to the public? Of course, it is desirable that appropriate scientific information informs public policy debates, even if it cannot decide them. And even if science communication is not a panacea that will resolve public concerns about specific health and environmental issues, the communication of science remains a perfectly proper goal for government and industry as well as scientific and educational institutions.

Audiences, Speaker and Venues

But who are the audiences for science communication? Journalists and communication programme planners often assume audiences to be either 'science fans' on the one hand or those who are risk averse or sceptical of science on the other. But people do not necessarily fit neatly into one of these two groups; many are interested in the broader social, economic and political context of science and technology and most especially in the policy implications – or how science and technology will play out in their own everyday life – and scientists may not be the best people to provide this.

Challenging conventional assumptions about the character of audiences for science outputs raises the question of how the media deals with science and technology, which can no longer be dealt with exclusively by science correspondents. Coverage that deals with wider questions around the social implications of science and technology usually comes from journalists other than those who cover 'science', such as those in the fields of health, politics or the environment.

Effective science communication involves a complex array of questions and players:

- How can science-based evidence be brought together and made available in accessible forms to inform policy and media debates?
- How is it possible to deal with issues around accuracy of reporting and the media's interest in controversy to drive up sales or viewing numbers?
- What is the role of facilities such as zoos and museums in communicating science?
- Does the competitive nature of the mass media inevitably have an overall negative effect on the quality of their output?

Research shows that it is ill-advised to treat 'the public' in an undifferentiated way, as lay people who think with one mind; different groups, ages, genders and people from different cultural backgrounds all bring widely varying perspectives and interests to the way they think about science and related developments. Indeed, individuals often have varying, conflicting or ambiguous opinions about such complex questions. The challenge of communicating science is therefore multi-faceted, involving diverse social groups, locations, techniques, media, topics, and aims.

"It is also important to recognise that science does not speak with a single voice"

This observation makes it difficult to use broad-brush shorthand terms such as 'people'; social scientists encourage us to be more accurate about exactly which people we are talking about, and in which contexts. Unless we discuss concrete examples, general talk of science, 'experts', 'lay/non-expert', 'effective communication' etc tend implicitly to smuggle back in discredited linear models of communication (communicating information from 'us' to 'them') that have been shown to misrepresent the more complex realities involved.

Just as it is mistaken to speak of a homogeneous public, it is also important to recognise that science does not speak with a single voice. Research by Dr Bell and colleagues reported here shows that some scientists are much more willing to engage in debate with non-scientists than others. For example, some are happy to provide explanations across a broad swathe of science – they are natural 'science communicators' – whereas others are more cautious and less willing to talk outside their immediate area of expertise. Some scientists seem to prefer to stay in the 'black box' of their professional expertise; by contrast, some acknowledge their role as citizens in addition to their professional status. This may help them to engage with the diversity of affected groups better. There are also significant divides within science – different disciplines have widely varying approaches to particular questions and problems.

Indeed, the very idea that conversations and communication about science and technology issues are essentially between scientists and publics is questionable. Research such as that reported in this brochure by Mary Ebeling shows that there are many different interests at stake in communicating scientific knowledge, in addition to scientists and lay people. Such groups include:

- the business and financial sectors, which are deeply invested in the successful public uptake of scientific knowledge and technological innovations
- religious organisations, which are either challenging the scientific methods for building knowledge and theory (eg creationists who challenge evolutionary theory) or that have interests in the outcomes of science communication and debates (eg those for/against stem cell research)
- politicians who see the potential of a positive public understanding of science in terms of economic growth, or who become influenced by one or other interest group.

The contexts and technologies available to those who wish to stimulate science communication are multiplying with the proliferation of media. The rise of mass media, particularly television and now digital/web technologies, has made available scientific knowledge on an unprecedented scale. This has provided expanded opportunities for learning but is also challenging sites such as museums and zoos to engage their visitors in more exciting ways, often involving virtual technologies as well as live exhibits.

This document looks at the different ways in which social scientists have been re-thinking science communication and the role of science in society in recent years.

It draws throughout on research conducted by the ESRC Science in Society Research Programme. The findings of individual research projects are summarised, and a number of strong conclusions emerge.

Cross-Cutting Themes

Three cross-cutting themes emerge from the Science in Society Programme's research on science communication:

- engaging science and other knowledge
- science communication as training and education
- new ways and places for communicating science.

All of these themes are characterised by complexity and uncertainty – in the topics that science is trying to grapple with, the social contexts in which it is being discussed, the different ways that might be adopted for communicating science, and the science itself.

Engaging Science and Other Knowledge

Public engagement with science and technology has two principal dimensions. First, there is what Stirling (2005) calls 'the social appraisal of science and technology'; this involves public engagement in the governance of science and is addressed in the companion brochure on Science in Governance and the Governance of Science.

Second, there is what has been termed 'new knowledge production' (Nowotony, Scott et al. 2001). Some of the research projects reported here, such as those by Forrester and Longhurst, were more closely involved in investigating and taking forward this second type – public engagement *in* science and the creation of new knowledge – and the communication challenges involved.

"How can different people's local 'unscientific' knowledge be compared and used?"

But the record of this kind of communication has been, at best, patchy:

- In the UK Foot and Mouth crisis there was good communication between scientists and policymakers but relatively poor public communication – while the scientists communicated the uncertainty in their advice well, policymakers did not do so well in their public pronouncements, conveying an inappropriate level of certainty.
- In the field of urban transport, the public has communicated relatively well to policymakers (eg the fuel protests). However, there has been relatively poor expert-to-policy communication – for example, policymakers are not getting clear advice from city network managers, traffic engineers and transport planners about their inability to cope with numbers of vehicles on our roads.
- The topic of pollutants and health has seen relatively poor communication all round, partly because those with different types of expertise do not communicate well with each other.
- Climate change has recently suffered a different kind of communication problem as some commentators believe that we are in danger of sensationalising the issue, accusing the media of 'climate porn' – each new report on the topic has to be more extreme than the last in order to sell copy, or to satisfy what are perceived to be people's jaded appetites.
- Good communication all round is hard to find but one example is that of CFCs and the creation of the Montreal Protocol to protect the ozone layer, and the associated high profile publicity campaign to explain why it was needed.

The first two projects reported here looked at ways in which local knowledge – of residents for example – can be brought together with technical or scientific knowledge to inform official policy-making. What sort of methods could be used? What were the outcomes? How can different people's local 'unscientific' knowledge be compared and used? These questions are addressed below. The research shows that these questions raise considerable challenges for official bodies that try to adopt a more consultative style of policy-making: this is as much a cultural challenge for organisations as anything else, but it also raises the need for new skills and ways of working.

Project: Consultation as Science Communication? The Case of Local Air Quality Management

Professor James Longhurst and his colleagues looked at local air quality management in the UK as an example where public consultation has become part of the policy process. Indeed, consultation is now required by law of local authorities when they are developing their local air quality management plans.

It is clear that local authorities pay attention to the need to consult internally. This is particularly relevant in the context of the general move towards 'joined-up government' and multi-agency planning and is especially necessary when dealing with cross-cutting environmental risks. Most authorities also consulted both expert statutory bodies and non-statutory stakeholders such as local community groups. However, there is a bias towards engaging with formal, institutional, and expert consultees.

Local authorities also lack experience and expertise in consultation. This is perhaps unsurprising given that the key department involved in managing local air quality – environmental health – is expected to perform a wide range of roles. The legislation does not provide guidance as to how this should be done. Local authorities find it difficult to embed the results of community consultation into their decision-making. A core concern was how best to record stakeholder responses, and how much weight to give particular responses. Furthermore, local authorities had difficulties in eliciting responses from non-statutory consultees; overall, community response rates were poor.

Given these facts, it is difficult to assess the precise extent to which stakeholder views are being integrated into Local Air Quality Management (LAQM) decisions. Consultation strategies are rarely evaluated by the local authorities themselves.

There is a broad spectrum of views on the merits of consultation among the local authorities, although the research found a general bias towards dissatisfaction with the process. This is significant in a situation where there are concerns about whether consultation unduly raises expectations about what LAQM can achieve. Does LAQM consultation constitute a real engagement of expert and community concerns, or is it a 'tick-box' exercise?

"Effective consultation results from a set of linked factors"

Effective consultation results from a set of linked factors. These include a well-informed and adequately resourced local community and an explicit connection between processes for participation and those used for making decisions. Consultation works best when informal non-statutory community networks are empowered to interact with formal statutory institutional networks, and this interaction can be enabled by skilled local advocates. This process works well when it is carried out over a reasonably extended time frame. Broad consultation may well need to be supplemented by input at a higher decision-making level.

Project

Consultation as Science Communication? The Case of Local Air Quality Management

Professor James Longhurst, University of the West of England

Local authorities are now required to hold consultations to review and assess local air quality management processes. How do stakeholders involved in these consultations experience and interpret the process? How can the consultations be improved, for both the local authorities and the public participating in them?

This research investigated these consultations and their effectiveness as a science communication tool. It found that:

- although local authorities tend to engage in two-way dialogue with statutory consultees (such as expert bodies) and other departments within the local authority, when it comes to dealing with the public, one-way information-provision strategies dominate
- local authorities find it difficult to embed the results of community consultation into their decision-making. A core concern was how best to record stakeholder responses, and how much weight to give particular responses.

http://www.sci-soc.net/SciSoc/Projects/Communication/Consultation+as+science+communication.htm

Moving from a project looking at the official processes used to manage air quality in the UK, the next project focuses upon how one Air Quality Management Area (AQMA) was established and consulted over in the city of York. Here, the emphasis was less on asking about the degree and type of consultation, and more on analysing what happened when attempts were made to bring lay perspectives in contact with the official process for assessing air quality.

Project: Public Involvement, Environment and Health: Evaluating GIS for Participation

How can the knowledge of non-scientists be brought together with scientific knowledge for use in policy decisions? One way is to develop Geographic Information Systems (GIS) through participatory mapping. While local authorities often conduct technical assessments of local air quality, residents and other stakeholders often have relevant knowledge and concerns that do not show up in these assessments but are based in their day-to-day experience of the local area. An assumption behind this approach is that GIS can assist in finding out what citizens already know, what information they need in order to make informed judgements, and that these judgements can be fed into policy making.

With the co-operation of the City planning officials, Dr John Forrester and colleagues engaged local residents in York in describing their experiences of local environmental issues and recording them on local maps. They focussed specifically on the effects of traffic on levels of air pollution and local people's concerns with congestion, safety, and noise (Cinderby and Forrester, 2005). Some of these consultations identified areas where the officials had not expected pollution to be particularly high but where local concerns were raised. Here, the officers found the detail of local knowledge useful and used it to site air quality monitoring devices. Otherwise, the mapping exercise largely confirmed that areas that the officials had identified as having the worst air pollution problems were also the areas that the public thought were worst. This suggests that the science is both reliable and socially robust.

A political decision was made to use the air quality management area suggested by the map outputs of participatory mapping groups rather than those based on technical assessment alone in the designation of the city's air quality management area. Thus, it can be argued that the 'new' knowledge superseded the technical assessment alone and in this case lay knowledge did not defer to scientific knowledge.

The significant convergence between local experience and technical models, provided useful cross validation of the two approaches. They also found that the GIS information helped scientists and policymakers to interpret lay knowledge and feed it into recommendations for action (Cinderby and Forrester 2005). It also assured community members that their knowledge and perspectives were being taken into account and used side by side with scientific knowledge.

Thus, the project was able to produce 'reliable knowledge'– that is knowledge that is both scientifically accurate but also 'socially robust' (Gibbons 1999, Gibbons *et al.* 1994). It demonstrated that it is possible to bring together very different forms of knowledge to create a common understanding of a problem.

However, there is little evidence for this experience from York being replicated elsewhere in the UK. This seems to be the case even in the field of air quality which, as Cinderby and Forrester (2005) note, is an area where technical and lay understandings of the issues are close, and there is little contention over what constitutes poor air quality and what is good. The finding that this research led to an atypical involvement of lay people in science policy decision-making is reinforced by Longhurst (above) and also by others (Petts and Brooks 2006). These research results suggest that while communication may be feasible between technical officers and policymakers or between technical officers and the public, it may be more difficult to engage all three parties simultaneously. In other words, there is sometimes dialogue but seldom 'trialogue'.

Project

Public Involvement, Environment and Health: Evaluating GIS for Participation

Dr John Forrester, University of York

It is frequently claimed that better public involvement with science and science policy can give more trusted and more applicable policy results as well as better and more trusted science. Yet practitioners in the field of the public understanding of science have identified problems that can arise when non-scientists hold naive understandings of science, and when naive sociological accounts are applied by scientists to complex social situations.

This research found that:

- geographical information system mapping helps scientists to interpret local people's knowledge. It also helps lay participants to feel that their knowledge is being taken into account and used side by side with scientific knowledge

- it is possible to create a common understanding of a problem as a basis to bring together different forms of knowledge and feed this combined knowledge into policy recommendations.

http://www.sci-soc.net/SciSoc/Projects/Communication/Public+involvement+environment+and+health.htm

Participation does not of itself confer public legitimacy on scientific controversy and debate: despite greater consultation and some participatory processes, there is little evidence of policy being informed by public perception. An exception to this is probably the Stewart committee's recommendations on the siting of mobile phone masts, which acknowledged that their location could have damaging psychological effects on local people, despite its view that there was a lack of evidence for any physical effects. Its response was to advocate a precautionary approach, in which planning rules were tightened, for example on the siting of masts on schools; government subsequently required more consultation with local people.

Precaution is a knotty problem, however. Where does one draw the boundaries of evidence and danger? When is it possible to act? Whose knowledge should be brought to bear? One of the powerful insights from social science in this area has been about the significance of 'framing' – the ability of certain groups to set the framework within which debate and the collection and consideration of evidence takes place. One example of this is the debate around the causes of breast cancer.

Project: Divided We Stand: Bridging Differential Understanding of Environmental Risk

The incidence of breast cancer has increased dramatically; in the UK, the lifetime risk for women is now one in nine. Some scientists argue that breast cancer may be increasingly common because of the increased exposure to a number of environmental chemicals. This claim has been taken up by campaigners in the US and the UK, urging better health protection by governments. Most health policy, however, reflects the mainstream scientific view that there is insufficient evidence that chemicals in the environment are related to breast cancer.

In this research, Laura Potts and colleagues wanted to identify the barriers to participation and exchange in this debate, and to understand what kind of evidence the different communities of interest find convincing about the causes of breast cancer. She found that a precautionary approach to possible breast cancer hazards has been given little prominence, despite being developed and promoted by some well-organised groups of concerned citizens and scientists.

What is the best course of action when the dominant scientific discourse about a particular health problem conflicts with the concerns and perspectives of lay populations? Here, the researchers aimed to create opportunities for stakeholders to engage as equal participants in debate on this controversial issue. Among other things, the researchers brought together players from these different groups in a national hearing

"Differing understandings of risk are shaped by stakeholders' ideological standpoints and their interests"

at the UK House of Commons. Those involved included health professionals, policymakers, 'lay' people (including women with breast cancer), and members of health and environmental Non-Governmental Organisations.

Possible explanations of the increased incidence of breast cancer and its highly complex origins include:

- genetic factors
- hormone factors such as HRT and the contraceptive pill
- smoking and drinking alcohol
- eating dairy products
- contact with artificial products such as plastics and pesticides, and
- the relation between the immune system, stress and the environment.

Difficulties in finding out what caused breast cancer are compounded by a lack of comparable studies and controls, and differing interpretations of the same data. The research found that there was little consensus on the direction and priorities for further investigation, which highlights the deeply divided nature of the debate. What is more, while the UK Government has seemed willing to engage the public over topics such as the safety of mobile phone masts and Genetically Modified (GM) foods, it has seemed less willing to generate a debate about the causes of breast cancer. Despite the lack of consensus found by the research project, the government's position is that the evidence about breast cancer does not justify concern about environmental factors.

But critics of the government's approach ask: 'What counts as good enough evidence?' Epidemiology, the study of the incidence and distribution of disease in populations, would usually be regarded as the main source of information in such a case. The opinion of those consulted during this research was divided about whether the science of epidemiology was yet able to provide adequate answers. Some participants questioned the validity of the studies conducted so far – most of which have focussed on blood samples rather than breast tissue and fat, which, it can be argued is a more relevant focus for this problem.

The researchers point to possible parallels with the BSE crisis in the 1980s and 1990s, where governments denied the existence of a problem, and pointed to 'science' as evidence to back this position. With breast cancer, some activists believe that the government is now denying the existence of clusters of cases, despite some evidence from the minority of studies that have analysed breast fat. Some respondents talked of 'cover-up' and people 'hiding behind barricades'.

Some public health specialists seem to concur with the activists view, although the researchers often noticed a difference between what people were prepared to say in private and what they would say in public – professionals were concerned that involvement in controversial debate could compromise their professional and career prospects in terms of funding, promotion and professional acceptance.

This is also a further example of the confusion of the 'lay-scientist' boundary touched on elsewhere in this document; alliances between the various communities of interest involved in this topic are not, as is often assumed, organised primarily along professional/lay lines, nor along lines of particular expertise. For example, some experts feel that there are strong environmental explanations for the causes of breast cancer while others even from the same area of expertise do not. Further, shared ideology – the ideas that people use to make sense of society and their role in it – was found to be more predictive of alliances between participants in the hearings than their identity as scientist or activist, for instance.

This research indicates that these differing understandings of risk are shaped by stakeholders' ideological standpoints and their interests. The ability of science to provide adequate, relevant evidence to inform such debates can be constrained by the way in which other players 'frame' the question in hand.

Divided We Stand: Bridging Differential Understanding of Environmental Risk

Laura Potts, York St John College

Exposure to environmental chemicals is perceived by several groups in the public to increase the incidence of breast cancer, but this view is not prevalent in the mainstream science community or among policymakers. What can be done to reconcile these differences in the understanding of environmental risk?

This research found that:

- a precautionary approach to possible breast cancer hazards has been given little prominence, despite being developed and promoted by some well-organised groups of concerned citizens and scientists
- differing understandings of risk are shaped by stakeholders' ideological standpoints and their interests
- the ability of science to provide adequate, relevant evidence to inform such debates can be constrained by the way in which other powerful players 'frame' the question in hand.

http://www.sci-soc.net/SciSoc/Projects/Communication/Divided+we+stand.htm

"Scientific and technical communication is increasingly part of the training of a variety of professionals"

Science Communication as Training and Education

Scientific and technical communication is increasingly part of the training of a variety of professionals including in medicine and engineering. What priorities are set for such education, how does this come about, and what are the wider social consequences? The formation of disciplinary identities and priorities can have profound effects on both the practices of trained scientists and engineers and the role that these experts imagine themselves to have in society.

Project: What Does Social Change Mean in the Context of Engineering Education

This research, conducted by Dr Jane Pritchard, was rooted in the idea that engineers, in seeking to solve a variety of significant problems are broadening their focus from narrow technical fixes – the *technofix* solution to social problems proposed by Weinberg in the 1960s (Weinberg cited 2002) – to encompass broader social and technical perspectives. Thus this project addressed the question raised in the Science in Society Programme specification, "What does it mean to solve human problems through science and technology?" What are the real problems we are trying to solve with 'engineering and science solutions'?

Often projects that are aimed at alleviating poverty ask questions of new technological developments that the world's rich do not consider important or appropriate. With many people around the world continuing to die from lack of clean water and food, what can engineering do to contribute to a socially just future? By contrast, what are the impacts on society of the increased need (or perceived need) for such devices as MP3 players and mobile phones? The education of engineers rarely seems to question the wider context within which those engineers will work, yet such a process could lead to engineers contributing to society in a more reasoned manner than at present. This research asked:

- How does engineering education promote social change and social justice?
- How can engineering education be made more socially robust and more relevant to social needs?
- Who decides what our engineers learn and what influence does this have on society?

The main emphasis of the work was to look at engineering education at universities and consider how it can promote social change. This project explored what engineering education meant to engineering academics, and what were their perceptions of social change and social justice in the light of their curriculum. The obvious answer from many is to work on development projects for charities or non-governmental organisations concerned with developing nations.

This project uncovered differences in responses to these questions from engineering faculty in the UK, Canada and Sweden. In all three countries the role of engineer and the rules governing curricula differ. This work also revealed that most academics considered social responsibility to be outside the remit of engineering (education). So whose responsibility is it? Should science and engineering education be without a responsibility to the wider social context? Should such responsibility be the bastion of the sciences, or should all education be aimed at global social justice?

PROJECT

What Does Social Change Mean in the Context of Engineering Education?

Dr Jane Pritchard, University of Glasgow

Who decides what engineering undergraduates are taught? How does this affect the ideology and worldview that engineers bring to their work, and what influence does this have on society?

This research looked at university-level engineering education in Canada and Sweden as well as the UK. It found:

- most faculty considered that social responsibility and the notion that artefacts – the things that engineers will ultimately produce – have politics to be outside the remit of engineering and engineering education
- that it was difficult to locate social responsibility in the field of engineering. Engineers were divided about whether science and engineering education should have a responsibility to the wider social context.

http://www.sci-soc.net/SciSoc/Projects/Communication/What+does+social+change+mean+in+the+context+of+Engineering+education.htm

Project: Deliberating the Environment: Scientists and the Socially Excluded in Dialogue

Dr Derek Bell and his colleagues explored the use of one-to-one exchanges between lay people and scientists. During these exchanges, participants discussed a range of environmental problems. The aim was to understand how scientists discuss such challenges with non-scientists and how lay people respond when they have the opportunity to enter into debate directly with scientists. The research asked:

- What communication strategies do scientists adopt, and which ones work best?
- How do personal motivations and characteristics affect such exchanges?
- How do the scientists think about science and other forms of knowledge when they are discussing environmental issues as citizens?

In this structured yet relatively informal context, where scientists were being asked to talk about subjects on which they were often not experts, with non-scientists whom had not met before, so the scientists had to construct their own role.

Some scientists, at least part of the time, took on the role of 'science communicator' – they were consistently willing and able to engage in science explanation across a range of issues. These scientists drew extensively on their own research and teaching supplemented by broad knowledge of environmental science and policy.

By contrast, other scientists deliberately avoided 'talking science'. They restricted themselves to discussing 'the issues' with the non-scientists and did not draw on their own research experience. These 'issues-only' scientists offered various reasons for their approach: they didn't want to set themselves up as an academic expert; they wanted to avoid technical language that their partner would find alienating and impenetrable; and they wanted their partner to see them as an equal, not as dominant or patronising.

For the 'science communicators', being seen as an 'expert' did not have the same negative connotations. Moreover, they were more confident about talking science without being patronising or using impenetrable language. There were many reasons for these differences in attitude but one striking difference between the 'science communicators' and the 'issues-only' scientists was their conception of the nature and difficulty of science. For the 'science communicators', science – or, at least, relevant environmental science – was not that special: it was more systematic than lay knowledge but not that difficult to understand. The 'issues only' scientists had a more esoteric conception of science, which may have discouraged them from trying to talk science to the non-scientists.

The non-scientists responded quite positively to all of the scientists irrespective of their approach. They did not feel that any of the scientists had either patronised them or been too technical. Their most positive reactions were to those two scientists who made most effort to find and develop common interests. Both of these scientists had considerable experience of public engagement but they also identified with their exchange partners. They were willing and able to draw effectively on their own lives as 'non-scientists' (eg as parents, partners, working class people, concerned citizens, confused 'green' consumers) to make a connection with their exchange partner and promote conversation.

The combination of a willingness and ability to talk science and to draw effectively on common roles and experiences was uncommon in the study – only one scientist. However, all of the scientists did enough in the exchanges to help break down some of the non-scientists' preconceptions of 'the scientist'. The non-scientists talked less than the scientists and often deferred to their 'superior' knowledge (even when the scientists were talking about issues far beyond their research specialisms) but the non-scientists were rarely silenced or overawed. Indeed, most of the non-scientists reported growing in confidence during the study. In sum, the one-to-one exchange provides a context in which mutual trust can be promoted quite quickly and scientists have the opportunity to encourage two-way communication by being 'people' as well as 'scientists'.

Deliberating the Environment: Scientists and the Socially Excluded in Dialogue

Dr Derek Bell, University of Newcastle

This project explored one-to-one conversations between scientists and lay persons as a method of mutual learning between the two groups. Pairs made up of a scientist and a non-scientist were asked to work together to address issues to do with the environment.

The project found that:

- some scientists were consistently willing and able to engage in science explanation across a range of issues. By contrast, other scientists deliberately avoided 'talking science'. They restricted themselves to discussing 'the issues' with the non-scientists
- sor the 'science communicators', science was not that special: it was more systematic than lay knowledge but not that difficult to understand. The 'issues only' scientists had a more narrowly-focussed view of science, which may have discouraged them from trying to talk science to the non-scientists.

http://www.sci-soc.net/SciSoc/Projects/Communication/Deliberating+the+environment.htm

"Exhibitions and museums have long been a method for making science accessible to the public"

New Ways and Places for Communicating Science

Many of the parties involved in science communication have expressed a desire to engage the public with science in new ways. This wish to enhance debate about advances in science and technology provides opportunities for those people and places that are already involved in communicating about science, such as museums and zoos.

At the same time, people are becoming more sophisticated in their use of media. As well as the proliferation of more familiar media such as television and radio (the rising number and diversity of channels), people are also taking to newer media that allow them to take an active part, such as the web, mobile phones, interactive gaming, and blogs.

The explosion of new media raises numerous challenges for designing effective exhibits for communicating science. Some can be expensive both to set up and run, especially those with interactive elements. And there are often conflicting ideas about audiences:

- How is it possible to capture the attention of people who are themselves prolific communicators?
- Do people now have shorter attention spans, or do they just expect more?
- Who is the key audience and what are the most effective means to reach them?

Where previous research on science communication has focussed on the producers of messages, and to some extent the messages themselves, today the emphasis is on how the messages are received in complex social contexts.

But even this account is to fall back to models that describe communication as the transmission of messages from one 'point' to another; at least as important to researchers now is the whole question of how messages and meanings are re-interpreted, transformed, or contested by so-called 'consumers'; consumers must now be regarded, at least in some respects, as producers themselves.

Signing In, Signing Out? Communication and Context

It is now widely recognised in the social sciences that the meaning of all manner of communications and signs varies according to the context. These contextual influences range from the immediate 'physical' or spatial characteristics of the setting in which the communication is taking place, to social and historical aspects such as age, gender, class, ethnicity and education.

For example, in the project described in pages 38 to 39, Dr Nils Lindahl-Elliot gives several examples of people visiting a zoo. In one he writes that:

A family reaches the Lemur enclosure and one of the children starts tapping on the glass. He does so despite the fact that he is standing in front of a large sign that says 'Please don't tap on the glass'. The parents are embarrassed that the child has contradicted the instruction. However, it becomes clear when they ask him to stop that he has only read the bottom part of the sign, which, from his height and angle of viewing, seems to say 'tap on the glass'.

Here we can see that communications can easily be read quite differently by different people. This contradicts the idea of an 'ideal sign' or piece of communication, which abstracts from the question of context. It forces us to go beyond stereotypical notions of 'the visitor' or the 'average visitor' and to engage with different people in different ways.

This perspective should also encourage those who are designing different types of science communication to allow for different levels of reading – younger and older readers, signs at different heights, but also different kinds of information – scientific, geographical, historical, and also some aimed more specifically at being fun.

Exhibitions and museums have long been a method for making science accessible to the public. Far from being stuffy and behind the times, many have embraced new technologies in their search for ways to excite and engage visitors – museum managers are well aware of the need to compete with other media such as television. Research within the Science in Society Programme has examined the use of multi-media technology in museums.

Project: Communicating Science Through Novel Exhibits and Exhibitions

Science centres and museums have become critical resources to communicate science to the public and engage people in discussion about scientific and technological developments. In recent years, new funds have been made available to support and renew the existing network of science centres and museums in the UK and abroad, and to search for novels ways to engage the public.

In this research, Professor Christian Heath and colleagues are seeking to understand how new exhibits and exhibitions are designed and developed, and how people interact with them and around them. Through interviews with designers it is apparent that they frequently focus on creating an experience for an individual visitor and thus neglect the fact that people mostly examine exhibits in interaction with others – both their companions and those who happen to be nearby.

Using both audio and video, the researchers have been recording how people interact with exhibits and with each other in science centres and museums in both the UK and the US, including the Science Museum London, Explore@Bristol and the Exploratorium in San Francisco. The research shows that individuals learn to manipulate and make sense of exhibits through hands-on exploration but also through imitation of other people's actions. Some visitors also 'perform' around exhibits in order to gain and sustain the attention of the people around them.

This social interaction is now being altered by the introduction of new multi-media guides. Museums have a long tradition of being pioneers in the use of novel technologies. For some time, they have relied on electronic audio guides such as portable tape and CD players. Today, multimedia-mobile devices like Personal Digital Assistants (PDAs) are increasingly popular with museum managers because they offer more flexible ways to interact with visitors by combining text, audio and video content, and by being able to adapt automatically to the specific needs, context and location of individual visitors.

Despite their flexibility in providing information and thereby enhancing the individual's engagement with particular exhibits, it is increasingly recognised that multimedia mobile guides often do so at the cost of impoverishing collaboration between visitors. People often come with companions to a museum and try to co-ordinate their exploration and examination of exhibits and information resources with each other.

The researchers observed that in many cases, visitors develop a curious division of labour, one participant attending to and voicing the information delivered by the multi-media guide, the other viewing the original object and articulating their discoveries. When all members of a group use a PDA they either separate for the duration of their visit or try to synchronise the information delivery by the system; they attempt to press the 'play-button' at the same time or may look for possibilities to connect multiple headphones to one device.

In many cases, visitors' attempts to view a museum collaboratively fail when they use novel digital resources. They give up either the device or the interaction with others. This research therefore challenges the use of these technologies and the people who are developing them – museum managers and designers – to take into account a these sorts of design sensitivities that until now seem to have been overlooked (Lehn, Heath et al. 2005).

PROJECT

Communicating Science Through Novel Exhibits and Exhibitions

Professor Christian Heath, King's College London

As the network of science centres and museums in the UK expands, managers and designers are developing new and different exhibitions, programmes and formats to try to encourage people to engage with science and to stimulate discussion and debate.

This research found that:

- museum designers frequently focus on creating an experience for an individual visitor and thus neglect the fact that people mostly examine exhibits in interaction with others
- in many cases, visitors' attempts to view a museum collaboratively fail when they use novel digital resources provided by the museum, such as mobile PDAs. They give up either the device or the interaction with others. The research challenges the people who are developing these technologies to take into account these sorts of design sensitivities.

http://www.sci-soc.net/SciSoc/Projects/Communication/Communicating+science+through+novel+exhibits+and+exhibitions.htm

"Many visitors expect zoo displays to look like 'nature'"

Zoos are another location for science communication. But what methods of communication are available to zoo managers, which do they choose, and what is the impact on visitors?

Project: The New Zoos: Science, Media and Culture

Dr Nils Lindahl-Elliot investigated how two zoos, the Bristol Zoo Gardens and the Paignton Zoo Environmental Park, are re-thinking their science and environmental education. Both have played an active role in the contemporary trend towards environmental education in zoos, as well as the search for new forms of display. These included what zoo curators describe as 'naturalistic' and 'immersive' forms of exhibiting wild animals.

The research investigated the changes associated with this trend by looking at three related aspects:

- the zoos' educational strategies, and their ways of structuring how visitors are able or encouraged to observe the animals and their enclosures
- visitor responses to the zoo displays
- the relationship between these two aspects and the mass media.

One of the main findings of the project was that the displays, and visitors' responses to the displays, tended to be based on one or more of the following modes of observation:

1. Predominantly visual modes where displays simulate, or appear to simulate, some visual aspect of the animal's original geography. More often than not, the frame of reference of this form of observation was found in wildlife documentaries on television.
2. Modes that focussed on the explanatory/educational signs, which were themselves based on a variety of popular forms of natural history.
3. Modes that involved visitors in sequences of actions and reactions, and that might also involve the sense of touch, smell, sound or in some cases, a very close proximity to the animals on display.
4. Modes in which the visitors engaged relatively explicitly in what the research described as the circuit of anthropomorphism and cosmomorphism: the visitors tacitly 'humanised' the animals on display by describing them in familiar terms ('That's the daddy lion'), even as they 'animalised' themselves by imitating the animals, or likening family members to one or more species: 'Daddy is a gorilla'.

The research revealed that whilst one of these modes was likely to be predominant in any given display's design (or in a given visitor's way of relating to a display), two or more modes might interact in any given display. Whereas a majority of the exhibits at the Paignton Zoo were more strongly structured along the lines of the first mode, the Bristol Zoo's displays were more strongly structured along the lines of the third mode.

Whilst a majority of the visitors stated a preference for displays structured on the basis of the first mode, their actual interactions with displays tended to privilege the third and fourth. This finding revealed that while the visitors might consciously prefer displays that 'looked natural' – where 'the natural' tended to be interpreted with reference to the images of nature found in the mass media – their actual ways of relating to the displays privileged displays that were more explicitly 'interactive' and 'anthropomorphic'.

These findings suggest that while zoos have taken significant steps to transform the ways in which they attempt to engage in environmental education, they face a somewhat contradictory challenge: on the one hand, many visitors expect zoo displays to *look* like 'nature', ie the nature seen on television. But at the same time, many visitors' actual ways of observing the displays confound this trend insofar as they seek closer, 'multi-sensual' and explicitly anthropomorphic encounters with the animals on display.

PROJECT

The New Zoos: Science, Media and Culture

Dr Nils Lindahl-Elliot, School of Cultural Studies, University of the West of England

Over the last 20 years, zoos have responded to animal rights concerns and changing concepts of what zoos are for by presenting themselves as places to learn about conservation and the environment, with corresponding changes to exhibitions.

This project looked at how families interact with the new style of exhibitions at Paignton Zoo Environmental Park and Bristol Zoo Gardens.

The researchers found that:

- exhibits either present the animals in a 'natural' setting, or allow greater interactivity, proximity to the animals, and/or multi-sensory features
- although people stated they preferred to view animals in 'natural' conditions, they actually preferred exhibits that allowed them to interact with the exhibit in some way.

http://www.sci-soc.net/SciSoc/Projects/Communication/The+new+zoos.htm

"The uncertainties and ambiguities inherent in science and technology deeply affect the communications related to them"

Helpful Ambiguity

Research also indicates that the uncertainties and ambiguities inherent in science and technology deeply affect the communications related to them. For example, in the field of nanotechnology, there are definitional problems and debates about what constitutes the label 'nanotechnology'. How nanotechnologies are defined will depend on who the actor is and what their interests are:

- as a scientist entrepreneur commercialising a nanotechnology developed from years of research
- as a public relations agent seeking to create a news market for nanotech
- as a private equity investor seeking to capitalise on the buzz around a novel and emerging technological sector
- or as a financial journalist who is sifting through and trying to make sense of the technical and financial claims being made by their sources.

Within the emerging commercial field of nanotechnologies, there are ongoing debates over which companies can call themselves 'nano-companies' and what technologies are considered truly to be nanotechnologies. Yet at the same time, people tacitly quantify the field as a single, bounded, investable market by employing projections of enormous returns for investors. Mary Ebeling's research investigates the ambiguity involved in this case of science communication.

Project: Spinning Science: the Nanotech Industry and Financial News

Imagine receiving a glut of messages all claiming that the next big money maker for investors is based not on some product that already exists or is ready to go to market, but rather on technologies that are still in the lab and will not be marketable at least for another five years. The projected market will be worth more than $1 trillion in the next decade, you are told. Such messages are coming from the financial news media, from your stockbroker, from individual companies and from the government.

In this research, Mary Ebeling asked how companies that are developing nanotechnologies communicate the financial risks and potentials through the financial media to investors. Most people working in the nanotech field are aware that over hyping the financial potentials of nanotechnologies could have detrimental consequences for the market and in turn, put their investments in peril; the spectre of the dotcom crash looms large. Nevertheless, due to pressures to create a market or to not miss an investment opportunity, many are compelled, and with much reluctance, to engage in hype around nanotech on some level.

Investors need to decipher these messages and separate hype from the more realistic expectations of the value that nanotechnologies can bring to an investment portfolio. Financial institutions and private equity investors play a crucial role in supporting the development of new fields such as nanotechnology. Investors have to decide not only about the potential of individual technologies and companies, but also about the legitimacy and acceptability of nanotechnologies as a whole – and therefore the likelihood of achieving returns on investments in the sector.

Nanotech start-up companies are those with the most invested in the successful commercialisation of nanotechnologies. These tend to employ communication strategies that while acknowledging public ambivalence towards nanotech and addressing concerns around its perceived risks, ultimately serve to drive the public, and especially the investing public, towards acceptance.

Two developments are making it more important to understand how media messages and financial risk communication influence stock prices and markets of high-tech companies: scientists are being groomed to become more 'media savvy'; and companies are employing sophisticated media strategies to control their messages. Some have even created their own journalism schools to groom journalists to be sympathetic to their messages – similar to the case of the US-based National Journalism Center funded by tobacco giant Philip Morris.

The research indicates that as the field is increasingly dominated by Public Relations, journalists are in a position in which, whilst they are often sceptical about the content and quality of the PR information they receive, they cannot afford to ignore this channel of communication in case they miss an important story about a new or projected application. They therefore adopt a range of practical strategies for evaluating information about new nanotechnologies, most of which do not involve direct analysis of underlying scientific claims. Assessments of financial viability are therefore often not based on informed scientific judgements.

PROJECT

Spinning Science: the Nanotech Industry and Financial News

Mary Ebeling, University of Surrey

How do companies that are developing nanotechnologies communicate the financial risks and potentials through the financial media to investors? Most in the nanotech field are aware that hyping the financial potentials of nanotechnologies could have detrimental consequences for the market; the spectre of the dotcom crash looms large.

This research found that:

- due to pressures to create a market or to not lose out on an investment opportunity, many involved in the industry are compelled, and with much reluctance, to engage in hype around nanotech on some level
- journalists are in a position in which they cannot afford to ignore this channel of communication in case they miss an important story. Most of their strategies for evaluating information about nanotechnologies do not involve direct analysis of underlying scientific claims.

http://www.sci-soc.net/SciSoc/Projects/Communication/Spinning+Science.htm

Conclusion

As science and technology become ever more pervasive in our lives, people have come to realise that we face choices over the directions they take. Science and technology cannot be viewed as neutral forces in society. Instead, we need to see them as political, since science and technology have substantial impacts on the ways we live and on how society is organised. Science and technology therefore need to be the subject of political debate and political choice. We all bear responsibility for this. It is not a simple matter of 'communicating' science to a more or less receptive 'audience'.

Indeed it is valid to question whether science has ever truly been considered neutral and apolitical. Early examples from the history of science, including the work of Galileo, Copernicus and Darwin for example, show how science and scientists have often been involved in debate and controversy. Nevertheless, the frequent contemporary appeals to 'sound science' as the basis for policy decisions often give the impression that science can be an objective force unaffected by social interests.

This again raises questions about how science is interpreted and utilised in addition to questions around communication. Science cannot cut through the Gordian knot of conflicting values in the policy arena.

These challenges are central to the task of re-thinking science communication. Due to the complexities involved, science and technology are frequently thought of as topics that only experts can analyse and advise on. But the stakes attached to scientific and technological advances are growing, such as the potentially huge sums that may be invested in areas such as nanotechnology. This requires many people beyond the world of science and technology to develop mechanisms for gathering intelligence, and making decisions, on science and technology.

"When it comes to science, only certified practitioners seem to be recognised by government, the media, and scientists themselves"

Connoisseurship and Engagement

The increased power of science and technology suggests that democratic governance in today's world requires a public capacity to engage critically with science. A Science in Society Programme workshop focussed on the observation that science appears to be highly unusual in that it is one of the very few areas of human endeavour in which society does not seem to recognise the existence of non-practitioner expertise. In art, literature, food, wine, sports, etc most of us rely on critical judgements made by critics, connoisseurs and other experts whose judgements we trust, despite the fact they clearly could not personally perform the activity in question with any degree of competence. Yet, when it comes to science, only certified practitioners seem to be recognised by government, the media, and scientists themselves. This is often the case even where the scientist in question is invited to pronounce on areas well outside their specific area of training and expertise. The workshop explored the possibility of popular connoisseurship of science and technology – the cultivation of non-practitioner experts who are able to make informed judgements about scientific claims, individuals and institutions (Healey 2004). In other words, debates and decisions about science and technology cannot simply be parcelled off to specialist advisory groups or committees on 'ethics'. Whether we like it or not, we are all involved.

It must be remembered that what is judged to be 'good' science is a result of battles over ideas and evidence. Attempts to create connoisseurship will be assisted by a growing awareness of the philosophy and sociology of science: what is good science practice? What is good evidence? What makes a good argument? Who is making the arguments and spinning the science? In any dialogue around science, people need to be empowered to understand what is worth engaging with and why. As one author commented nearly 25 years ago, remarkably few scientists or others are trained in these aspects of scientific enquiry (Richards 1983), and there is little evidence that anything has changed since.

Both scientists and non-scientists can gain from engaging with each other, but scientists need to acknowledge that these engagement processes are not purely about achieving acceptance for the latest piece of science or technology. Instead, engagement may introduce some difficult challenges to standard assumptions about the rate and direction of developments in science and technology, and how policy for science and technology should be developed and implemented.

Equally, people bring their own knowledge and perspectives to science-policy debates. It would be counter-productive to dismiss these perspectives out of hand – for example on the causes of breast cancer or what constitutes good air quality. Instead, we need to continue to explore ways of bringing such knowledge out into the open. Of course, such knowledge, like the science, may turn out to have gaps, uncertainties and other problems, but an engaged approach is more likely to persuade people that their perspectives have at least been explored and tested. It may also help to develop the 'connoisseurship' recommended above – the ability of people to engage in robust, vigorous ways with complex scientific and technological developments that are beyond their own expertise.

False Dichotomies

Those involved in media portrayals of science- or technology-based issues also need to develop more sophisticated understandings of what is at stake. How do they report 'novel' scientific developments? Mary Ebeling's studies of nanotechnology in the financial news have shown the tendency to hype the 'next big thing'. Must journalists always dwell on either the promise of novelty or the controversial aspects?

Research is also challenging our ideas about the nature of power around the question of science communication. Frameworks that simply oppose 'expert' and 'lay' subjects, the 'scientist' and the 'non-scientist', the 'science communicator' and the 'audience' fail to address the complexity and in some cases the fluidity of social formations.

This is partly because it is impossible to think of 'the public' as one homogeneous mass; many individuals are at once both pro- and anti- particular developments in science and technology. Those who are developing pieces of 'science communication' therefore need to think carefully about their audiences and how they will receive particular messages.

Science in Context

Science discourses are always immersed in complex cultural contexts. Zoos offer a good metaphor of the 'lived' nature of science communication. Here, the communication of science takes place in contexts that are not themselves exclusively, or even primarily structured around questions of a scientific nature. For example, science on television, or indeed in zoos, is not simply a matter of 'scientists' communicating about science to non-expert audiences: the science documentary is one 'choice' more in a menu of channel options devoted to entertainment. Here, the audiences are the 'experts' as to what counts as a 'good' documentary.

Researchers therefore emphasise the importance of the context in which communications relating to science take place. But the question of context has itself also come under scrutiny. Some accounts of science communication seem to assume that contexts are relatively sealed-off entities that, in the manner of a laboratory experiment, can be studied in isolation from other contexts. But as Lindahl-Elliot states, globalisation, social mobility, and the rise of multi-modal, multi-channel media all mean that these widely different contexts intermingle. 'Science communication' cannot be separated from these developments.

"It is a myth that a picture is worth a thousand words"

Communication and Diversity

The emphasis on cultural diversity in determining the meaning of communications means that attempts at communication need to bear in mind people's different interests. In zoos, some visitors may wish to have access to relatively elaborate scientific information about species, whilst others may be more interested in the 'biographical' information of the animal itself, or cultural-historical information about the zoo. Clearly, it is impossible to cater to all preferences, all backgrounds, and all contexts of reception. But there is some scope to move from a relatively homogeneous (and homogenising) order of communication, to one that is more diverse and addresses a wider range of interests.

However, there are certainly some costs associated with the trend towards more 'popular' forms of communication, such as those that use more pictures and less text. As Lindahl-Elliot says, it is a myth that a picture is worth a thousand words. That may be true in some contexts, but one cannot explain certain ideas just by way of pictures. Communications that highlight dramatic or 'extreme' characteristics work against more subtle accounts, for example of species and their ecology. Indeed, Lindahl-Elliot's research suggests that zoos rarely try to tell stories about the complex and dynamic character of ecosystems in their displays.

However, the use of maps, visualisations and other pictorial representations has been found useful in discussions around air quality and other issues where there is a strong spatial element (Cinderby and Forrester 2005). For this reason, diversity and contextualisation of method is important. Where complex ideas need to be communicated (such as in Lindahl-Elliot's ecosystem ecology example above) over-simplification of method is not appropriate.

Challenging Science

The requirement to make decisions over complex issues such as the environment means that it is often impossible to wait for conclusive scientific evidence before acting. This raises the need to combine whatever scientific knowledge that is available with other forms of knowledge such as local knowledge that may also bring useful perspectives. This creates huge challenges of process and legitimacy. It also means that scientists and engineers need to re-think how they approach problems and how they set the agendas for their work.

Engagement will also almost certainly challenge the science community to re-visit their evidence, assumptions and how they have applied their methods. In the example of breast cancer, the complexity of the interactions of chemicals in the environment and in human bodies challenges the scientific community to come up with new ways of tracking and investigating such complex effects. It is no longer good enough to say that 'absence of evidence equals evidence of absence' – in other words, if we cannot prove something, there is nothing to prove.

Those involved with science should welcome critical involvement in scientific and technological development, rather than fearing that any criticism of science is a sign that people are 'anti-science'. After all, as Andy Stirling says, if someone criticises a particular policy, s/he is not labelled 'anti-policy' (Mayer and Stirling 2004). Instead, scientists and science policymakers need to understand public engagement with science to be what it is – complex, influenced by many factors that vary from case to case, and in many instances very positive.

Where scientific and technological developments potentially have great impacts on the future of society, it is entirely rational for people to bring wider perspectives to these debates – indeed, it is irrational to think that only scientific considerations are relevant. Scientists need to see the communication imperative as an inherent part of their work, but also to see it as a two-way process in which they will be challenged to think more broadly about the social context of science and in a more sophisticated way about the basis for public engagement with science.

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Science in Society

Research projects listed under topical themes

The Science in Society Programme is one of the ESRC's major investments and is a six year commitment running from 2002 to 2007. The Programme, originally conceived following a parliamentary report on science and technology, is both broad in scope and diverse in its research focus and has been host to 45 different research projects during its lifetime. The Programme is separated into six themes, each one acting as an umbrella for a variety of projects, all of which consider a different aspect of the science-society relationship.

Science in Governance and the Governance of Science

Social and Human Rights Impact Assessment and the Governance of Technology
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Interdisciplinarity and Society: A Critical Comparative Study
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Using Public Environmental Knowledge in Industry
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Childhood Cancer Tissue Donations: A Gift Relationship?
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Contesting Environmental Science: Business and Environmentalist NGOs
Dr Sally Eden, University of Hull *s.e.eden@hull.ac.uk*

Credibility Claims as Scientific Commodities
Dr Sally Eden, University of Hull *s.e.eden@hull.ac.uk*

Inside or Outside the Bio-science Tent? The Presentation of the Laboratory-self
Dr Lena Eriksson, research undertaken at Cardiff University – now at the University of York *le502@york.ac.uk*

Caught Between Science and Society: Foot and Mouth Disease
Dr Brigitte Nerlich, University of Nottingham *brigitte.nerlich@nottingham.ac.uk*

Public Perceptions of Risk, Science and Governance
Professor Nick Pidgeon, research undertaken at the University of East Anglia – now at Cardiff University *pidgeonn@cardiff.ac.uk*

Accountability and the Governance of Expertise: Anticipating Genetic Bioweapons
Dr Brian Rappert, University of Exeter *b.rappert@exeter.ac.uk*

Simulation Modelling of Contentious Scientific Knowledge Claims in Society
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Resolving Conflicts in Selecting a Programme of Fisheries Science Investigation
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Reproducing the Centre: Performing Innovation at Xerox PARC
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Governance and Accountability Relations in Mundane Techno-Scientific Solutions to Public Problems
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Re-modelling Science Communication

Deliberating the Environment: Scientists and the Socially Excluded in Dialogue
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Spinning Science: The Nanotech Industry and Financial News
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Public Involvement, Environment and Health: Evaluating GIS for Participation
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Communicating Science through Novel Exhibits and Exhibitions
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Experiments In Science Communication: A Pilot Study with a Digital TV Channel
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The New Zoos: Science, Media and Culture
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Consultation as Science Communication? The Case of Local Air Quality Management
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Divided we Stand: Bridging Differential Understanding of Environmental Risk
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What Does Social Change Mean in the Context of Engineering Education?
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Science in the Economy and the Economics of Science

Mobility and Excellence in Scientific Labour Markets: The Question of Balanced Growth
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The Impact of Enlargement of Scientific Labour Markets
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Work Roles and Careers of Academic Scientists in University-Industry Collaboration
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Making Science History: The Regionalisation of Science Policy
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Building Science Regions in the ERA: Governance in the Territorial Agora
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Labour Markets and Knowledge Flows in the Chinese National System of Innovation
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Issues Involved in the Diffusion of Knowledge through Migration of Scientific Labour
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The Impact of Gender Innovation on Regional Technology, Economy and Society
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Science, Technology and Globalisation

Institutional Impacts of North-South Partnerships in Agricultural Biotechnology
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Regulatory Practices and Challenges of the African Crop Biotechnology Sector
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Science, Technology and Water Scarcity: Investigating the 'Solutions'
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Childhood Vaccination: Science and Public Engagement in International Perspective
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The World Wide Web of Science: Emerging Global Sources of Expertise
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Databases, Naturalists and the Global Biodiversity Convention
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Science and Gender, Ethnicity and the Lifecycle

Boundary Work, Normal Ageing and Brain Pathology
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Public Perceptions of Gamete Donation in British South Asian Communities
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Gender Theories and Risk Perception: A Secondary Analysis
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Asbestos Diseases: Scientific Definitions and Gendered Identites
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Genomics and Society

Doing Embryo Ethics: Safety and Efficacy in Research and Practice
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Farmers' Understandings of Genetically Modified Crops within Local Communities
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Pharmacogenomics, Diagnostic Tests and Clinician Acceptance
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Science, Security and Regulation: How Effective are Export Controls?
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Dual Use Controls and Genomic Research
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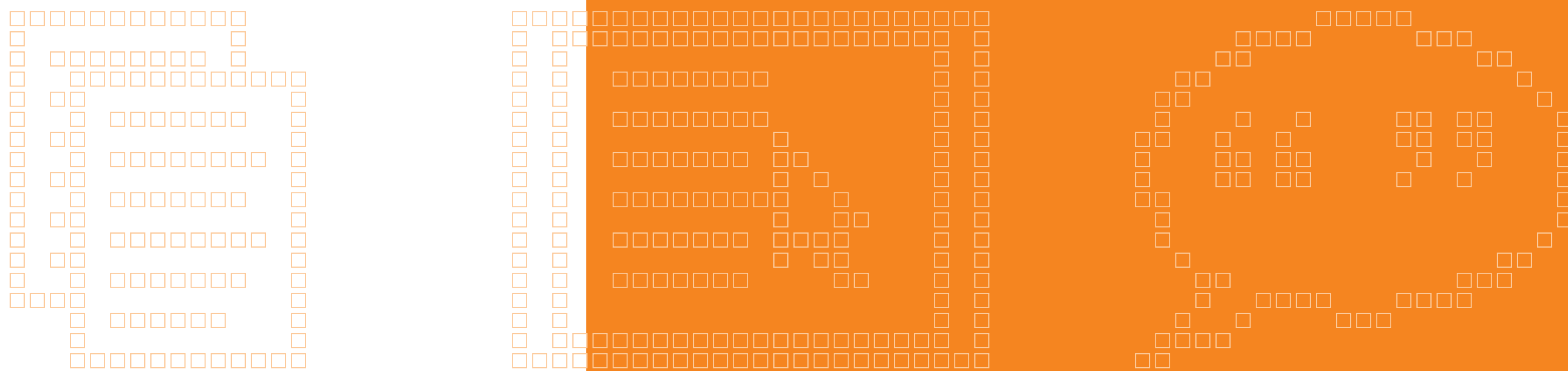

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